

A photograph of a smiling woman with a colorful patterned headwrap, wearing a white button-down shirt. She is holding a large, flat, woven tray filled with many brown eggs. The background is a rustic, wooden structure, possibly a chicken coop or a storage area for eggs. The lighting is warm and natural.

EMPOWERING SMALLHOLDER POULTRY PRODUCTION THROUGH RENEWABLE ENERGY:

Challenges and The Way Forward

February 2022



Disclaimer

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Acronyms

ACSI	Amhara Credit and Savings Institution
ATA	Agricultural Transformation Agency
CBE	Commercial Bank of Ethiopia
CSA	Central Statistical Agency
DBE	Development Bank of Ethiopia
DOC	Day-old Chick
EAFIG	Ethiopian Animal Feed Industry Association
EIAR	Ethiopian Institute of Agricultural Research
EPPPA	Ethiopian Poultry Producers and Processors Association
ESAP	Ethiopian Society of Animal Production
ETB	Ethiopian Birr
EVA	Ethiopian Veterinary Association
FAO	Food and Agriculture Organization
GoE	Government of Ethiopia
LED	Light-Emitting Diode
MFIs	Micro-Finance Institutions
MoA	Ministry of Agriculture
NPTC	National Poultry Training Center
NVI	National Veterinary Institute
OCSSCO	Oromia Credit and Saving Share Company
RARI	Regional Agricultural Research Institutes
REB	Regional Water and Energy Bureaus
SNNPR	Southern Nation Nationalities and People's Region
TVET	Technical and Vocational Training and Education
USD	United States Dollar
VDFACA	Veterinary Drug and Feed Administration and Control Authority



Executive Summary

The poultry sector, which mainly includes the production of chicken meat and eggs, is one of the fast-growing agricultural sub-sectors in Ethiopia. Despite the various advantages to the masses, the sector faces several obstacles hindering its growth. This assessment identified the key challenges smallholder poultry farmers face and how to address them using solar energy interventions. The ecosystem approach was used to holistically evaluate the sector on; technology, policy, finance, linkage, and capacity building. To conduct the assessment: primary data collected from poultry farmers, hatcheries, feed companies, and other key stakeholders, together with secondary data collected from relevant sources, were used.

The assessment focuses on smallholder poultry farmers, either small-scale intensive farmers or backyard poultry farmers. They comprise about 97% of the poultry producers in Ethiopia, where rearing poultry provides a source of income and ensures food and job security for these farmers. Also, the regional states of Oromia, Amhara, Southern Nations, Nationalities, and Peoples' Region, and Tigray account for 96% of the chicken population in Ethiopia.

This report has identified and presented three critical energy-related challenges that obstruct the overall poultry welfare and productivity of smallholder farmers in Ethiopia. The first one is the ineffective incubation process, caused by an inconsistent supply of electricity, which causes the DOC supply to decrease, making some smallholder farmers idle for up to 7 months. The second is poor lighting and heating in poultry sheds during brooding, also caused by lack of electricity. It has caused low productivity in smallholders' poultry products as it directly affects feed intake, growth, and meat yield. The lack of cold chain storage is another crucial energy-related challenge that affects vaccine effectiveness, leading to the high mortality of chickens. It has also affected smallholder farmers' ability to regulate their chicken meat supply as they cannot store slaughtered meat.

This assessment shows that solar appliances can help poultry farmers overcome these critical challenges and increase efficiency and productivity. Solar incubators increase egg productivity and ensure a better hatchability rate by minimizing the side effects of unreliable power supply. Providing adequate solar lighting can improve feed intake at night and maximize egg production in layer chickens. Moreover, providing sufficient heat in poultry sheds decreases chick mortality. It improves feed conversion rate by encouraging growing chickens to use consumed feed to gain weight instead of maintaining a constant body temperature. Solar refrigerators can be used to ensure vaccine effectiveness and unlock the potential of engaging in value-adding processing activities for smallholder farmers.

Poultry Sector Overview

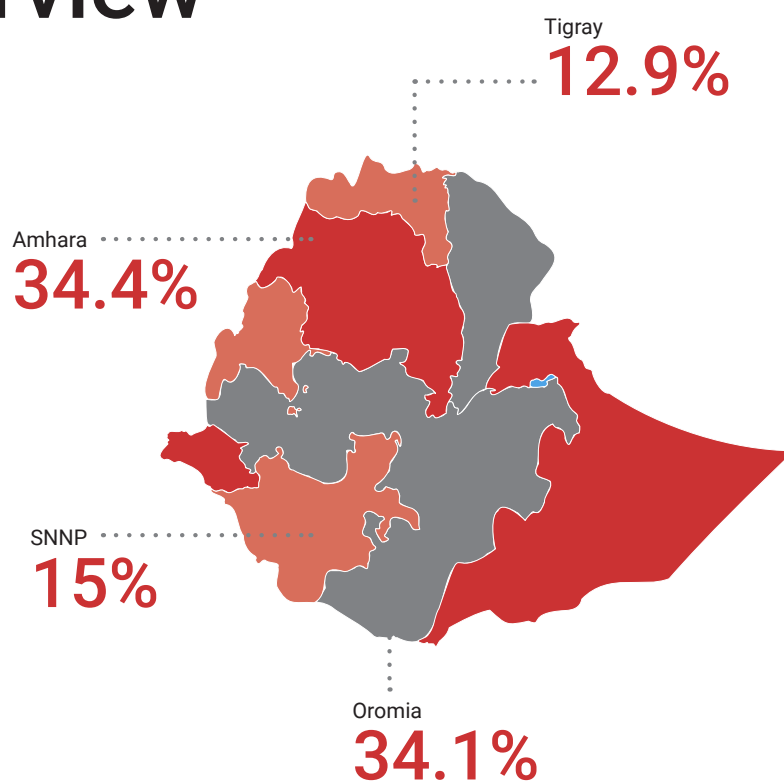


Figure 1: Poultry population of Ethiopia

Country Context

Ethiopia has the second largest population in Africa, about 115 million inhabitants, with 78% living in rural areas. It is also one of the fastest-growing countries globally, with annual GDP growth of 6.1% registered in 2020. Agriculture has dominated the country's economy for decades and remains a significant part of livelihoods by employing about 67% of the population.¹ Poultry farming is one of the most practiced forms of animal husbandry in Ethiopia, with 56.8 million chickens in 2019/20. The commercial poultry sector, which utilizes exotic breeds that lay 85% more eggs, is growing. 97% of chickens that existed in 2012/13 were of indigenous breed, with their share decreasing to 82% in 2019/20.²

One of the main elements for sustaining a more productive and efficient agriculture sector is energy. As

of 2019, electricity access in Ethiopia was 44%, with 11% of this off-grid. The government plans to achieve universal electricity access by 2025, 35% of which will come from off-grid sources. To support agricultural activities and enhance economic productivity, the government plans to assess areas with high agricultural potential and provide them with access to electricity.

The poultry population of Ethiopia is concentrated mainly in the regional states of Oromia, Amhara, Southern Nations, Nationalities, and Peoples' (SNNP), and Tigray. These states collectively account for about 96% of the national poultry flock. Also, they have a good experience in adopting off-grid solar systems, each obtaining 36.3%, 22.5%, 7.8%, and 36.9% of their energy from off-grid sources, respectively.³

¹ Ethiopia Job Creation Through Off-Grid Energy Access, 2021

² CSA Report on Livestock and Livestock Characteristics, 2019

³ National Electrification Plan 2.0, 2019

The Poultry-Energy Ecosystem

The poultry-energy ecosystem approach assesses core components of a value network concerning technical and financial infrastructures, policy environment, capacity building, and linkage. This holistic approach ensures an all-rounded sector overview to contextualize the challenges and sustainable energy interventions.





Why Poultry?

Poultry plays a significant role in the livelihood of the rural population as a source of income, job opportunity, food security, and women empowerment.



Income Generation and Job Opportunity

Both in the backyard and small-scale production systems, the sector has high job creation potential for the youth and the abundant labor in rural and urban areas of Ethiopia. As chickens have a short production cycle and thus a high turnover rate, raising chickens allows farmers to generate income faster. Furthermore, the employment rate in the livestock sector is expected to grow by 14% and create 550,000 new direct jobs and 1.66 million indirect jobs by 2025, with the poultry subsector expected to grow at the same rate.⁴



Nutrition and Food Security

The poultry sector in Ethiopia mainly consists of chicken meat and table eggs production, which are sources of good-quality protein and minerals valuable for growth and health. With lower production costs, poultry can become a cheap source of protein for low-income families that are the main victims of malnutrition. In addition, the increased urbanization rate and rising per-capita income are creating higher demand for poultry products.



Government Focus

The government has recognized the poultry sector as one of the key sectors to reduce poverty and improve food security in the country. It plans to industrialize the sector by providing improved breeds to farmers to increase their productivity. It also plans on exempting tax on poultry and feed equipment to encourage the private sector to take part in the production and address the various bottlenecks in the value network. The government has also set a goal of increasing chicken meat production from 48 thousand tons to 106 thousand tons and egg production from 2.8 billion tons to 5.5 billion tons by 2030.⁵



Women's Empowerment

Smallholder poultry production generates opportunities for women in rural areas since it can be operated on a small amount of land and requires a low initial investment. It can also go together with other household activities rural women are usually tasked with, making it easier to manage. Rural women mostly use the income generated from selling chickens and eggs to cover household expenses. Thus, chicken production can also potentially contribute to the improved livelihood of the household.⁶

⁴ Plan of Action for Job Creation, 2019

⁵ Ten Years Development Plan 2021-2030

⁶ Poultry Sector of Ethiopia, 2019

Poultry Production Systems



Ethiopia's smallholder farmers fall under the backyard and small-scale production systems, accounting for 97% of the total chicken population together. The large-scale system takes up only 3%.

89%

of the total chicken population

8%

of the total chicken population

3%

of the total chicken population

1. Backyard Production System

Backyard poultry production systems account for 89% of the total chicken population. Farmers in backyard production usually own indigenous chicken breeds that subsist on a scavenging diet and have low productivity, have a poor feed conversion rate (the amount of feed intake needed to gain an additional one kilogram of chicken weight), and longer rearing periods. The hens provide natural brooding to their chicks with various diseases causing high chicken mortality rates due to lack of vaccination. The farmers produce poultry for self-consumption or to sell live or manually-slaughtered chickens locally, mostly during holiday seasons.

2. Small-scale Production System

Small-scale production systems account for nearly 8% of the total chicken population. The farmers in these systems obtain layer or broiler DOCs from large-scale farms or government hatcheries. They use various energy sources, including kerosene lamps and charcoal, to provide a conducive environment for the growing chickens.

The chickens in these systems are raised for sale, but the farmers lack market connections. Hence, they sometimes sell live birds in wet markets or perform manual, unregulated slaughtering. These farmers also face problems with the availability of vaccines and the high feed price. They obtain feed from commercial feed producers or large-scale poultry farmers.

3 Large-scale Production System

The large-scale poultry production system accounts for 3% of the total chicken population in the country. Farmers in this category own exotic layers and broilers with high productivity but require a conducive environment to survive. Some of these farmers import DOCs while others own parent stocks and hatcheries to produce DOCs. Most large-scale producers own slaughtering plants and distribute frozen chicken meat to supermarkets, restaurants, and hotels. Some of them also own feed mills, while others acquire feed from commercial feed-producing companies. These farmers provide regular vaccinations to their flocks.



Key Challenges in the Poultry Sector

There are challenges in every stage of the smallholder poultry value chain that can be solved with access to energy. The key challenges with the highest impact on smallholder productivity are inefficient incubation caused by inconsistent electricity supply, decreased productivity due to intermittent lighting and heating, and the absence of cold storage services for poultry products.

	Input	Production	Processing	Distribution
Overall Challenges	 Feed Lack of feed processing facilities, as well as inconsistent quality and availability of feed  DOCs Low supply of DOCs as hatcheries don't perform at full capacity due to lack of electricity  Vaccine Vaccine ineffectiveness due to lack of cold chain storage	 Hatching Shortage of DOCs due to low hatchability rate caused by the unavailability and inconsistency of electricity  Brooding High chick mortality and low productivity of chickens due to inefficient means of lighting, heating and ventilation	 Meat Processing Improper hygiene management during manual slaughtering Low quality of slaughtered meat due to lack of cold chain facilities	 Retail Smallholders' inability to regulate their supply due to lack of cold chain storage for their slaughtered meat
Energy Solutions	 Feed Feed Processing units  Vaccine Vaccine cold-chain storage	 Incubation Egg Incubator  Brooding Lighting, Heating and ventilation systems	 Meat Processing Slaughtering/De-feathering Machine	 Retail Cold-Chain Storage

Table 1: Overall Challenges and Energy Solutions in the Poultry Sector



Inefficient Incubation due to Inconsistent Supply of Electricity

During the inputs acquisition process, small-scale farmers using exotic chicken breeds find it hard to obtain fertile eggs or DOCs. Almost 90% of small-scale layer farmer inputs, such as DOCs, are obtained from hatcheries owned by commercial producers, which are few. Government-owned breeding and multiplication centers also provide day-old chicks occasionally.

The hatcheries can't perform at full capacity due to infrastructure problems, such as erratic power supply. That jeopardizes the hatching process (as eggs need a stable environment to hatch properly) which, together with the low supply of fertile eggs, exacerbates the shortage of DOCs. The low supply is caused by the low number of parent stock imported due to shortage of foreign exchange. The inconsistent power supply also causes increased chick mortality and a low hatchability rate due to insufficient and irregular heating as well as irregular humidity. This reduces DOC supply and causes long waiting lists and unoccupied poultry houses of smallholders for up to 7 months or longer. The hatcheries use diesel generators as a backup to mitigate the side effects of erratic power supply, despite the high fuel cost.⁷

Natural incubation is practiced in backyard poultry farms with indigenous chickens. The low quantity of eggs to be hatched, poor hatchability due to prolonged incubation time, and unavailability of inputs to facilitate the growth of chickens are the main drawbacks causing the practice of natural incubation to be inefficient.⁸

Decreased Productivity due to Intermittent Lighting and Heating

During the brooding process, chickens have to be provided with a conducive environment to ensure their health and survival because they are homeostatic and convert feed into body heat in a cold environment. Thus, maintaining the temperature of the poultry shed is important to ensure optimal weight gain and egg production in chickens.

Smallholder farmers without electricity access widely use charcoal to provide heat for their chickens. However, charcoal requires a long time to heat initially, has a rapidly rising price, emits harmful gases, and has a high risk of causing a fire. It also has low efficiency during rainy seasons as it gets wet. Smallholder farmers connected to the grid, on the other hand, face issues like an inadequate power supply which limits the use of appliances like heating lamps and significantly lowers the productivity of chickens, even causing mortality. Some farmers with electricity use electric stove resistors as an alternative means of heating.

⁷ Poultry Sector of Ethiopia, 2019

⁸ Invest in the Ethiopian Poultry Sector ENTAG 2020

Case Box I: Paying large amount of money for lighting poultry sheds: Engida Smallholder Farmer



Engida is a poultry and dairy farmer who lives in Bishoftu. He currently owns around 2700-layer chickens he purchased at 3 months old. He houses them in three separate sheds. He used to have a higher number of chickens but decreased their number recently as the cost of inputs got higher.

Feed for the chickens is obtained from large-scale poultry farms and feed companies. The chickens arrive at the farm already vaccinated for various diseases. However, a large number of chickens sometimes perish due to disease outbreaks. When the chickens are bought, there is no record of the feed and vaccine that has been administered to them, which makes it difficult to assure their quality.



The connection costs Engida ETB 35 - 50 for a single bulb with a total cost of ETB 700 per month to access electricity.

Each shed requires 8 bulbs. There is an erratic power supply where, on average, electricity may not be available for 2-3 days per week. The farm is not connected to the grid, but it has an extended electricity line from its neighbors. The connection costs Engida ETB 35 - 50 for a single bulb with a total cost of ETB 700 per month to access electricity. According to Engida, if the farm had electricity access, day-old chicks could be purchased and provided with the appropriate vaccine, lighting, and heating to ensure high productivity and a low mortality rate.

Case Box II: Utilizing charcoal to provide heat for chickens: Demesew, Smallholder Farmer



Demesew is a poultry farmer living in Bishoftu with the capacity to rear 2000-layer chickens. He acquires day-old chicks from large-scale farmers and sells the grown chickens to nearby farmers. When obtaining DOCs, Demesew is regularly faced with a long waiting list which causes him to be idle for as long as 3 months.

A single lamp is used to provide light for the farmer to supervise the chickens and prevent piling and suffocation. Electricity is acquired through an extended connection from nearby houses, and power is unreliable and erratic.

Heating is provided at night using charcoal stoves laid out in rows in the chicken shed. Six charcoal stoves are used to heat 2000 chickens. Along with transportation and labor, charcoal costs Demesew ETB 510 per quintal, where a quintal of charcoal lasts for three days.

Live chickens are sold in the local market, where demand fluctuates seasonally and peaks during holidays. During this time, chickens are prone to contamination and diseases as they are placed in a wet market with no biosecurity measures.

SIX
charcoal stoves are used to heat
2000
chickens.

Along with transportation and labor, charcoal costs Demesew
ETB **510**
per quintal, where a quintal of charcoal lasts for three days.



Absence of Cold Storage Services

Cold Storage for Vaccines

Smallholder farmers face a higher mortality rate of chickens despite vaccinating their flocks. Newcastle Disease accounts for the largest proportion of mortality in all parts of the country, with fowl pox being the second. Newcastle Disease influences price movements as farmers sell their flocks to avoid significant losses when they expect the disease to occur. The National Veterinary Institute produces vaccines for these diseases. Distributors then buy the vaccines to sell to farmers. Farmers transport the vaccines on ice to either immediately provide to the chickens or to store in a neighbor's house with electricity. The high mortality of chickens is attributable to handling vaccines poorly, storing vaccines at inappropriate temperatures due to lack of vaccine refrigerators, and mixing vaccines with contaminated water.

Smallholder farmers are also faced with the unavailability of vaccines as vaccine distributors are required to have refrigerators to acquire permits for selling vaccines. An erratic power supply can decrease vaccine effectiveness even when refrigerators and access to grid connections are available.

Cold Chain for Chicken Meat

Smallholder farmers engaged in broiler farming generally lack slaughtering facilities. Those who slaughter chickens at their farm use hired butchers and brokers who have access to cold storage and slaughter, dress, and freeze the meat for marketing. Manual slaughtering performed on farms runs a high risk of contamination due to a lack of hygiene management. Additionally, the absence of a cold room or refrigerator to store slaughtered meat forces smallholders to keep their flocks beyond the expected time of slaughter, which requires more resources such as feed, vaccines, and labor. To avoid the loss, the farmers sell the chickens at a loss. When the farmers have access to refrigerators, inconsistent supply of electricity and high price of fuel for backup generators causes a decrease in amount of income.⁹

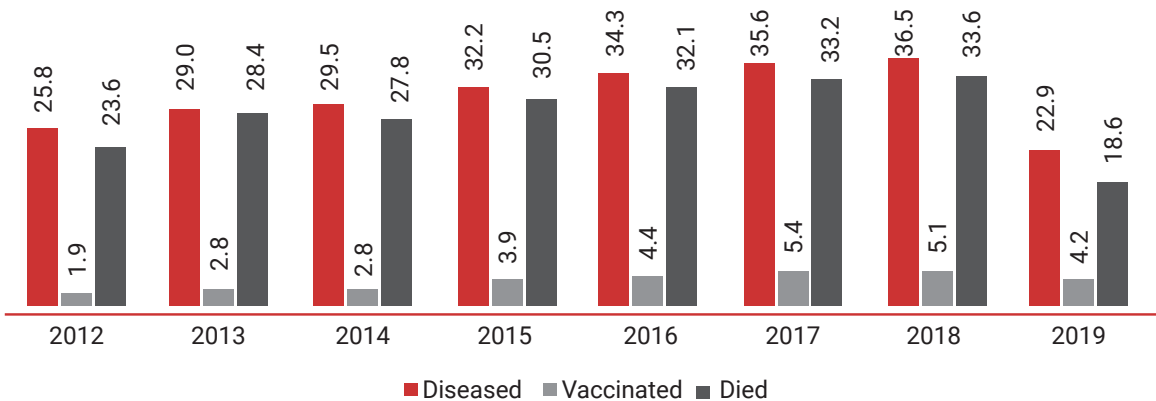


Figure 2: Number of Chickens Afflicted, Treated and Died of Disease in Ethiopia (million heads)¹⁰

⁹ Investment opportunities in the Ethiopian Poultry Sub-sector, 2015

¹⁰ CSA Report on Livestock and Livestock Characteristics, 2019

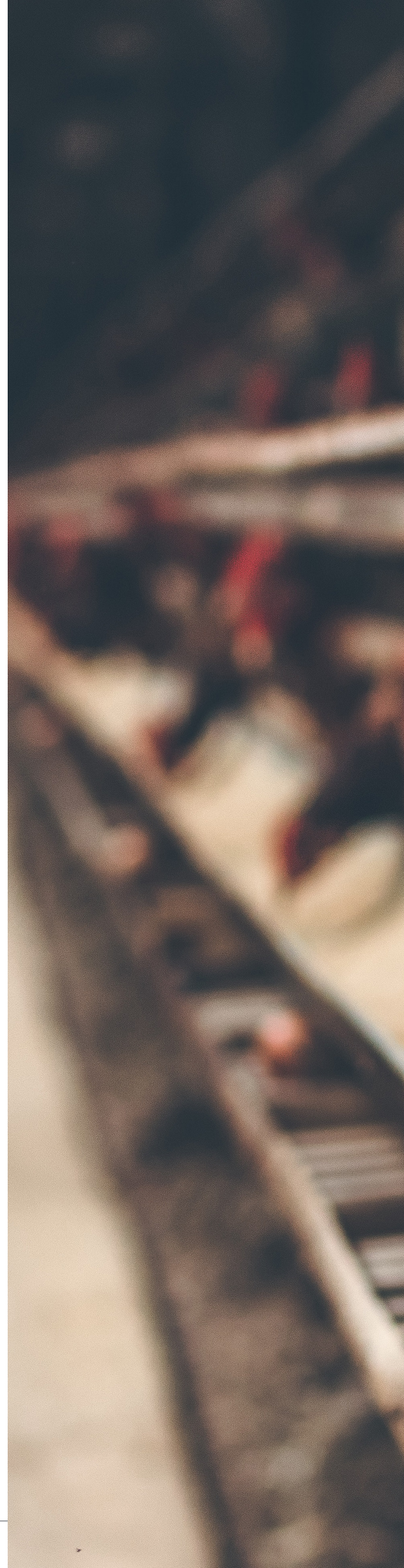
Case Box III: Selling broilers at a lower price due to lack of cold storage: Girma, Smallholder Farmer



Girma is an out-grower for a large-scale commercial producer in Bishoftu. He currently owns 1000 broilers and 300 layers. He obtains day-old chicks on credit from the large-scale producers and sells them when the agreed-upon weight is reached. Since the price of chicken in the market can double during certain seasons, the price per kilo paid by the large-scale producers is difficult to accept for him. As the price of feed is increasing daily, it is difficult for him to agree with the pre-set price for the chickens in his contract with the large-scale producer. However, Girma still prefers selling the chickens to the large-scale producer as it is a sure market with minimal risks.

Lighting bulbs are used on the farm for illumination and cost ETB 400 – 415 per month as day-old chicks require consistent light and heat for 21 days without interruption. Girma has lost numerous chickens despite providing vaccines due to diseases, mainly Newcastle Disease. He stated that it is challenging to access veterinary advice from suppliers. Instead, he gets advice from local veterinary drug stores.

Smallholder broiler farmers who are not out-growers sell chickens at local markets, hotels, and restaurants. Since they mostly do not have refrigerators to store slaughtered chicken meat, they hire professionals that buy the chickens for a lower price to manually slaughter, dress, and freeze the meat. These professionals usually have access to markets and refrigeration.





Potential Renewable Energy Interventions

Productive use appliances with renewable energy sources enhance farmers' income by increasing the efficiency of the production process or by removing the cost of operating and maintaining nonrenewable energy-utilizing equipment used on farms.

Implementing renewable energy solutions in the poultry value chain enables smallholder farmers to address their challenges in accessing high-quality day-old chicks and vaccines and helps them acquire better yields of meat and eggs. Based on our assessment, solar energy interventions that can have a high impact on smallholder poultry farmers include solar egg incubators, solar lighting and heating systems for brooding, and solar cold storage systems to ensure the quality of inputs and poultry products.

Solar Egg Incubators

Eggs require an environment that ensures optimum temperature, ventilation, and humidity for 21 days to hatch, which incubators provide. For the first 18 days of the incubation period, eggs are placed in the setter and turned regularly. After which, they are moved to the hatcher to hatch. Modern solar incubators usually have automatic egg turning to ensure better temperature control and healthy development.¹¹

Incubators free the hen to produce more eggs instead of incubating the eggs they already laid. Incubators can also hatch more eggs at a time, ensure a better hatchability rate by providing a consistent environment, and enable smallholder farmers to produce even-aged flocks that are easy to manage and vaccinate. Solar incubators have the additional advantage of minimizing the side effects of unreliable power supply by providing a consistent internal environment in the incubator. Small-scale poultry farmers that own incubators can provide hatching services to other poultry farmers.

For instance, small-scale poultry farmers in Kenya started selling eggs and day-old chicks to other farmers after using solar incubators. They managed to increase their yearly egg production by 10 times and their monthly income by nearly 50%.¹²

Solar Lighting and Heating Systems

Poultry farms can use LED bulbs with photovoltaic systems that consist of photovoltaic panels, inverters, and battery units used for lighting. As they use most of the provided energy to generate light and not heat, LED bulbs are highly energy-efficient and have lower maintenance costs.

Providing adequate lighting improves feed intake by encouraging the chickens to feed at night. It also improves egg production by triggering the hormonal response of layer chickens.

For heating, infrared lamps with photovoltaic systems are mostly used. They are efficient sources of heat as they directly warm the body of the chickens instead of the air in the house.¹³

Providing growing chickens with heating systems that maintain a temperature range of 19°C – 33°C improves the feed conversion rate of chickens. In the absence of heating, the consumed feed would instead be utilized to keep the chickens warm and affect their weight-gaining potential. Solar heating appliances would minimize the harmful effects and costs of using other alternatives like charcoal as a heating source. Integrating solar systems into lighting and heating would minimize the reliance on grid electricity.

¹¹ Photovoltaic for Productive Use Applications Catalogue, 2016

¹² USAID Feed The Future, 2016

¹³ Lighting Africa, 2011

Solar Cold Storage Systems

Poultry vaccines usually must be stored under a constant low temperature to maintain their effectiveness. Solar refrigerators that use solar energy to freeze water and then use the frozen bank to keep the vaccines cold are usually utilized to store and transport vaccines in areas without electricity access. Solar cold chains can reduce mortality by ensuring vaccine effectiveness.

Cold storage can also be used to store chicken meat to reduce the risk of pathogens contaminating the meat. Solar cold storage of different sizes with well-insulated cooling cabinets and a battery bank ensures the quality of processed meat. Cold storage can be freezers that store products under a temperature range of -10°C to -20°C , refrigerators for storing under temperatures from 2 to 8°C , or walk-in cold rooms that can store large quantities of produce at the same time.

Solar cold chain enables farmers to store processed products without depending on a grid connection. It also helps them regulate their supply of products (as they can store it in refrigerators) and gain maximum advantage from the products instead of selling them at a lower price for fear of loss.

Enabling Ecosystem for Solar Interventions

To enable smallholder farmers to get the maximum impact from the solar interventions, a robust ecosystem that can sustain the technology solutions and unlock their potential is essential. Testing the efficiency of the existing ecosystem on pilots among smallholder poultry farmers is vital to identify a business model that is sustainable, scalable, as well as profitable.

Technology Solutions



Viable ownership models need to be explored to make solar interventions available for poultry farmers across Ethiopia. Some of these solar interventions like poultry lighting and heating can

be directly owned and operated by the farmers to maximize their profit on the farm. Farmers can use other interventions such as solar egg incubators and solar cold storage systems to start their businesses and provide services to other farmers to generate sustainable income. Farmer cooperatives can also play a major role in adopting these solutions and providing various services to their member farmers.

Finance Solutions



Solar companies in Ethiopia have been partnering with microfinance institutions to provide loans to end-users to make solar home systems affordable to the farmers. However, the high collateral requirements to acquire the loans and the short repayment periods are challenges these farmers face. Poultry farmers also face challenges accessing loans to purchase the inputs needed to sustain their farms.

In addition, productive use appliances have a higher cost. Thus, they have a higher risk margin relative to solar home systems, making MFIs reluctant to provide loans for them. Availing viable end-user financing models for productive use systems is important to make them affordable to farmers across the country. Also, if groups of farmers or cooperatives can own solar interventions such as incubators and solar cold storage, the initial costs and risks of the appliances will be minimized. Then, the farmers can reap the benefits of economy of scale.

Policy Solutions



Government bodies play a fundamental role in creating a suitable environment for solar interventions by implementing policies. These policy measures include implementing accessible importing procedures for poultry inputs and solar products and harmonizing the requirements to conduct business in the off-grid sector across regions. The government can also support communicating the lessons from the interventions to farmers across the country and creating awareness of the

benefits of using productive use equipment on the farm. Policy implementation is important to address financial problems of end-users as well as to solve problems in the supply chain.



Linkage Solutions

A strong and sustainable value chain is required to unlock the full potential of solar interventions in the poultry sector. These interventions also require an enhanced understanding of the benefits of productive use equipment by end-users. Existing solar companies utilize various linkage models to avail their products near farmers and provide after-sales service. These models include youth enterprises, microfinance institutions, and farmer cooperatives. More engagement in providing productive use equipment across the country is needed for a far-reaching impact.

Inputs required in poultry farming such as feed, day-old chicks, and vaccines are in short supply across the country. After production, farmers will also need forward market linkages to sell their products to consumers. Putting these farmers into groups such as cooperatives or utilizing out-grower schemes helps them find wider opportunities to access inputs and customers, creating a stronger value chain.



Training and Capacity Building Solutions

Improving the capacity of workers in the areas around the farmers gives the farmers easy access to technicians that operate and maintain their systems. Providing consistent training for local youth enterprises on installing and maintaining solar products increases the pool of experts for the farmers to consult. It also creates more jobs for the youth.

Poultry farmers also require guidance on best practices in poultry management, business ownership, and the benefits and operation of solar interventions.





Appendix I: Stakeholders in the Poultry-Energy Ecosystem

Poultry Producing Enterprises

Poultry enterprises have a substantial overall impact on the poultry sector. The growth and development of small-scale enterprises to large-scale ones is what results in the development of the sector. Below are some of the biggest poultry enterprises that influence Ethiopia's poultry sector.

Company Name	Company Profile	Engagement with Smallholder Farmers
EthioChicken	Established in 2010 G.C, EthioChicken is one of the leading poultry producing companies in Ethiopia and East Africa. AGP poultry PLC, Mekele Poultry Farms LTD, and Andasa Poultry PLC are its sister companies.	The company produces and sells improved breeds of chickens to smallholder farmers. To get DOCs and/or pullets from the farm, poultry farmers fill out registration forms and wait for about 2 to 3 months, after which they deposit the necessary amount of money to MFIs or other financial institutions a few days before receiving the DOCs.
Ethiopian Poultry	A Netherlands poultry company that supports entrepreneurs in the bio-industry sector in Ethiopia in areas such as the production of fresh eggs and pullets. By providing advice and monitoring, they work towards a higher and more sustainable return under high production standards.	They provide training for poultry farmers, and they are open to working alongside new and existing enterprises.
Alema Farms	Established in 1996 G.C, Alema Farms is one of the leading poultry meat and egg producers in Ethiopia. It has fully integrated poultry meat and egg production systems, including DOC production, DOCs and/or fertile eggs distribution, broiler production, meat processing, and meat distribution through its sales outlets	The farm supplies DOCs to small and medium-scale farmers. It also distributes layer DOCs to small and medium-sized poultry farms. To get the DOCs, these small and medium-scale poultry farms fill out registration forms and wait for about 3 to 6 months, after which they deposit the necessary amount of money to MFIs or other financial institutions a few days before receiving the DOCs.



Company Name	Company Profile	Engagement with Smallholder Farmers
Elere Farms	It was established in 2008 G.C and works on poultry development and animal feed processing.	The farm supplies DOCs to a wide range of individual poultry farmers, women organizations, youths under microenterprises, and institutional buyers.
ChicoMeat	It is a slaughterhouse with a production capacity of 1000 broilers per hour. Chico Meat also provides parent stocks to a local hatchery to provide DOCs to its out-growers.	It has an out-grower business model, and the company provides DOCs to smallholders on credit and buys the fully grown chicken from them after about 40-50 days. It provides extension services to the farmers.
ELFORA Agro-Industry	Established in 1997, the company has three major operations: Food Processing and Crop Production, which manages five meat processing plants, Livestock Operations, which is engaged in live animal supply, purchasing centers, ranches, and quarantine stations, as well as the Poultry Operations which has modern broiler processing and packing units. It produces table eggs, broiler meat, and day-old chicks.	The company sells DOCs to youth enterprises.
Maranatha Farms	Established in 2008 G.C, the company produces DOCs, pullets, and poultry feed. They grow their own pullets and sell table eggs to the market. Every aspect of the pullet rearing and hatchery processes runs on solar power. They only use grid connections for the energy needs of their feed production.	They sell DOCs to external pullet growers, and they sell some of the feed they produce to these pullet growers.

Off-grid Solar Enterprises in Ethiopia

Currently, hundreds of companies are registered as solar importers in Ethiopia. Most of these companies are distributors, while some work on assembly, productive use programs, and other innovative solutions. Few companies are involved in poultry equipment importation. Below are some of the biggest off-grid solar enterprises that influence Ethiopia's off-grid energy sector.

Company Name	Company Overview	Off-grid Products for Agriculture	Distribution Channels
Yasart Engineering PLC	Engaged in supplying, installing, testing, and commissioning electromechanical solutions.	Currently provides productive use appliances, specifically solar pumps. Can innovate solar solutions for poultry.	Direct sales
LYDETCO PLC	Engaged in importing and distributing solar products and components.	Currently importing solar pumps and lanterns.	MFI Youth Enterprise Sales Agents
Solar Development	Engaged in importing, distributing, consulting, and installation of solar products.	Works on solar pumps and solar lanterns.	MFI Youth Enterprise Sales Agents
ACME Engineering and Trading PLC	Engaged in importing and distributing solar products.	Currently working on solar pumps and solar lanterns.	Sales Agents Representatives
Sun Transfer PLC	Services include the import and distribution of solar products.	Currently working on importing solar pumps and solar lanterns.	MFI Youth Enterprise Sales Agents
Rensys Engineering and Trading PLC	Engaged in distribution and marketing of solar products.	Currently working on solar lanterns and solar pumps.	Hidase Telecom Youth Organization

Poultry Technology Enterprises in Ethiopia

The companies below import equipment utilized during poultry production and processing.

Company Name	Company Overview	Products for Poultry	Distribution Channels
Agro-Vet PLC	Imports and distributes equipment for dairy, beekeeping, veterinary services, artificial insemination, and poultry. Imports chemicals, reagents, scientific and educational equipment.	Imports de-beakers, incubators, vaccine syringes, chicken feeders and drinkers, and egg trays	Direct sell

Government Institutions

Below are government institutions relevant to the poultry sector that work on formulating policies, conducting researches, recommending solutions, and implementing support.

Institution	Mandate
Ministry of Agriculture (MoA)	• The Ministry of Agriculture has a livestock department that consists of three main departments: Animal Production, Animal Health, and Pastoralists. • It is responsible for the development of policy and strategy in the agriculture sector and oversees their implementation at the federal and regional levels. • The Agricultural Offices at the regional level and woreda (district) level also implement regional-level policies and strategies.
Veterinary Drug and Feed Administration and Control Authority (VDFACA)	• Accountable to the Ministry of Agriculture, VDFACA formulates policies and legislation governing veterinary drugs and feed. • It is responsible for controlling the quality and safety of veterinary drugs and animal feed in the country, issuing certificates, and setting standards for those who intend to import and distribute vet supplies. • It is also responsible for preparing the list of veterinary drugs and feed additives for the country and revising the list when necessary.
Ethiopian Institute of Agricultural Research (EIAR)	• It is a federal agricultural research institute responsible for running research centers, conducting research at its federal center, as well as operating Regional Agricultural Research Institutes (RARIs) at various locations across the country. • It is also mandated with advising the government on agricultural research policy formulation.
National Veterinary Institute (NVI)	• It has been the major provider of vaccines for livestock production in Ethiopia, including poultry. Its core business is the production of vaccines for livestock diseases. • It also provides feed analysis services and laboratory tests.
Agricultural Transformation Agency (ATA)	• It is an agency created to help accelerate the growth and transformation of Ethiopia's agricultural sector. • It conducts studies to identify constraints in agricultural development and recommends solutions to ensure sustainable transformation. It also supports the implementation of the solutions to ensure the effectiveness of agricultural development activities.
Ethiopian Meat and Dairy Industry Development Institute (EMDIDI)	• It has the objective of developing the meat and dairy sector and improving the competitiveness of the sector in the global arena. It has prioritized the agro-processing sector.
Regional Water and Energy Bureaus (REBs)	• These are government bodies that sign Memorandums of Understanding with solar companies to enable the companies to operate and distribute solar products in their respective regions. • They support rural electrification in off-grid areas and oversee issues related to product quality and marketing in their regions. They also help link companies with youth enterprises as well as develop regulations for using youth enterprises to distribute solar products and provide maintenance. • They also provide direct support in the promotion of solar products to farmers using REB experts.

Financial Institutions

Banks

There are 18 banks in Ethiopia, 17 of which are commercial banks, and one is a development bank. All banks provide loans and credits for agricultural operations. Out of these 18 banks, 2 are public, while the rest are private. The two large state-owned banks in Ethiopia are:

- **Development Bank of Ethiopia (DBE):** It is one of the state-owned financial institutions engaged in providing short-, medium-, and long-term credits. The bank offers loans for commercial agriculture, agro-processing, manufacturing, and extractive industries. DBE took the poultry sector as one of its priority areas. To support the poultry sector, it slashed lending interest rates for farmers by 4% to 7.5%.
- **Commercial Bank of Ethiopia (CBE):** It is the biggest bank and the leading loan provider in the country. It provides loans for agricultural operations.

The commercial banks and DBE disbursed ETB 271.2 billion in new loans in 2020, which was 14.8% higher than what was disbursed a year ago. About ETB 24.95 billion (9.2%) of the loan went to the agriculture sector, including the poultry sector. About 55.3% of the loan was disbursed by the two state-owned banks (i.e. CBE and DBE), while 44.7% was provided by the private banks.

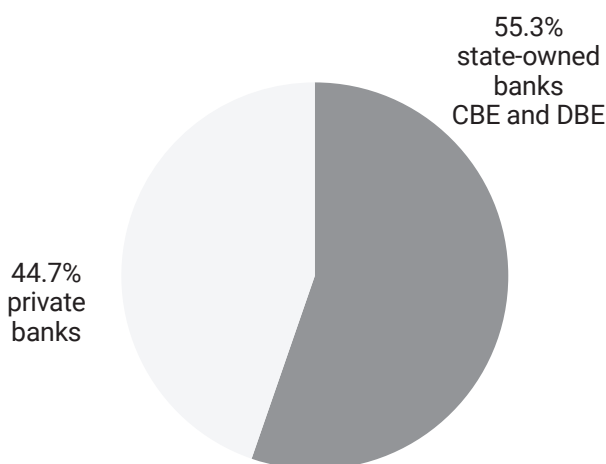


Figure 3: Loan provided by banks for agriculture sector

Micro Finance Institutions (MFIs)

There are 38 MFIs across the country holding 6% of all financial sector assets. While almost all lend to agriculture (which includes poultry producers and processors), 14 MFIs lend to off-grid solar companies and end-users. The sector saw a 25% asset growth between 2018 and 2019.

The government has a plan for creating access to financial institutions that aim to place an MFI branch in each woreda of the country, serving an average household number of 24,000 each.

The five prominent MFIs that provide loans in Ethiopia are: Amhara Credit and Saving Institution (ACSI), Oromia Credit and Saving Share Company (OCSSCO), Dedebit Saving and Credit Institution (DECSI), Omo Microfinance Institution, and Addis Credit and Savings Institution. Among them, Amhara Credit and Savings Institution and Oromia Credit and Saving S.C are the largest.

• Amhara Credit and Savings Institution (ACSI)

ACSI is the largest microfinance institution in Ethiopia and one of the largest in Sub-Saharan Africa. It operates primarily in the Amhara region and is working to improve the economic situation of low-income people in the Amhara region through increased access to lending and saving services. It grants loans to farmers engaged in small ruminant fattening, poultry, and related livestock businesses. These loans are usually provided on a group guarantee basis and are mostly short-term.

• Oromia Credit and Saving S.C (OCSSCO)

OCSSCO is a microfinance institution that works to strengthen the economic base of low-income rural and urban people in Oromia. The institution provides credit, savings, money transfer, and micro-insurance services for smallholder farmers and low-income urban residents in the region via its branches.

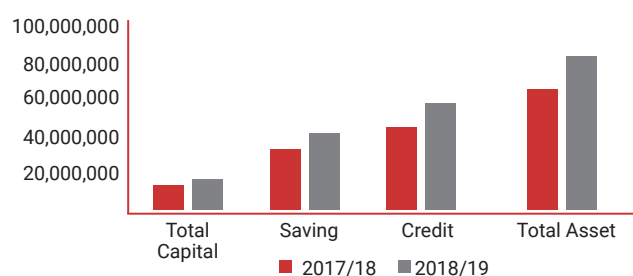


Figure 4: Micro Finance Institution Performance as of 2019

Poultry Associations

The poultry sector has associations that promote the interest of the members among the government and other relevant stakeholders.

Ethiopian Poultry Producers and Processors Association (EPPPA)

Overview	Association Objectives	Arrangement and membership
EPPPA is working to support the development of the poultry sector in Ethiopia by addressing the key challenges of its members. It works in collaboration with key stakeholders to address policy matters that affect the sector.	Promotes modern farm management technologies and public awareness to improve poultry consumption. Promotes access to farm input and output, as well as current market and business information to its members to maximize producers' income. Works on creating an enabling environment for members to get credit services and capacity-building training.	EPPPA has a General Assembly and Board of Directors. Members are small and large poultry enterprises.

Ethiopian Veterinary Association (EVA)

Overview	Association Objectives	Arrangement and membership
EVA contributes to the emergence of an efficient, effective, and competitive livestock industry. It is dedicated to policy advocacy, development, promotion, and dissemination of knowledge and good practices in the livestock sector.	It strives to protect the interests and rights of veterinarians. It serves as a bridge between veterinary medicine and other professions by creating a networking platform. It also supports veterinary and educational activities, qualities, and standards.	EVA has a general assembly of two executive boards. Its members are veterinarians.

Ethiopian Society of Animal Production (ESAP)

Overview	Association Objectives	Arrangement and membership
ESAP is a platform and knowledge hub of animal scientists, policymakers, researchers, farmers and pastoralists, and stakeholders in the private sector.	It mainly works on creating a sustainable and resilient livestock sector.	It has a General Assembly with an executive body. Members include charities and social agencies.



Poultry Associations

Ethiopian Livestock Traders Association

Overview	Association Objectives	Arrangement and membership
The association is established with the main objective of promoting domestic and international livestock trade.	Provides linkage from producers to the export market. Advocates for the sector as well as conditions animals in feedlot areas for export.	Members are domestic livestock traders and feedlot operators

Ethiopian Meat Producer-Exporters Association

Overview	Association Objectives	Arrangement and membership
The association is established with the objective of ensuring that Ethiopian meat products meet international standards and promoting these products to the international market.	Provides linkage to its members to the export market. Ensures food safety and quality assurance.	Members include meat processing and exporting companies

Ethiopian Animal Feed Industry Association

Overview	Association Objectives	Arrangement and membership
It is a non-profit organization established with the objective of transforming the Ethiopian animal feed industry.	Engages in enhancing the understanding and cooperation between the members and the public sector regarding the animal feed industry. Has the objective of improving the quality and availability of necessary production inputs.	It is governed by General Assembly and a board. Members include feed factory owners, private dairy farmers, and dairy cooperatives.



Training and Research Institutions

Currently, several institutions actively engage in poultry-related research and development activities. They offer courses to students, farmers, and extension workers.

Institution	Poultry Research Activities
The TVET system (Technical and Vocational Training and education)	All the regions have two or more Agricultural TVETs, all of which include livestock training in their programs. They offer short courses for farmers, extension officers, and government extension workers at the woreda level.
National Poultry Training Center (NPTC)	It was officially opened in 2015 and it is located in Debrezeit. It is not currently operational. However, the Ethiopian Poultry Producers and Processors Association and the Ethiopian Meat and Dairy Industry Development Institute are working closely with the MoA Poultry Directorate to reopen the training center.
The Pan African Veterinary Vaccine Center (AU-PANVAC)	Provides training and technical support services to veterinary vaccine and quality control laboratories. Controls the quality of veterinary vaccines produced in and imported to Africa and facilitates the standardization of veterinary vaccine production and quality control techniques in Africa. Produces and distributes essential biological reagents for animal disease diagnosis and surveillance, and promotes the transfer of appropriate vaccine production technologies to Africa.



Appendix II: Poultry Value Chain for Various Poultry Production Systems

The Large-Scale Commercial Poultry Production Value Chain

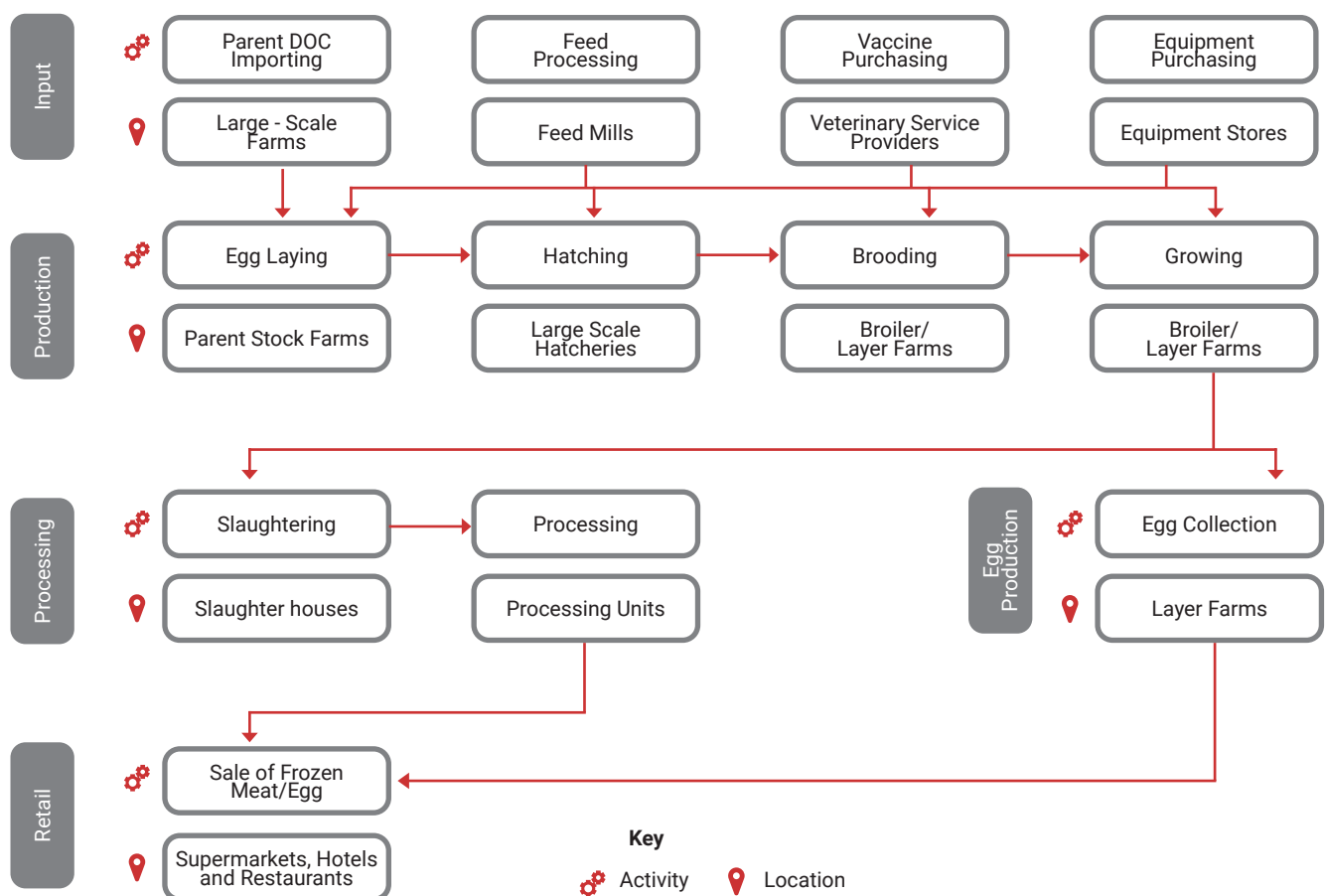


Figure 5: The Large-Scale Commercial Poultry Production Value Chain

The Small-Scale Commercial Poultry Production Value Chain

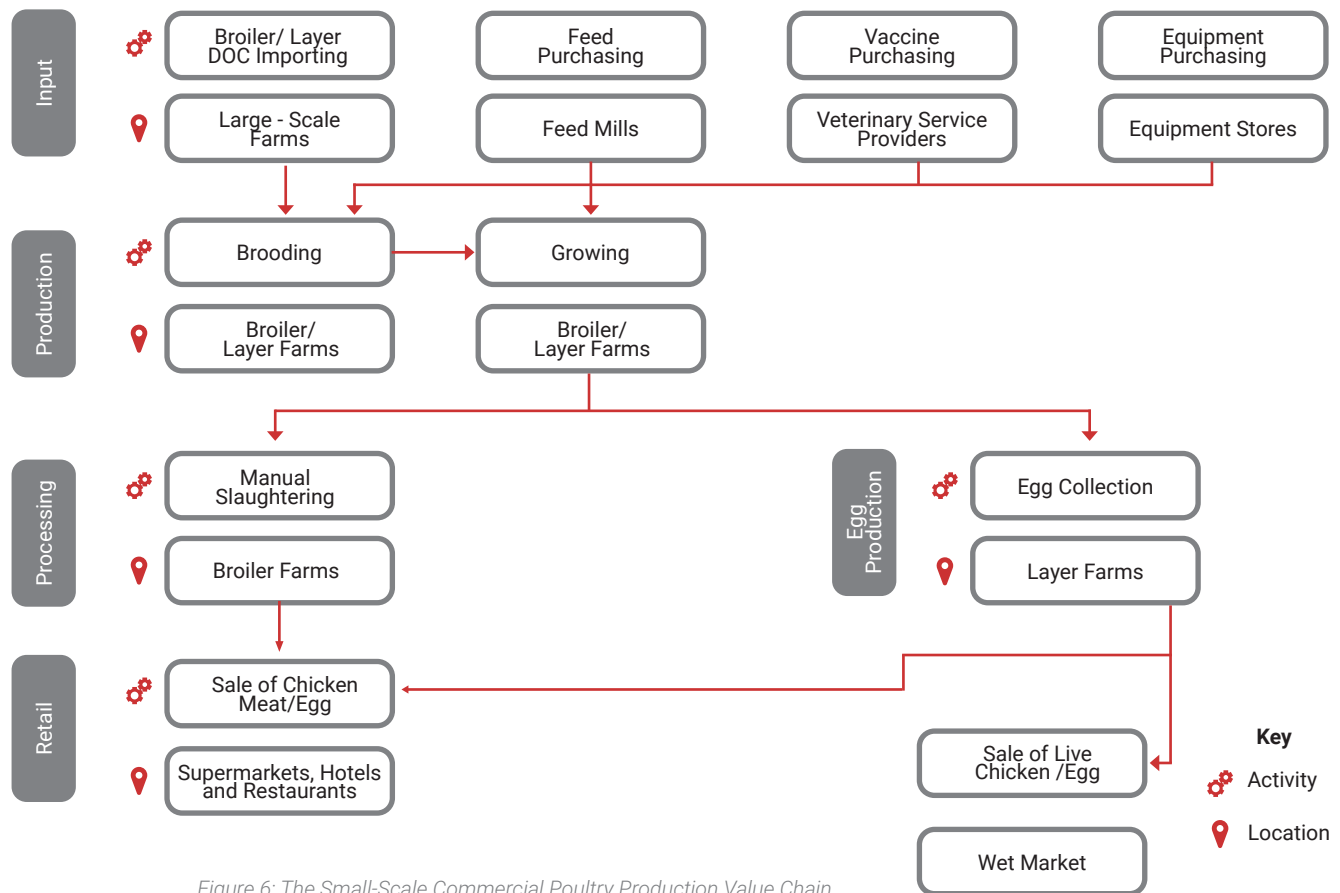


Figure 6: The Small-Scale Commercial Poultry Production Value Chain

The Backyard Poultry Production Value Chain

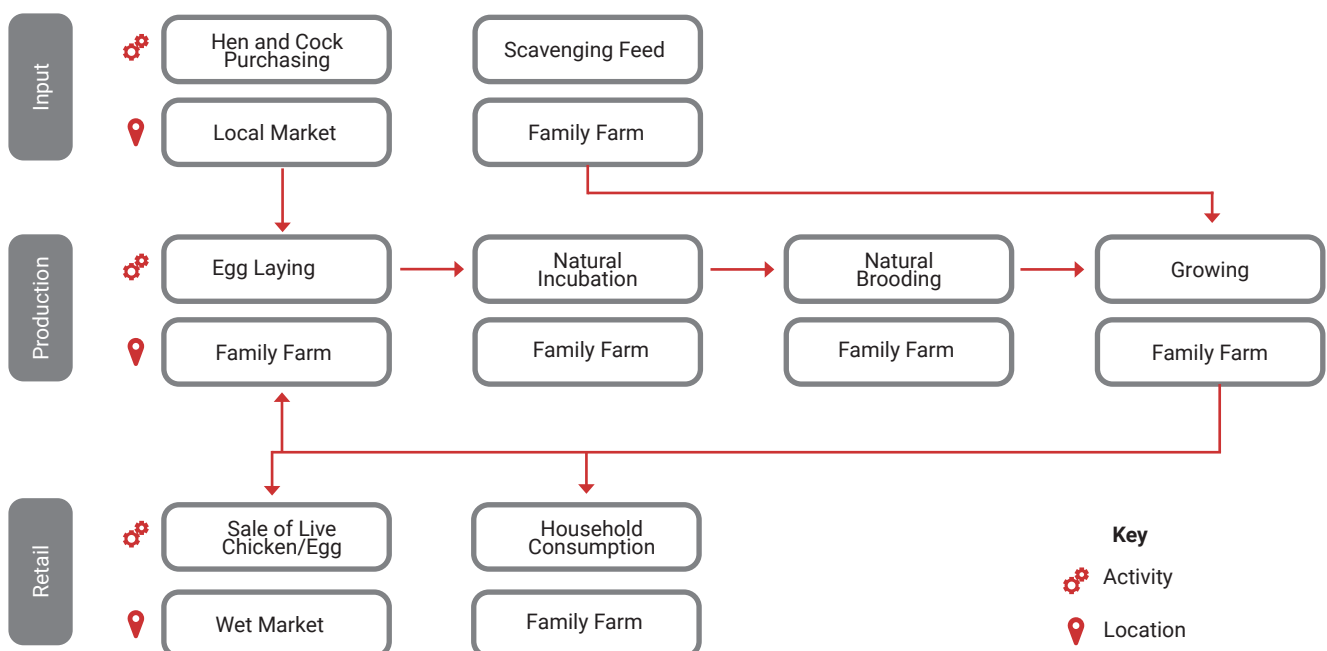


Figure 7: The Backyard Poultry Production Value Chain



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