Poultry Technology Toolkit Catalogue

TAAT Clearinghouse

Clearinghouse Technical Report Series 016

Poultry Technology Toolkit Catalogue

The Technologies for African Agricultural Transformation (TAAT) is funded through a grant from the African Development Bank and is implemented by the International Institute of Tropical Agriculture (IITA) in close collaboration with other CGIAR centers (formerly the Consultative Group for International Agricultural Research) and specialized institutions such as the African Agricultural Technology Foundation (AATF), the Forum for Agricultural Research in Africa (FARA), the International Fertilizer Development Center (IFDC) and others. For more information, email *plwoomer@gmail.com.*

Front cover photographic credits: Kuroiler, a popular dual-purpose chicken breed available in Africa (left) and vaccinating chicks against Newcastle Disease (right). Credit: ILRI and Global Alliance for Livestock Veterinary Medicines.

Correct Citation: TAAT Clearinghouse. 2022. Poultry Technology Toolkit Catalogue. Clearinghouse Technical Report Series 016, Technologies for African Agricultural Transformation, Clearinghouse Office, IITA, Cotonou, Benin. 28 pp.

Poultry Technology Toolkit Catalogue

A Report by the Technologies for African Agricultural Transformation Clearinghouse, August 2022

Table of Content

Purpose and Introduction

This catalogue describes a suite of proven poultry technologies that advance increased productivity of animal enterprise in Africa. It was developed through a collaborative effort between the Technologies for African Agricultural Transformation (TAAT) Program of the African Development Bank and its Small Livestock Compact coordinated by the International Livestock Research Institute (ILRI). Compilation was also supported by the Project Platform for Agricultural Solutions (ProPAS), an information portal where innovations are systematically characterized for open access over the internet. Both activities are addressing the imperative to better connect proven technologies to those who need them, but each undertakes this goal in a very different manner. Small livestock is one of nine commodity compacts with proven technologies that ensure greater self-sufficiency in protein for food and nutrition security in Africa. Poultry is also targeted as an agro-industrial commodity for processing and trading on domestic and regional markets. The Compact supports a wide variety of stakeholders through capacity development and technological outreach, and this catalogue contributes to that mandate. During the first Phase of the TAAT Program (2018-2021), the Compact introduced and reinforced these technologies in several countries including Ethiopia, Kenya, Mali, Nigeria, Tanzania, Uganda, and Zimbabwe, and plans to expand its reach into 2022 and beyond.

About TAAT. Weaknesses in the production and supply of food commodities are responsible for Africa's food insecurity, need for excessive importation of food, and unrealized expansion of Africa's food exports. The TAAT Program led by the International Institute of Tropical Agriculture (IITA) is pioneering new approaches to the deployment of proven technologies to African farmers. TAAT arose as a common effort of IITA and the African Development Bank (AfDB); and is an important component of the latter's Feed Africa Strategy. Currently, TAAT is advancing over 100 carefully selected technologies through 88 interventions in 31 countries organized around 15 "Compacts" that represent priorities in terms of achieving Africa's potential in achieving food security and advancing its role in global agricultural trade. Nine of these Compacts relate to specific priority value chains of fish, small livestock (including poultry), common bean, rice, wheat, maize, cassava, sweet potato, sorghum, and millet. Together these Compacts design interventions in collaboration with national programs to introduce technologies and innovations designed to meet ambitious targets for agricultural development. In many cases, these targets are addressed through the implementation of projects resulting from sovereign country loans awarded by development banks, where TAAT's role in the design, planning and execution of these loan projects is a vital element of their success and uptake.

About ProPAS. The Product Platform for Agricultural Solutions (ProPAS) provides a mechanism to compile and access innovations and manage technologies and products needed for Africa's agricultural transformation. The platform provides two pathways: it permits users to enter their proven and promising solutions into a database, and then encourages others to sort through its options to reveal a suite of opportunities that can assist their agricultural objectives. ProPAS results from the recognized need by IITA to more systematically compile the full range of agricultural solutions available to modernize and transform African agriculture. Its operations provide ready access to different institutions or individuals to accelerate technology uptake and progress towards agricultural transformation in Africa.

About TAAT Technologies. The Clearinghouse developed a database of the Top 100 Technologies that are transforming African agriculture. It is based upon the approaches of the TAAT Commodity Compacts but also includes those from the CGIAR Collaborative Research Programs that are recently described as ready for next user. These technologies have a direct role towards the achievement of the Sustainable Development Goals. This catalogue presents ten technologies that serve to modernize poultry production systems, ranging from flock improvement, to feed formulation, broiler production and value addition to poultry meat processing manure, in Africa. Details on each of these ten technologies are included in the catalogue. It also describes the management of poultry with regards to climate action.

Technology 1. Flock Improvement of Meat and Layer Breeds

Summary. Inferior breeds with poor genetics and poorly controlled diseases are major limiting factors for poultry production in Africa. Naturally selected local chickens exhibit adaptation to adverse conditions but offer lower meat and egg production than improved breeds raised under better management. Heritable traits of interest in chickens include growth rate, egg yield, average daily gain, and feed conversion efficiency. Improved breeds are distributed through large hatcheries that produce and market chicks at affordable prices. Flock improvement refers to the process of successive improvement of chickens through improved genetics and management. The different breeds of poultry are grouped according to their production purpose (meat, eggs and dual-purpose). Chickens bred for meat are known as "broilers" while those for maximum egg production are "layers". Genetically improved chicken breeds, however, are not suitable for extensive production systems without supplementary nutrition, shelter, and veterinary services. Some chickens serve dual purpose, providing both meat and eggs often under less intensive management regimes suited to small-scale farming systems (see Technology 2). For more information contact Tadelle Dessie of the African Chicken Genetics Gains program at t.dessie@cgiar.org.

Improved breeds of broilers (top) and layers (bottom)

Technical Description. Improvement of chicken breeds involves accurate identification of individual chickens, accurate recordkeeping, and measurement of desired production traits. With reasonable knowledge of genetic selection, it is possible to develop new breeds that better suit producers' conditions. Chick producers select birds with desirable traits in meat production (for broilers), and egg production (for layers). The best performing males (cocks) are mated with the best performing females (hens), and the fertilized eggs recovered. These eggs are incubated and hatched over about 21 days in commercial facilities with capacity to produce thousands of chicks in a continuous manner. The common product is day old chicks (DOCs) that are marketed to farmers who rear them either for meat or egg production. The DOCs are best delivered alongside other technologies described in this catalogue including vaccination and feeding practices.

Uses and Composition. Breeding for flock improvement by industrial chicken farms mainly takes place through semen collection whereas in extensive small-scale system the genetic resources are preserved in living populations. Breeders and farmers can collaborate in developing new breeds of chickens better adapt to specific management and environmental conditions. The requirement for maintaining an improved chicken flock include suitable protection from predators and inclement weather, good nutrition through balanced feeds and routine vaccination. It also requires good infrastructure and capital investment.

Application. Different methods are used for flock improvement, such as individual selection, family selection, progeny testing, sibling testing, and pedigree selection. Techniques such as artificial insemination and semen collection and preservation can be applied. The DOCs are generally reared in a brooder house under controlled climate conditions and optimal nutrition. The brooder house, which simulates the traditional brooding of a mother hen, is aimed at conserving heat and light, nurturing, and protecting the DOC from predators. A brooder house can be constructed from simple materials such as cardboard, wood, insulated metal sheets or concrete. Poultry houses must be constructed on well-drained lands, and need to control heat, light and wind. The ideal temperatures for chicks 34° to 38°C and birds become more adaptable as they get older. The feed, water and medication are delivered to chicken via feeders and drinkers. The feed of improved chickens is formulated rations with specific energy protein and mineral contents (see Technology 5). Feeds formulations change over time as chickens develop.

Selective mating for flock improvement

Commercialization, Start-up Requirement and Production Cost. Several industrial brooding companies in Africa rear improved breeds, such as Zartech in Nigeria, Kenchic in Kenya, Ethiochicken in Ethiopia, and Irvine's Poultry in South-Africa. Under enabling national policies that promote private sector participation, international companies can partner with a local private sector and the public sector. The start-up requirement for developing a flock improvement program include acquiring a license to breed stock and market chicks. The production facilities such as the breeding pens, incubators and hatcheries must be designed and installed according to sound management principles and a rigorous financial plan. The cost of establishing a poultry breeding company can run into millions of dollars.

Customer Segmentation and Potential Profitability. Production of improved poultry breeds is a lucrative commercial activity and suitable for specialty breeding centers and intensive farms. For layers, the main objective of a breeding program is to bring improvement in traits such as age of first laying, egg number, egg weight, fertility, egg quality and feed efficiency. For broilers, the indicators for maximizing economic value include body weight at maturity, growth rate and feed conversion rate. Tolerance to high temperature is a key factor that can be improved by incorporating single genes that modify or reduce feathering such as naked-neck, scaleless and frizzle genes. Improved breeds can attain 1.5 to 2.5 kg live weight gain in only 6 to 8 weeks in contrast to local breeds that may require to six months to attain the same weight. The annual egg laying potential of local breeds reared under extensive management is 30-60 per hen with an average egg weight of 38g while for improved breeds of chicken under intensive management this around 250 per hen with average egg weight of 50-56g.

Licensing Requirements. Poultry flock improvement programs operate in both the public and private sectors and access to improved parent material may be negotiated through them. Livestock research institutes such as ILRI also develop chicken breeding program.

Technology 2. Dual-Purpose Chicken for Small-Scale Producers

Summary. Most indigenous chickens have low levels of egg and meat productivity and high mortality rate. Breeders have developed "dual-purpose" chicken that produce both egg production and meat, and are low cost, disease resistant, heat tolerant, and feed efficient. The distribution of these improved breeds to farmers takes place by companies that establish a parent stock and hatchery operation. Day old chicks (DOCs) from the parent stock farm are then transported to brooder units who specialize in the brooding, feeding, and proper vaccination process for the first 30-40 days of the chicks' life. This model makes it possible to deliver improved dual-purpose breeds to large numbers of farmers and gives chickens a high chance of survival due to their good start. One of the best examples of this approach is the African Poultry Multiplication Initiative (APMI) which started 1,590 brooder units in Tanzania and Nigeria, delivering 10.7 million DOCs to 525,000 smallholder farmers. For more information contact Tadelle Dessie of the African Chicken Genetics Gains program at t.dessie@cgiar.org.

A young farmer rearing improved dual-purpose chickens

Technical Description. Dual-purpose chickens are more appealing than indigenous breeds because of their excellent performance in small free-range flocks, mixture within different age groups, ability to scavenge, efficient use of nutritional supplements, and better performance in both meat and egg production compared to indigenous breeds. The improvement strategy used in producing dual-purpose chickens is the same as purebred broiler and layer breeds (see Technology 1). Distribution starts with a private company that acquires a parent stock and supplies brooder units with DOCs alongside feed and proper vaccination. After rearing the chickens for about four weeks, they will be sold to smallholder farmers who rear them under extensive production system for up to three months for sale as broilers. Another model involves raising chicks under semi-intensive systems for 6-12 weeks for meat. Alternatively, these chicks may also be reared for five months and sold as pullets to other farmers who rear them for egg production over the next 10 to 15 months before selling the "finished" layers for meat.

Uses and Composition. Distribution chains for dual-purpose chicken can be set up in any African country but may need adjustments per country. Dual-purpose chickens are often better suited to less intensive management. These dual-purpose breeds are known for many desirable features of indigenous chickens, such as colorful plumage, resistance to diseases, adaptation to tropical conditions and the ability to scavenge their own food. The main improved dual-purpose breeds are Kuroiler and Sasso, which are available in Uganda, Tanzania, Zambia, Ethiopia, Mozambique, Burkina Faso, and Zimbabwe. Some indigenous chicken breeds such as the Fulani Ecotype are also considered as dual-purpose.

Application. Brooding unit operators receive technical support in the production of healthy, vaccinated chickens and gender empowerment from Village Poultry Agents. DOCs receive additional heat, light, feed, and medication for up to 21 days before the young birds are allowed scavenge outdoors. This prevents predators and supports early, specialized nutritional and physiological needs. These units are built to specification according to the desired production capacity. Necessary inputs are formulated feeds such as chicks-, grower-, and layers-mash (see Technology 5), adequate clean water, vaccination, provision of vitamins. The poultry house must be cleaned, disinfected between production cycles to avoid pests and diseases.

Distribution model for the dual-purpose chicken breed

Commercialization, Start-up Requirements and Production Cost. Viable commercial production of dual-purpose chickens is ongoing across multiple African countries. Ethiochicken has production farms, two hatcheries and a feed mill that have delivered 10 million DOCs to over a million households across the country. Amo-Sieberer in Nigeria has 1.2 million birds, a 120,000 metric ton feed mill and over 2,500 staff. Smaller scale operations are also feasible depending on resource availability and desired flock size. To start a dual-purpose chicken enterprise, one should build a simple chicken house, buy the necessary rearing equipment, and have sufficient resources for buying feeds and vaccinating. A 100 to 150 m^2 room is suitable for rearing 1000 to 2,000 chicks for 4-5 weeks, including spaces for a brooder unit, growers house, and equipment/utility store. It costs about US $930 to purchase and rear 1000 birds for five weeks.

Customer Segmentation and Potential Profitability. In most cases, dual-purpose chicken breeds are produced by the same companies that supply broilers and layers. The profitability of a standard brooding unit in Nigeria is 30% per batch, depending upon reliance and cost of purchased feed. Under smallholder conditions, these chickens can reach a weight of 1.5 kg to 2.0 kg in 3 months and produce about 120 to 180 eggs annually. This contrasts with indigenous chickens that weigh 1.2 kg to 1.7 kg after six months and lay only 75 eggs per year. Improved dual-purpose breeds also have lower mortality and better growth rate. Studies by SAPPSA in Nigeria, Tanzania, and Ethiopia, have shown that smallholder farmers can substantially improve their livelihood by rearing dual-purpose breed.

Licensing Requirements. The ownership of the dual-purpose Chicken breeds belongs to the commercial poultry hatcheries that market them, although once purchased these birds can reproduce on their own.

Technology 3. Artificial Hatching in Semi-Automatic Incubators

Summary. The number of chicks that can be produced by hens via natural incubation is limited to 10-12 chicks per hatch. Such a rate does not allow rapid scaling of new breeds and reliable supply of young birds needed to expand poultry farming. Artificial hatching in semi-automatic incubators makes it possible to rear day old chicks (DOCs) within 21 days. These incubators successfully hatch 85-90% of fertilized eggs, save space and lower production cost which are key factors in obtaining good profit for an enterprise. Further advantages of artificial hatching are that many chicks can be produced in a short period of time and that production can be planned when there is need or demand. The process also avoids spread of parasites and diseases. Improved supply of chicks allows for increased consumption of eggs and poultry meat, leading to greater incomes for chicken farmers.

Digital semi-automatic egg incubator

Technical Description. Artificial hatcheries mimic the process of incubation by a brooding hen but at a larger scale. Small incubators are designed to hold 50-150 eggs at a time. Semi-automated incubators heated with kerosene, or a battery-powered light bulb offer an alternative to grid electricity. In semi-automatic hatcheries, eggs must be turned manually but trays and traction rod can be used that allows you to rotate all of them at once. Fully automated incubators exist that turn eggs with rollers, but these are more expensive. Less sophisticated versions that do not require electricity have oil lamps as heating source and an insulated wooden box for hatching. Incubators may also be made from refashioned refrigerators. Many simple designs are available that use cardboard boxes and incandescent lights as heating sources.

Uses and Composition. Small semi-automatic artificial hatching incubators are ideal for rural communities that are removed from commercial distribution networks, making it possible for them to access healthy chicks of improved breeds. Large fully automated incubators serve the needs of areas that have several industrial scale poultry farms. There are many commercial artificial incubators of varying capacities. Most depend on electricity, but some use gas or kerosene for heating. Semi-automatic incubators powered by electricity consist of temperature and humidity micro-controllers, low-speed axial fans, wet and dry build thermometer, hatching shelves and metal casing.

Application. Fertile eggs must be collected carefully and stored properly until they are incubated. Eggs initially need a very controlled heat input to maintain the optimum temperature of 38°C. As the embryo grows (especially after 18 days), it produces more heat than it requires and may even need cooling. Moisture levels of 60% to 80% are important to stop excess moisture loss from the egg contents through the porous eggshell and membranes. Eggs must be turned three times a day for about 18 days. Hatchability will decrease if eggs are handled poorly or get too hot or too cold. The hatching incubator must be placed in a clean location where it can be securely operated. These eggs are inspected to be free from cracks and dirt and marked on one side with a marker to facilitate systematic turning of the eggs. Eggs are inspected against a light to determine their development stage, referred to as "candling". Young chicks must be vaccinated against Newcastle Disease, can then be sold to brooder units. After each batch, remove the unhatched eggs, clean, and disinfect the incubator to prepare for the next cycle.

Candling to determine egg development stage

Commercialization, Start-up Requirements and Production Cost. Semi-automatic incubators are sold by suppliers of farm equipment in Nigeria, Ghana, Cote-D'Ivoire, Ethiopia, Kenya and elsewhere. The prerequisites for successful chicken incubation are enthusiasm for the business, training in incubation operations, and identifying markets for the young birds. Sales often occurs through nearby agro-veterinary shops in conjunction with the sales of feed mash specifically intended for chicks (sometimes referred to a starter mash). It is important to produce improved breeds of poultry. Start-up and production costs include incubators costing as little as US $100 depending on size and sophistication. A 64-egg manual solar unit costs $150 and a fully automated 96 egg unit costs US $200. Fertilized eggs cost between US $0.15 and $0.35 each, and vaccination offered at a cost of US $0.05 to $0.10 per chick. Labor costs are about US $20 per batch for semi-automated operations.

Customer Segmentation and Potential Profitability. As the demand for improved chicken breeds in rural and urban regions increases there is ample scope for retail of artificial egg incubators and starting a hatchery. The market for artificial incubators is differentiated according to size, application for farm or breeding, and power source. A hatchery generates revenue from selling chicks which are priced at US $0.60 to $0.85 each. Investing as little as US $500 can start a hatchery business with a return on investment of 20% when cycles are well organized and input costs are kept in check. Factors like loan interest, depreciation, energy tariffs, vaccine costs, hatchability and technical broiler performances strongly influence the best size of hatchery operation and its profitability.

Licensing Requirements. Due to the risk of spread of poultry diseases such as Fowl pox, Pullorum and Newcastle disease, quality control is critical in running a hatchery. National veterinary departments in most countries may have regulations and require licenses to approve the operation of a commercial chicken incubator business.

Technology 4. Low-Cost Cage and Free-Range Containment

Free-range chickens in a pasture

Summary. Housing poultry protects birds from predators and climate extremes in ways that minimize stress and enhance productive gain. In addition, suitable housing contributes to ease of collecting wastes, biosecurity, sanitation, and feed management. Commercial poultry production requires sophisticated housing types and automated equipment. However, most smallholder farmers cannot afford the cost of building elaborate poultry houses. In addition, consumer interest is growing with regard to organically produced foods and free-range birds receiving access to green vegetation and outdoor, rather than caged conditions. As a result, there is rapid growth in demand for construction and deployment of movable pens. This mobility also prevents the accumulation of pests and disease, reduces feed costs, and naturally spreads manure across fields.

Technical Description. Moveable, low-cost poultry sheds accommodate free-range chickens. These houses provide night shelter and are usually equipped with nests and perches. During the day, birds are permitted access to surrounding fields where they scavenge and feed. The birds are not confined to battery cages or crowed pens like in conventional industrial scale production systems. Improved dual purpose chicken breeds such as Kuroiler and Sasso are best raised in low-cost, free-range conditions. Besides shelter, the chickens receive supplementary feeds in form of formulated ration, water, and necessary vaccinations against virus diseases. In contrast to intensively reared chickens, free-run chickens are usually not administered antibiotics. Access to green leaves, insects and worms assures a strong immune system and healthy chickens. Organic chicken production is more feasible under free-range conditions.

Uses and Composition. Low-cost, movable containment and free-run poultry operations chickens is practiced at a commercial scale in many countries, including Kenya, Nigeria, Cote D'Ivoire, Ethiopia and Ghana. This production is well suited to peri-urban areas and integrated into cropping by moving chickens around within blocks of open land. The materials required for constructing a movable, free-run chicken pen includes wood, roofing sheets and flexible galvanized chicken mesh of 0.3 cm to 1.0 cm dimensions. Chickens require about 0.2 m^2 of floor each or 20 m^2 for 100 birds. For layers, an additional 0.03 m^2 nest box is required, positioned in ways that allows easy access to eggs. In general, houses should not be longer than 5m to 8m or they become too difficult to move. Larger houses can be equipped with wheels or rollers for ease of moving it around.

Application. Poultry houses should have good ventilation by providing about 30 cm of mesh on top of two opposite sides. Cross Ventilation provides fresh air and regulates house temperature. It facilitates expelling of CO_2, ammonia, moisture, dust, and odor. It should have a disinfectant dipping vat at the entrance. The house should be cleaned and disinfected between production batches and after removal of accumulated manure. Other basic requirements for these poultry houses include good drainage, placement on level surfaces and secured entry against predators, wild birds, and rodents. The house should be aligned in an east-west orientation to minimize prolonged sunshine inside the house. The floor of the house can be raised about 0.2 m from the ground and finished with mesh to permit dropping to fall through to the ground.

A moveable poultry house for free-range production with sheltered forage area

Commercialization, Start-up Requirements and Production Cost. Start-up begins with access to suitable land for free-range production. This land should be flat or gently sloped and contain edible green vegetation, but not crops that can be damaged by foraging birds. Prospective poultry farmers should conduct market assessment to determine that there is demand free-range chickens. Once housing is secured, costs depend on whether the land is bought or leased, the cost of chicks, supplemental feeds, veterinary care and marketing. An estimated US $350 is sufficient to raise 150 to 200 chickens under a free-run system.

Customer Segmentation and Potential Profitability. There is strong market demand for free-range chickens and willingness of consumers to pay a premium for them. The dividing line between traditional free-range chickens and free-run improved chickens can be thin and will depend mainly on the breed of chicken used. Free-run meat chickens attain a mature weight of 2.0 to 2.5 kg in 3 to 4 months compared with commercial broilers that reach the same weight in only six weeks. Free-range birds may also be raised for eggs, providing about 180-200 eggs per year. The eggs from free-run chickens have bright yellow yokes due to the consumption of carotenoids in green leaves. The meat and egg from free-run chickens are considered tastier but usually cost more than commercial broilers. Birds raised for US $3 each can typically be sold for US $4 to $5 each, resulting in a return on investment of 50% on investment. This return does not consider enhancement of land quality within the free-range area.

Licensing Requirements. There are no licensing requirements for operating a low-containment free-run chicken. Nor are there usually authentication mechanisms for claims of free-range and organic production.

Technology 5. Local Production of Quality Affordable Feed

Summary. Availability of safe low-cost poultry feed is a prerequisite for enterprise profitability and growth. Efficient feeding systems promote high productivity and reasonable profits despite feed generally comprising about 70% of conventional production costs. In the same way, lack of affordable and adequate feed prevents small-scale farmers from expanding their operations. This raises the possibility of producing lower cost feeds from locally available and seasonal materials. Local energy and protein ingredients may be blended and combined with purchased additives, into formulated feeds for different development stages of birds. Costs of feed can further be reduced by free ranging (see Technology 4), use local by-products and edible leaves. Proven technologies exist to combine these diverse feed sources into systems that improve local supplies of meat and eggs and generate additional profits for local producers.

Different types of composite feed for varying stages of development

Technical Description. The purpose of locally blended feeding is to select the right combination of feeds for a balanced ration while at the same time reducing dependence on more expensive purchased feeds. Energy, protein, minerals and vitamins are required in different proportions by chickens depending on their age and level of production. Feeds falling below a critical threshold of crude protein (about 20%) impede weight gain or egg production. A simple blended feed consists of 50% maize or wheat, 21% soybeans, 14% bran, 8% oil press cake (e.g., groundnut, palm, sunflower), 2% fish and bone meal, 1.5% fortified "premix" (poultry supplement), 1% limestone and 0.5% salt. Feed formulations are further ground into mash for chicks or pelleted for larger birds. This formulation illustrates the importance of increased cereals, soybean and cooking oil production. This basic blended feed can be supplemented with other locally available or seasonal ingredients.

Uses and Composition. There is broad range of feeds with different formulations recommended for broilers (for meat) and layers (for eggs), and chicks are provided mash rather than pellets. Inexpensive options for feeding chickens include use of kitchen wastes, fodder from free-range practice (see Technology 4), and provision of green leaves and insects, although some of these sources are difficult to scale. Maggots are a rich source of proteins for chickens but less available than green materials. Chickens may be fed on whole or crushed grains, including broken and off-grade cereals but care must be taken to assure that


A horizontal mixer (top), mill (left) and pellet machine (right) used in small-scale feed production

Trays of hydroponic sprouted cereals intended for poultry feed

A chicken feeding on protein-rich maggots

the grains are not contaminated with mycotoxins. Sprouting grains increases their vitamin contents and digestibility and may be scaled through hydroponic culture. Note that improperly stored grains and household wastes are susceptible to rot that negatively affect the health and growth of chickens. The use of dried, milled cassava peels is increasingly recognized as an alternative energy ingredient.

Application. Traditional poultry producers have long fed locally available feed materials to chickens in household production systems, and the challenge is how best scale up this knowledge. Sprouted grains are produced by soaking seeds in in water for one to two days and then placing them in shallow trays to germinate for about seven days. The by-products of grains from milling are also suitable for poultry. Maggots can be produced by mixing fresh animal manure with dry straw in a large basin, attracting flies. This technology is scaled through production of confined Black Soldier Flies that feed upon the peels and wastes of fruit.

Commercialization, Start-up Requirements and Production Cost. Localized manufacturing of pelleted chicken feed represents a viable enterprise opportunity in support of expanding poultry production in Sub-Saharan Africa. Use of sprouted grains in poultry feed is now commercialized in Kenya and Tanzania. The costs of feed production depend upon the projected level of production and the available ingredients and costs. A machine that grinds, mixes and pellets 1 ton of poultry feed per hour costs about US $36,000 in Nairobi. Larger units process up to 5 tons per hour and produce pellets of different sizes ranging from 2.5 mm to 4 mm. Mixers, mills and petting machines purchased separately that can process and bag 100 to 200 kg feed per hour cost about US $3,000.

Customer Segmentation and Potential Profitability. The manufacturing of fish feed pellets with locally sourced ingredients and automated equipment is relevant for privately owned or community-based enterprises. Companies that supply, engineer, and build feed production lines need to maintain close contacts with local producers, distributors, and government agencies for delivering services that match market conditions. In Malawi, use of local ingredients at a commercial scale reduced the cost of feed from US $482 to $270 per ton. Mash from transformed cassava peels is only 50% the cost of grain and can replace 20% of the maize used in growers ration and 35% of the maize for layers mash.

Licensing Requirements. There are no licensing requirements for operating a local, low-cost feed production, however, once commercialized feed producers are subject to a suite of standards and regulations intended to ensure the quality and safety of their products.

Technology 6. Universal Vaccination against Newcastle Diseases

Summary. Poultry production in Africa is severely undermined by the Newcastle disease. This viral disease spreads by airborne droplets from coughing or sneezing among infected birds making it highly contagious. Wild birds, contaminated eggs and dirty clothing also transmit the virus. Chickens of all ages are affected but young chicks are most susceptible, with mortality levels as high as 100% percent. In older chickens, mortality is usually lower, but egg and meat production are much reduced. Fortunately, Newcastle Disease is controllable through vaccination and widely practiced by commercial poultry producers. In the past, adopting universal vaccination has proven difficult across Africa, particularly at the village level largely due to the rigorous cold chain requirement for distributing the vaccine. More recently, the development of new thermostable vaccine ND I-2 has resulted in proactive and strict control of this disease threat.

Symptoms of Newcastle Disease

Technical Description. Universal vaccination using the thermostable ND I-2 vaccine is an ambitious but achievable goal. ND I-2 vaccine was developed using a temperature tolerant strain of the Newcastle Disease virus that results in thermostability of the antigen. Nonetheless, cold chain requirements should be respected when transporting the vaccine to remote areas by carrying it in coolers with ice packs. Other advantages of available vaccines include low-cost, availability of smaller vials containing 100-200 doses, ease of reconstitution using pre-packed sterile water, suitability for chickens of all ages and the simple means of application using plastic eye droppers. The latter characteristic minimizes the chances of contamination during application and reduces the risk of vaccine failure. An important backstopping measure is the widespread training of vaccinators.

Uses and Composition. Vaccines can be transported in thermos flasks on bicycles and motorbikes and quicky distributed to villages and flocks offering affordable services for smallholder poultry farmers in remote communities. Effective immunity against local strains of Newcastle Disease from many countries is provided by the vaccine. This vaccine is easily administered by eye droppers but should be used the same day or following day after refrigerated purchase. After reconstitution (rehydration), the vaccine should be used within 2-3 hours. For full protection of layers, three doses are required at four monthly intervals. Vaccinators use insulated cooler bags, ice packs, syringes, sterile water bottles, and plastic eyedroppers to deploy the vaccines on the specified schedule. Vaccinators must wear recognizable uniforms and badges for wider recognition of their efforts.

ND I-2 vaccine is available in small vials

Application. These vaccines are produced in Africa through a technique known as "master seed egg amplification" from disease-free flocks. In Uganda, Brentec Ltd. recently produced over five million doses of ND I-2 vaccine. DBellium Nigeria Ltd. administered two million doses of ND I-2 vaccine in Jos over one year. Similar production levels occur in Kenya and Tanzania through support from the Global Alliance for Livestock Veterinary Medicines (GALVmed). Prior to vaccination, vaccinators assess the number households and chickens, and then register interested households, agreeing on the date of vaccination. Vaccines are stored at 8°C until deployment. Poultry farmers must gather their chickens in advance to assure streamlined operations.

Vaccination droplet to eye of mature chicken

Commercialization, Start-up Requirements and Production Cost. The ND I-2 vaccine is widely available in several African countries including Kenya, Zambia, Uganda, Mozambique, Ethiopia, Cote D'Ivoire, Ghana, Malawi, Nigeria, and Tanzania. Vaccination campaigns may be conducted as local businesses by veterinarians and trained vaccinators. Farmers must be sensitized to the threat of Newcastle Disease and be willing to pay for vaccination. Service providers must register clients and arrange for vaccines, usually at three-to-four-month intervals. Chick producers should also vaccinate their young birds before marketing them. A dose of the ND I-2 vaccine costs only US $0.02 and is inexpensive to administer. A farmer with twenty chickens may expect to pay about $2.50 for one round of vaccination. An investment of only $250 is sufficient to launch a local vaccination campaign at the village level.

Customer Segmentation and Potential Profitability. There is no specific segmentation regarding vaccination as all poultry owners benefit similarly but larger operators have the option of administering vaccines via drinking water or independently treating their own flocks. Under field conditions in Tanzania and Uganda, data shows that a vaccinator can treat up to 2,000 chickens per month when supported by GALVmed, making it a profitable enterprise.

Licensing Requirements. Administration of vaccines and biologicals, including the ND I-2 vaccine, is governed by the national veterinary services of the respective countries. This is because sourcing vaccines from the right source, cold chain management and vaccine administration are best regulated to ensure the efficacy of vaccines. Vaccine misuse can inadvertently introduce new disease strains with dire consequences on the poultry industry. However, poultry farmers, accessing the service through registered vaccinators do not require licensing rights to use this technology. Vaccinators and veterinarians are therefore licensed and guided by their respective national veterinary drug control laws.

Technology 7. Biosecurity for Disease Prevention

Summary. Due to the large number of poultry and concentration in flocks it is imperative that producers put in place precautionary measures to prevent the introduction and spread of disease-causing organisms. Biosecurity consists of a bundle of preventative disease control measures practiced by poultry producers. It reduces the risk of disease agents moving onto farms from outside, the movement of diseases within same farm, and carryover of disease agents between different flocks on a farm. Diseases may lead to mass culling of a flock or even an entire farm, thus justifying the cost of attention to fundamental strategies that prevent transmission of pathogens in the farms. The effectiveness of a biosecurity program can be optimized by regional participation since the practices are more effective if all poultry producers apply them.

Technical Description. Biosecurity involves a set of practices and strategies that are guided by the design and day-to-day management of poultry production units. Its three main elements are isolation, traffic control and sanitation. Poultry farmers and workers benefit from training on the importance of biosecurity measures for their personal health and profitability of the business. Diligent surveillance is key for early detection which can greatly reduce the impact and spread of disease to other flocks. Poor biosecurity standards can undermine vaccination and medication, and good flock and feed management practices.

Uses and Composition. Precautionary measures against diseases are required in every part of the poultry value chain

Key elements of biosecurity on a poultry farm from breeding centers, hatcheries, brooding units, layer and broiler farms to feed blending and processing factories. Biosecurity measures protect against a wide range of pathogens, incl. Newcastle disease (see Technology 6), Avian cholera, Marek's disease, Salmonella, Coccidiosis, Mycoplasmosis, Colibacillus, and Avian Influenza, some of them also posing a threat to humans.

Application. Poultry houses should be located away from heavily populated human settlements, and other animal production systems. Every poultry operation should have an isolated area for the treatment of sick chickens until their full recovery. Newly acquired birds should be quarantined for fourteen days and vaccinated before being introduced into the main flock. Workers must always wear boots, overcoats, gloves, and face masks, and these must be regularly disinfected. Each poultry house should have a footbath at the entrance with a strong cleaning solution. Facilities for feed storage and processing birds should be located 30m to 50m away from production houses. Vehicles entering the premises have to drive through a water sanitation pan. Poultry manure is to be kept at least 20m away from production units (see Technology 8). Infected chickens must be burnt or buried off site. Fencing of premises with mesh wire helps to keep out rodents, wild birds, and domesticated animals that carry diseases.

Wire mesh fencing to keep out animal pests (left) and drinking device for reduced water-borne disease spread (Source: dreamstime.com)

Commercialization, Start-up Requirements and Production Cost. Poultry farmers should work with veterinarians and engineers to design secure premises and appoint a staff member as biosecurity leader. The cost of biosecurity is about 2% to 5% of total operations cost. Materials for preventing disease spread amount to as little as US $0.036 per bird for broilers and US $0.076 per bird for hatching egg producers.

Customer Segmentation and Potential Profitability. Biosecurity practices are equally relevant to commercial and smallholder producers but vary depending on flock size. Prevention of disease is always less expensive than treatment and can lead to a 50% reduction in veterinary costs. Increased egg production and feed efficiency due to precautionary measures render it highly cost-effective, with a cost/benefit ratio of 1:49.

Licensing Requirements. There are no licensing requirements for operating biosecurity measures on poultry farms, rather it is considered a sound business practice. Serious disease outbreaks should be reported as soon as possible to local authorities. In some cases, requirements are in place for signposting disinfection points, entrances and exits, and clean and dirty areas.

Technology 8. Value Addition to Poultry Manure

Manure accumulated on the poultry house floor (left) and finished compost ready for use as an organic fertilizer (right)

Summary. Chicken manure is useful as an organic fertilizer to food and feed crops. It has the highest concentration of nitrogen, phosphorus, and potassium of all the manures. Chicken manure is seldom used directly because it can contain pathogens such as salmonella; it can 'burn' plants by damaging roots, and its odor is off-putting. Fortunately, it composts quickly into forms safe for people and plants. Small amounts of chicken manure produced in mixed smallholder farming systems is an asset, particularly when used as an ingredient of mixed compost and then applied to fertilize higher value crops. Massive amounts of manure produced by large commercial farms, on the other hand, pose an environmental and social liability from its unpleasant odor, leaching into groundwater, and methane emissions. Industrial scale processing options exist such as the production of organic fertilizer pellets and anaerobic digestion into biogas. Otherwise, the responsible disposal of waste from large poultry farms poses a major production cost.

Technical Description. Each chicken produces about three to five kg of manure monthly. Nutrients in chicken manure are valuable, but the material must be handled properly because fresh manure can damage plants. Composting detoxifies manure, and while doing so it is important to minimize the loss of ammonia. Optimal composting and storage conditions for chicken manure include keeping it in a covered area and retaining its liquid, because a significant amount of its nitrogen exists as urine. A simple way to add value to poultry manure is to operate a free-run chicken production system (see Technology 4). Another option is to collect manure from the poultry house floor, heap it a safe distance from the flock, cover the pile and allow it to compost for two to six months. Compost is ready when a stick buried 50 cm into the pile no longer feels hot to touch. The processed manure is then applied to the farmlands, reducing the need for chemical fertilizers.

Uses and Composition. Fresh chicken manure is rich in plant nutrients, containing 0.5% to 0.9% nitrogen, 0.4% to 0.5% phosphorus, and 1.2% to 1.7% potassium, as well as essential mineral nutrients in balanced ratio. Larger-scale industrial processing involves drying, granulation and pelleting.

Application. The main materials used in manure composting are the poultry manure and litter. In many cases fresh manures collected from poultry houses contains bedding material soaked with urine. Poultry composts may be layered with other materials every 10 to 20 cm and then mixed every few weeks. Low-tech equipment is needed such as forks, spades, and wheelbarrows. Pelletized manure is prepared by drying and grinding poultry manure, mixing it with ground husk or straw and a starch binder, and then passing it through an extruder or granulator. This process facilitates storage, transportation, and field application. The resulting product releases nutrients slowly and reduces leaching and run-off. These fertilizers also contain organic matter that acts as a soil conditioner, improving retention of nutrients and water. Poultry manure can also be used as a feedstock for anaerobic digestion to break down organic material for biogas and digestate production in a sealed vessel known as reactor. The biogas can be used to provide electricity and gas for cooking, while the digestate can be used as plant fertilizer and soil amendment.

Fertilizer pelleting machine (left) and final product (right)

Commercialization, Start-up Requirements and Production Cost. There is economic opportunity associated with value-addition poultry manure. Simple drying and pelleting equipment able to process several tons per day cost about US $5,000 to $10,000. An organic fertilizer production line from fermented manure that includes crushing, mixing, granulation, drying, screening and packaging able to process 15 tons per hour is available in China for about US $30,000. A 15 m^3 anaerobic digester able to process 300 kg of poultry manure per day costs about US $3,000 in China.

Customer Segmentation and Potential Profitability. Bagged chicken manure is sold as fertilizer for about US $50 per ton. Removing feces from poultry houses reduces the ammonia emissions from poultry sheds by about 90% which decreases respiratory illness of birds and mitigates the climate footprint of production.

Legal Requirements. Regulations against uncontrolled waste discharge and environmental protection laws drive investment in poultry manure processing. The nutrient contents of fertilizers must be labeled and authenticated through testing.

A batch digester for producing biogas from poultry manure

Technology 9. Mechanized Defeathering and Egg Sorting

Summary. The rapid increase of demand for chicken meat and egg calls for more intensive production systems with automated cleaning and sorting processes. After slaughtering chickens for meat, they require scalding and defeathering, before cutting the carcass. When done manually, this step is time-consuming, reducing output, and posing serious occupational hazard to workers. Grading eggs to specified weight, size and color is also labor-intensive and inaccurate when performed by hand. Mechanized defeathering and egg sorting systems are commercially available for smaller scale farm enterprises that increase throughput and improve product quality. When chicken reach target weight it is critical to process them quickly as the productive gain and feed efficiency decline. Defeathering equipment allows producers to quickly process chicken without damage and avoid rushed sales at a lower price. For eggs, different grades are demanded by hotels, restaurants, confectionery industries, and bakeries according to weight and color. Egg producers benefit from speedy, reduced handling costs and attracting premium prices for their highest-grade eggs. Mechanized sorting distinguishes grades faster and better than manual approaches, ease packaging and transportation, and reduce losses due to breakage.

Benchtop defeathering machine

Technical Description. Defeathering, also known as plucking, is the removal of feathers from carcasses. After chickens have been slaughtered, and the blood completely drained, the carcasses pass through a series of steps for removing different sets of feathers. The body is first submerged in hot water at 60°C for 2 minutes. Once scalded, the chickens are placed into a defeathering machines. These can typically handle four or ten chickens at a time, and the feather removal process is completed in only 30 seconds, whereas manual plucking typically takes several minutes per chicken. The removed feathers come out at an opening below the machine. Defeathered chicken are then passed on for evisceration where internal organs are removed. Systems for egg sorting are equipped with different sets of sensors that detect specific quality parameters like weight, color, shape, and cracks. Usually, a tubular lamp is fitted on the table so operators can see eggs that are "candled" while handling the infeed and packing. Egg graders consume little electric power and have very low maintenance costs.

Uses. Defeathering machines handle a wide range of poultry such as cockerels, broilers, turkeys, and old layers. Simple plucking drums that can handle one to five chickens at a time are available for small and medium scale poultry producers. Egg sorting machines are versatile and can be used for any type of small bird like hen eggs, quail eggs, duck eggs and goose eggs. Different configurations of graders suit different needs and demands, with lower capacity machines being ideal for small free-range layer chicken farmers.

Composition. Most defeathering machines are made of a drum that is fitted with multiple high-speed rotating metal discs that bear rubber fingers. The movement of these protruding parts over the body removes the feathers. Egg sorting machines are made of a series of weight sensitive belts that allow eggs to roll onto spaces to received eggs of different grades. The calibration of these belts determines the sorting and thus a critical part of operations. Egg sorters may be coupled with collectors in cages and box loading machines for full automation.

Automated egg sorter

Application. The capacity of the defeathering and egg sorting machines must be matched with the flock size and production line specifications. Both technologies require well-trained staff, and adequate water and electricity supply are required. Specialty slaughtering equipment are required to minimize animal suffering and keep meat safe. Once defeathered the whole chicken is coated to improve preservation or moved to a filleting line (see Technology 10). A fridge or freezer is needed to safely store the meat. For eggs, after collection they are first washed using an odorless detergent solution with cool water to prevent it from moving through the shell. It is common practice to spray eggs with food-grade oil to reduce moisture loss and bacterial growth. Processing equipment is made of stainless steel and must be cleaned regularly for maintaining quality standards and prevent adulteration with foreign materials.

Commercialization, Start-up Requirements and Production Costs. Chicken processing machinery is sold by retailers in most African countries and can otherwise be imported from overseas. When investing in mechanized equipment poultry farmers must have a good business plan with reliable market demand and prices. To match production volumes with machine capacities, there is need for technically competent personnel. It is necessary to understand environmental regulations and establish waste management procedures for successful mechanical defeathering. A heavy-duty electric benchtop defeathering machine with a drum of 50 cm diameter that can process three to four broiler chickens in less than two minutes is sold for US $550 by international suppliers, excluding taxes and shipment. Smaller models are available from US $250. Rubber fingers for replacement inside the drum cost about US $30 per set of 100. A medium-sized sorter with a capacity of 4,000 eggs per hour which can distinguish up to seven different grades costs US $5,500 - $7,000 without taxes and shipment.

Customer Segmentation and Potential Profitability. These automation technologies are suitable for poultry farmers with a few hundreds of chickens and may also be offered as a contract service. The use of defeathering and egg sorting machine saves costs and facilitates dressing and packing of chickens into various components. A defeathering business handling 200 to 500 chickens per day can generate a 15% - 20% return on investment. Egg grading ensures that farmers achieve appropriate quality and pricing which promotes marketing and increases profit margins.

Licensing Requirements. National food safety and environmental regulations apply to chicken defeathering and egg processing, with licenses required for operation.

Technology 10. Value Addition and Storage Techniques

Summary. Currently, less than 30% of chicken meat is processed into clean precut preserved products across African countries. Most poultry are sold on live markets and slaughtered on-site which gives farmers lower returns and causes supply shortages and public health hazards. Secondary processing of whole raw chicken into value-added products and cold storage allow sales to a larger consumer base all year round thereby increasing revenue for producers. The demand for ready-to-cook or precooked chicken meat by households, institutions, and restaurants is rapidly increasing due to urbanization, income growth, and awareness for healthy diets and food quality. Expansion of product ranges and sales of processed chicken meat is limited by a lack of adequate technology and skill, insufficient cold chain facilities, poorly organized marketing system, and trade barriers. Mechanized equipment makes it possible to process high volumes, and refrigerators and freezers allow long-term storage and long-distance transport. Value addition and storage facilities are available for small and medium enterprises, and farmers can form cooperatives to raise sufficient capital and volumes.

Processed poultry products popular with consumers

Technical Description. Poultry farming is showing rapid growth across Sub-Saharan Africa, but the secondary processing industry of this value chain does not advance at an equal pace. Precut and precooked chicken are convenient for consumers because they reduce preparation time, offer relished portions and parts, reduce health hazards and risks of home butchering. Processing and storage technologies make it possible to expand the range of poultry products, augment value for producers, stabilize supply on local markets, and upgrade this agro-food industry. Strict hygiene and quality norms of processed poultry products must be maintained to promote marketing and consumption patterns. Small electric slicers, deboning machines and grinders are best suited for low volume poultry processing, while fully automated outfits exist for large enterprises. Packaging for storage, transport and marketing can be done using wrapped trays or airtight packages, each serving different markets. Chamber-style vacuum sealers allow strict portion control, long shelf-life, and high food hygiene. External vacuum sealers are fast to operate and inexpensive. For preservation, processed poultry products must be rapidly cooled to 4°C within two hours after slaughter, achieved through different combinations of forced air, water immersion, spray, or vacuum chilling.

Uses and Composition. Semi-automated processing plants for small to medium-scale operations are usually located on poultry farms that have a capacity of handling a few thousand chicken per day. Fully mechanized chicken processing plants are located close to clusters of large poultry farms and usually have a capacity of more than 50,000 chickens per day. Equipment for cutting, deboning, grinding, and chilling can be bought as individual components or as an assembly production line. Depending on preferences of consumers poultry can be processed into two halves or separated into wings, legs, and breasts, with or without skin and bones. Further processing involves ready-to-cook marinated, chopped, breaded, crumbed, glazed, roasted, fried, and grilled products.

Low-capacity external vacuum sealer

Application. After defeathering (see Technology 9) and disembowelment the whole bird is passed onto cutting stations where it is divided into different parts. Deboning is most common for breasts (fillets and tenders), and sometimes applied to thighs. Before packaging and chilling, the clean and cut meat is portioned based on weight, length, width, and thickness. This step is key for marketing, price control and food safety. Restaurants and fast-food kitchens rely on portioning since they apply standard cooking procedures where meat is placed in a fryer at a set temperature and time. Portions that are too heavy or thick will not reach a safe internal temperature with programmed settings.

Commercialization, Start-up Requirements and Production Costs. Small to large poultry processing equipment is sold by retailers and manufacturers as part of the wider meat industry in large urban areas of many African countries. Various factors must be considered when beginning a poultry processing business; most importantly the laws and regulations concerning food safety and enterprises to get the permits and licenses, the target market to get the right product and sales strategies, the location with access to clean water, reliable electricity and waste disposal, and the appropriate size of equipment, staff training and quality assurance procedures. The main investment for a poultry processing plant are the machines for cutting, deboning, chilling, and refrigeration. Costs heavily depend on the capacity, location, and sundry expenses. Prices of small electric processing machines range from US $ 500 to $1,000. A basic processing plant with defeathering, cutting and storage lines for 500 chicken per day has a start-up cost of US $15,600. Further costs include salaries for butchers and electricity for running machines and cold storage facilities, which are more than US $4,000 in total for a 500-bird per day plant.

Customer Segmentation and Potential Profitability. The largest client base for processed poultry are supermarkets, restaurants, caterers, and institutions (e.g., schools, hospitals, and factories). High-quality and appropriately portioned chicken products open new markets and have a very large growth potential. Information from Ghana's poultry industry shows that a 500-bird processing plant has a net present value of more than US$ 110,000, a value:cost ratio of 1.06, and internal return rate of 303%. The sector analysis shows that investments become financially nonviable when the supply cost or sales incomes change by 9%. Generally, higher gross profits are obtained by larger enterprises, smaller operations have to manage costs more carefully.

Licensing Requirements. Some of the knowhow for preparing precut and precooked chicken products is a Public Good while details about the equipment design and production lines are protected. Food safety, enterprise and environmental regulations exist for poultry processing industries in African countries that must be through licensing and regular inspection.

Youth-Led Poultry Enterprise

Poultry offers one of the most promising business avenues for youth in Africa. A broiler farm offers returns in only 6 to 10 weeks. Layers require longer periods but offer incomes over many months. Depending on the scale of production, poultry business offers full time self-employment or a significant second income. Both rural and urban markets are strong for eggs and meat that poultry provides. This section describes the business models followed by youth in different parts of Africa.

Chicks raised under protective conditions (above) and black soldier fly raised in nets (below)

The most common poultry ventures are broiler production and egg production, both depending on reliable sources of chicks and feed. In Nigeria, a team of trained youth invested US $2,410 and eight weeks later realized a return on investment of 45% (= $1,084) from broilers raised in confinement. Day-old chicks from reliable hatcheries were carefully raised for 21 days and then transferred to pens and grown for an additional 42 days. They were sold live when the birds reached 1.8 kg. Feed was the most expensive production cost and the youth reduced it by blending their own feed from locally available, less expensive ingredients. For young poultry farmers, it is feasible to begin on small scale and then expand over time as new skillsets are achieved and capital accumulated.

At a Youth Agribusiness Park located in Awe, Nigeria, youth developed a poultry operation with a capacity of 2,700 birds. Birds are raised in battery cages with automatic water supply and manual feeders. The enterprise was established with US $8,660 of startup funds and after twelve months of operation, profits of $16,268 were realized, offering a Return on Investment of 188%. Manure is composed and packed for use as organic fertilizers by crop enterprises at the Park. This poultry enterprise was established to fulfil two purposes; the first to operate as profitable agribusiness enterprise and the second to serve as a youth training opportunity. It is succeeding on both fronts. The cost and availability of feed posed a constraint to the layer operations of a youth group near Cotonou, Benin, prompting their search for new feed sources. One solution involved the production of black soldier fly larvae that are rich in protein. Part of the fly diet is manure, further reducing feed costs. Another measure involved the processing of cassava peels into meal, partly substituting for maize mash as an energy source (see Technology 5). Indeed, youth are among the first to adopt some of the technologies presented in this catalogue! Nonetheless, there are some pitfalls associated with youth-led poultry enterprises.

Youth marketing live birds at a local market

Over-reliance upon self-hatching. Some youths do not rely upon the purchase of chicks from commercial hatcheries but rather strategize on producing their own. While this may save some costs, it delays the growth of their flocks, and may reduce their access to improved breeds as they become available. The situation is confounded by hatching errors resulting in unnecessarily high mortality rate of young birds. It is important that young farmers view reliance upon larger farms and commercial hatcheries as an asset and not a liability and not fall aback in scaling their businesses.

Incomplete disease management. Inexperience with poultry diseases threaten youth-led poultry enterprise. For example, a young broiler entrepreneur in Kaduna State lost about 15% of their 1,500 birds because he failed to detect a disease outbreak early. Nor was he practicing basic biosecurity protocols (see Technology 7). It is extremely important that young poultry farmers seek assistance from more experienced farmers, extension specialists and veterinarians and at the same time access information and diagnosis using digital tools.

Need for better recordkeeping. Queen Opute operates a 2000-layer egg production enterprise in Lagos, Nigeria and believes the key to her business success is through training in recordkeeping. Previously she was consumed with day-to-day production and marketing demands and failed to calculate her profits and losses. When she did so, it allowed her to adjust her operations in a meaningful manner.

Queen Opute learned the importance of accurate recordkeeping as essential to successful egg enterprise

Reluctance to engage in free-range operations. Youth-led start-ups seldom include free-range operations, rather they rely upon rearing in battery cages or pens. Perhaps free ranging suggests the less profitable non-confined mixed poultry rearing of non-commercial smallholders and youth do not understand the nuanced differences of Technology 4. Perhaps youth lack access to land required for free-ranging or are less able to access their niche markets. As customer demand for more humanely reared and organically raised poultry grows, more youth will likely be attracted to these systems.

Teams of youth are well positioned to explore horizontal operations to reduce production costs and access better markets. For example, an "angel investor" linked to a youth group to establish Chicken Chaos, an integrated farm and restaurant and together they managed a series of challenges. First, they produced small broilers suited for restaurants at six-week production intervals. Then they milled and blended their own feeds, including substitution with cassava peel meal to reduce production costs (see Technology 5). Next, they established the popular restaurant "Chaos Chicken". These youth operate as co-owners of the business. Means must be found to encourage these sort of ventures that combine experienced businesspersons with the ambitions and hard work of young poultry farmers.

TAAT as Your Technology Broker of Choice

The TAAT Program offers its services toward the advancement of modernized agriculture. It brokers a wide range of needed technologies and bundles them through a process of co-design into winning solutions. It recognizes that modernized agriculture must serve as the main engine for economic growth in Africa and operates accordingly. Change is intended to achieve not only food and nutritional security but also to meet obligations under climate agreements allowing collaborative efforts to better combine global, national, and community-level interests. TAAT operates from a unique perspective to mobilize innovative solutions through better partnering that includes honest technology brokerage and effective, scalable skills development through five key mechanisms.

- ☑ **Unique understanding:** Expertise is offered in the areas of site characterization and problem identification.
- ☑ **Innovative solutions:** Leadership is provided in technology brokerage and solution bundling based upon a dynamic portfolio of candidate technologies.
- ☑ **Better partnering:** Assistance is offered in the better co-design and management of projects prompting agricultural transformation.
- ☑ **Replicable approaches**: Assistance is available to advance skill sets in technology brokerage and project management through customized Training of Trainers activities.
- ☑ **Honest brokerage:** An independent capacity for impact assessment and constructive learning is achieved through standardized monitoring and evaluation.

These partnership mechanisms are applied to the technologies featured in this catalogue as:

1. **Improved Poultry Breeds** offering the latest advances in breeding for egg and meat production, and disease resistance.
2. **Models for Small-Scale Chicken Farming** including local hatcheries and affordable housing systems linked with community-based, franchising and outgrower production systems.
3. **High-quality and Affordable Feed Supply** to meet nutritional standards, accelerate growth rates, increase conversion efficiency and reduce production cost.
4. **Disease Surveillance and Vaccination Services** to prevent outbreaks of fast-spreading diseases, mass culling of flocks and public health risks.
5. **Value-added Processing and Storage** that enhance returns for producers, product and market supply and creating opportunities for industrialization and reduction of imports.

The TAAT Clearinghouse and Compacts are ready to assist in the design of national programs seeking to improve food and nutritional security, reduce importation of food and develop greater capacities to enter world trade through agricultural exports.

Conclusions

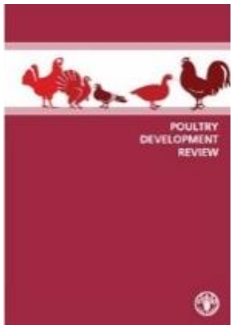
This catalogue provides a wide variety of options for modernizing poultry production and processing in Africa. It identifies means to improve meat and egg yield, feed supply, prevent disease, and strengthen marketing. In terms of flock improvement, it highlights two improved lines of chickens, Kuroiler and Sosso that are both fast growing, used for both meat and eggs and resistant to many diseases. These two breeds offer a wide variety appearances and characteristics that are not fully portrayed in this catalogue. Description of containment facilities in this catalogue relate to the option for free range management, in large part because the design of conventional poultry houses is well established. This choice is based upon a pathway for better smallholder management. This management also recognizes that commercial poultry feeds are often too expensive for small-scale producers, and it highlights some local ingredients that can partly substitute for and be better combined within these feeds. Foremost among those under-utilized ingredients is meal prepared from cassava peels.

The catalogue presents disease management from two perspectives; first optimization of biosafety to prevent and limit the spread of several diseases, and second to promote vaccination against the most ominous disease, the Newcastle virus. This catalogue presents chicken manure as a useful byproduct; both for use on mixed farms and for larger-scale processing into an organic fertilizer. The “danger” posed by fresh manure to crops may be overstated as it readily “self-composts”, but the risks of greenhouse gas emissions are not. Indeed, agriculturalists widely recognize the benefits of manure’s mineral nutrients but not the risks associated with its gaseous losses. The benefit of small-scale mechanization is a theme across all of TAAT, and in this case, the labor savings from de-feathering and egg sorting are obvious. Value addition through larger-scale processing of poultry meat and its products is an important means to link rural producers and urban markets, and to reduce dependency upon imported frozen products.

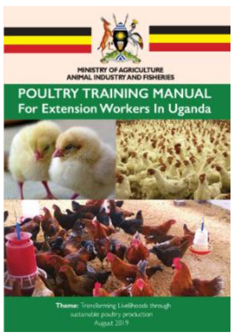
This catalogue understates the importance of modernized poultry farming upon food and nutritional security and climate change mitigation. Chicken meat is one of the most consumed animal protein sources. Their small size, relatively low establishment costs, and ease of management underlie this popularity. Chicken meat is also favored for its low-fat content. Indeed, demand for poultry products in African countries has been growing by about 6% annually. Equally important, chicken has the lowest environmental footprint of all animal protein. Greenhouse gas emission from chicken rearing is 12 kg CO_2 equivalent per kg meat, much less than beef. Land use requirements for rearing and feeding chickens is 14 m^2 per bird, 17-fold lower than for beef. Chicken production requires 505 liter per kg; four times lower than beef. The nutritional and environmental arguments in favor of poultry production are strong.

This catalogue was prepared with contribution of scientists with proven expertise in poultry production and processing. It is meant for a variety of users whether they be producers, agents of agricultural development or private sector investors. One weakness of this catalogue is that it is limited to chickens., without reference to turkeys, ducks or geese. Nonetheless, farmers and development specialists alike can use many of these catalogue items as production guidelines. Members of the private sector, including broiler and layer companies, feed manufacturers, processors and investors can also benefit from the contents of this catalogue.

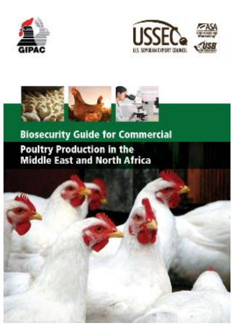
Information Sources



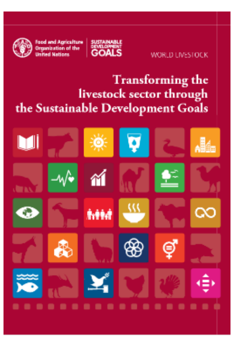
Poultry Development Review. 2013. Food and Agriculture Organization, Rome. 120 pp. Includes sections on poultry health and disease control in developing countries, poultry disease diagnosis, site biosecurity and supporting strategies for disease control and prevention, and poultry welfare in developing countries. https://www.fao.org/3/i3531e/i3531e.pdf



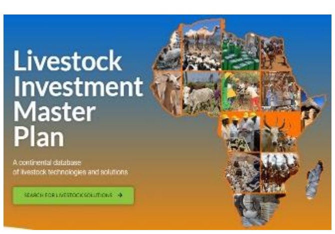
Poultry Training Manual for Extension Workers in Uganda, Ministry of Agriculture, Animal Industry and Fisheries (2019). https://www.agriculture.go.ug/wp-content/uploads/2020/07/ MAAIF-Poultry-Manual.pdf



Biosecurity Guide for Commercial Poultry Production in the Middle East and North Africa. US Soybean Export Council. 34 pages. Includes information on design for bio-secured poultry farms, movement control prevent disease, importance of feed and water quality and decontamination procedures. https://ussec.org/wp-content/uploads/2017/05/Biosecurity-Guide-ENGLISH-BR-27.pdf



Food and Agriculture Organization,. 2018. World Livestock: Transforming the livestock sector through the Sustainable Development Goals. Rome. 222 pages. https://doi.org/10.4060/ca1201en



Livestock Investment Master Plan: A continental database of livestock technologies and solutions. This digital search engine maps investments and initiatives that assess country and agro-ecological zones comparative advantages in livestock development. ILRI, Nairobi. https://livestockinvestmentmasterplan.info/

Acknowledgements

This catalogue results from a unique blend of two parallel efforts; the Technologies for African Agricultural Transformation Program (TAAT) and the Product Platform of Agricultural Solutions (ProPAS). A first version was compiled by Adeniyi Adediran of the TAAT Clearinghouse. Dries Roobroeck and Paul L. Woomer from the TAAT Clearinghouse included further information and formatted the catalogue to make the final version. Teams from the International Livestock Research Institute, that coordinates TAAT's Small Livestock Compact (including poultry), are advancing the technologies presented in this catalogue across Africa in collaboration with national counterparts, and some of the photographs used in this booklet reflect this effort. The TAAT Clearinghouse is funded by the Bill and Melinda Gates Foundation and the larger TAAT Program, including its Small Livestock Compact, is supported through the African Development Fund of the African Development Bank. For more information on the TAAT Program, please visit its website at https://taat-africa.org/. All technologies featured in this toolkit catalogue are also found on the ProPAS webportal (see http://propas.iita.org/).

Day Old Chicks in a brooder unit with lights, feeders, and drinkers

Technologies for African Agricultural Transformation (TAAT) and its Clearinghouse Office

The development objective of TAAT is to rapidly expand access of smallholder farmers to high yielding agricultural technologies that improve their food production, assure food security and raise rural incomes. This goal is achieved by delivering regional public goods for rapidly scaling up agricultural technologies across similar agro-ecological zones. This result is achieved through three principal mechanisms; 1) creating an enabling environment for technology adoption by farmers, 2) facilitating effective delivery of these technologies to farmers through a structured Regional Technology Delivery Infrastructure and 3) raising agricultural production and productivity through strategic interventions that include improved crop varieties and animal breeds, accompanying good management practices and vigorous farmer outreach campaigns at the Regional Member Country level. The important roles of sound policies, empowering women and youth, strengthening extension systems and engaging with the private sector is implicit within this strategy. The Clearinghouse is the body within TAAT that decides which technologies should be disseminated. Moreover, it is tasked with the responsibility to guide the deployment of proven agricultural technologies to scale in a commercially sustainable fashion through the establishment of partnerships that provide access to expertise required to design, implement, and monitor the progress of technology dissemination campaigns. In this way, the Clearinghouse is essentially an agricultural transformation incubation platform, aimed at facilitating partnerships and strengthening national agricultural development programs to reach millions of farmers with appropriate agricultural technologies.

Back cover photo: Chickens considering the management options presented in this catalogue (left) and a trained vaccinator protecting young chickens from virus disease (right). Photos from ILRI and GALVmed.

Poultry Technology Toolkit Catalogue

In collaboration with:

IITA Transforming African Agriculture

FARA Forum for Agricultural Research in Africa