CGIAR

INITIATIVE ON
Sustainable Animal Productivity

Theory of change for the chicken value chain in Kenya developed for the CGIAR Initiative on Sustainable Animal Productivity for Livelihoods, Nutrition and Gender Inclusion

Theory of change for the chicken value chain in Kenya developed for the CGIAR Initiative on Sustainable Animal Productivity for Livelihoods, Nutrition and Gender Inclusion

Mulugeta Y. Birhanu, Jane Poole, Ochieng Ouko, Wondmeneh Esatu, Fasil Getachew, Kumlachew Geremew, Mekonen Girma, Tsion Yemane, Ochieng Laurence, Karen Marshall and Tadelle Dessie

International Livestock Research Institute (ILRI)

December 2023

Editing, design and layout—ILRI Editorial and Publishing Services, Addis Ababa, Ethiopia.

Cover photo: ILRI/Susan MacMillan

Citation: Birhanu, M.Y., Poole, J., Ouko, O., Esatu, W., Getachew, F., Geremew, K., Girma, M., Yemane, T., Laurence, O., Marshall, K., and Dessie, T. 2023. Theory of change for the chicken value chain in Kenya developed for the CGIAR Initiative on Sustainable Animal Productivity for Livelihoods, Nutrition and Gender Inclusion. Nairobi, Kenya: International Livestock Research Institute (ILRI).

Acknowledgements

This work was conducted as part of the CGIAR Initiative on Sustainable Animal Productivity for Livelihoods, Nutrition and Gender Inclusion (SAPLING). CGIAR research is supported by contributions to the CGIAR Trust Fund. CGIAR is a global research partnership for a food-secure future dedicated to transforming food, land and water systems in a climate crisis.

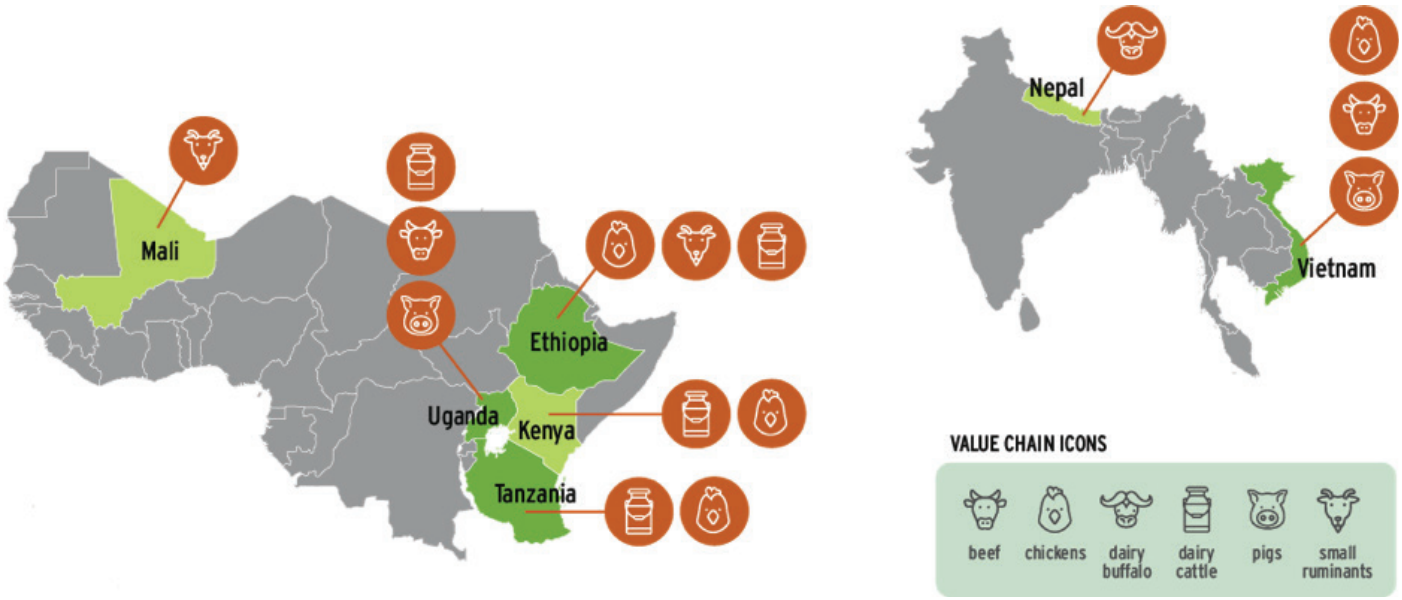
Contents

1 The SAPLING Initiative

The CGIAR Sustainable Animal Productivity for Livelihoods, Nutrition and Gender Inclusion (SAPLING) is an initiative that focuses on sustainable animal productivity. This initiative aims to contribute to transforming livestock sectors in target countries to make them more productive, resilient, equitable and sustainable (see Box 1 on how this objective will be achieved).

The initiative is working in seven countries located in East Africa (Ethiopia, Kenya, Tanzania, Uganda), West Africa (Mali), Southeast Asia (Vietnam) and South Asia (Nepal) on a total of 15 livestock value chains (Figure 1). Within the One CGIAR, SAPLING is mapped to the action area Resilient Agrifood Systems.

Figure 1: SAPLING focal livestock value-chains, which number 15 in total, across seven countries (Ethiopia, Uganda, Kenya, Tanzania, Mali, Nepal and Vietnam) and six livestock types (beef cattle, chicken, dairy buffalo, dairy cattle, pigs and small ruminants).



From: https://cgspace.cgiar.org/handle/10568/128150

Box 1 SAPLING's objective will be achieved through five work packages:

Technologies and practices for sustainable livestock productivity: developing, adapting and testing new and existing productivity- and resilience-enhancing, low-emission, scalable technologies and practices across the three main pillars of livestock productivity: improved feeds, animal health products and genetics (Work package 1).

Innovations and practices for safe consumption of livestock-derived foods as part of diverse diets: co-creating innovative models and approaches for social and behaviour change communication (SBCC) and testing, and evaluating approaches for incentivizing market actors to enhance the supply of safe, nutritious and affordable livestock-derived foods (Work package 2).

Sustainable livestock productivity for gender equity and social inclusion: understanding constraints and opportunities, identifying best-bet entry points, addressing constraints, and developing tools to measure progress (Work package 3).

Competitive and inclusive livestock value chains: generating evidence on institutional arrangements and technical interventions to transition towards more profitable, inclusive and sustainable livestock value chains (Work package 4).

Evidence, decisions and scaling: generating and consolidating evidence, models and tools to support public and private decision-making for a sustainable and inclusive livestock sector (Work package 5).

Photo credit: KALRO/Ochieng Ouko

2 The chicken value chain in Kenya

2.1 Overview

Smallholder poultry production has significant economic, social and cultural benefits to most rural and agricultural households in Kenya. The sector supplies significant proportions of eggs and meat consumed by rural and urban households, and poultry is the most common livestock species found in rural and peri-urban households (Omondi, 2019). About half of the total households (5.5 million) own at least one chicken, and the proportion is even higher in rural areas (75%) and some districts (more than 96%) (FAO, 2019).
The smallholder poultry production system in Kenya comprises commercial and traditional village-based production systems (Okello et al., 2010). These production systems can be broadly classified as follows (FAO, 2019):

- Extensive, low-input, low-output indigenous breed-based production system that is more common throughout the country;
- Semi-intensive production system, which is found throughout the country, mainly using improved chicken with better housing and additional feeds; and
- Intensive production-market oriented production system, mainly found in urban and peri-urban areas.

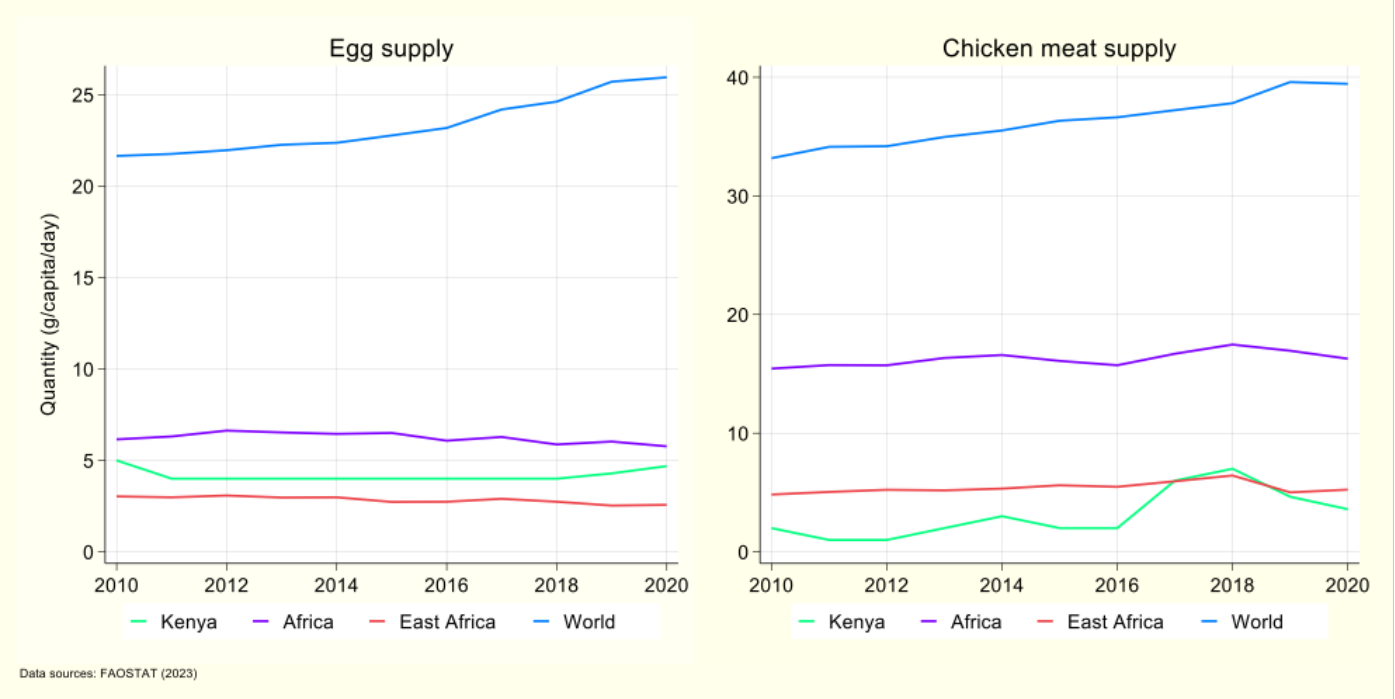
The extensive and semi-intensive production systems supply the largest proportion of meat in the country. Although poultry production in Kenya comprises chicken, ducks, turkeys, guinea fowls, quails and pigeons, chicken constitutes the largest proportion of the poultry species (Omondi, 2022).

Evidence generated from FAO (2023) shows that compared to global and regional averages, poultry product consumption in Kenya is low (Figure 2). For instance, the annual average egg supply from 2010–2020 was 4.18 g/capita/day, which is higher than the supply in eastern Africa (2.84 g/capita/day) but significantly lower than continental (6.23 g/capita/day) and global averages 23.31 g/capita/day. Similarly, the annual average meat supply in the same period was 3.11 g/capita/day, while the regional and global averages were 16.27 and 36.28 g/capita/day, respectively.

The trend in the supply of eggs and chicken meat remained constant from 2010 to 2020. Lower consumption and inadequate growth in supply could be associated with lower production and productivity levels due to various constraints, including production, marketing and other sociocultural factors (Anyona et al., 2023, Omondi, 2019, Otieno et al., 2023). Given its significant contribution and existing gaps in production and productivity, poultry production is among the prioritized value chains in the country's agricultural policy (MoALFC, 2021).

According to the recently developed agricultural policy, improving the production and productivity of the livestock sub-sector demands improvement of animal genetics, control of trade-sensitive diseases, value addition of livestock produce and increased access to markets (MoALFC, 2021). Research and development efforts that aim to enhance the production and productivity of the low productive traditional production system should focus on integrated interventions that include genetics, feed, health, capacity building, access to finance and other interventions (Birhanu et al., 2021).

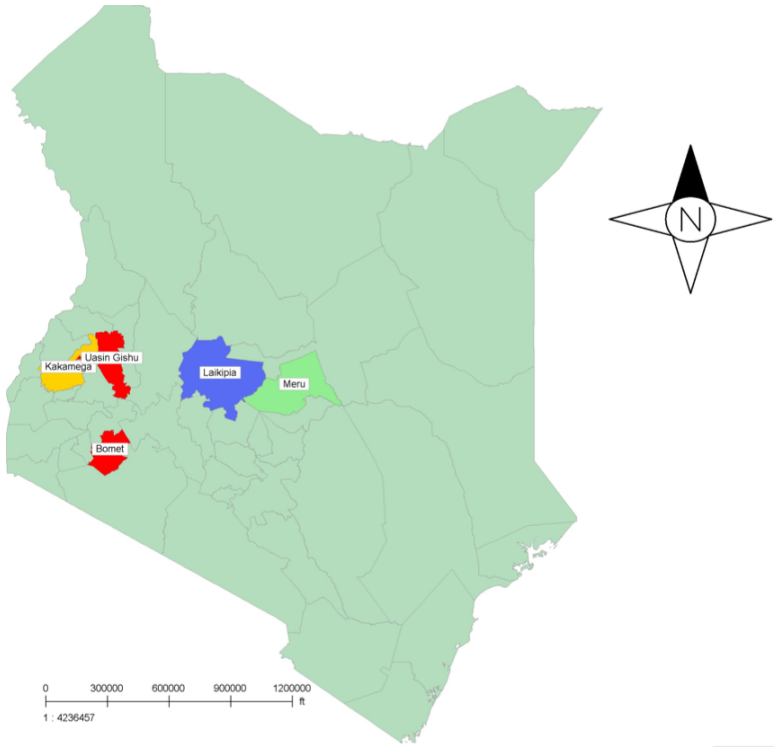
Figure 2: Supply of eggs (hen eggs in shell, fresh) and chicken meat (meat of chickens, fresh or chilled) in Kenya and other countries from 2010–2020.



2.2 Sites

The Tropical Poultry Genetics Solutions (TPGS) and SAPLING on-farm chicken value chain activities in Kenya have had two implementation phases. TPGS is a genetics innovation strategy for identifying and testing high-producing farmer-preferred poultry genotypes and using them at scale to address income, nutrition and empowerment challenges in Africa, Asia and beyond. Phase I (2021–2023) covered five counties, namely Kakamega, Bomet, Laikipia, Uasin Gishu and Meru (Figure 3). Phase II started in 2023 and constitutes two counties; Kakamega and Bomet. The Phase II activities are being implemented in five sub-counties (Mumias East, Shinyalu, Matungu, Chepalungu and Bomet East) and six villages. The selection of sites for TPGS-SAPLING on-farm activities considered the contribution of chicken to the livelihoods of the community (in terms of wealth creation, household nutrition and women empowerment) and potential to transform to semi-intensive poultry systems.

Figure 3: Location of TPGS-SAPLING chicken value chain activities (Phase I and II) in Kenya.



2.3 Key value chain research questions

The key research questions are:

1. What are the changes in the knowledge and skills of smallholder farmers applying improved poultry production and marketing practices?
2. How do tropically adapted improved chicken breeds perform under smallholder management conditions in terms of productive, adaptive and economic performance?
3. How much genetic progress can be achieved per generation through selective breeding on locally developed chicken lines?
4. What is the breed (strain) and trait preference of smallholder farmers?
5. What are the scalable non-conventional feed sources that can substitute some of the feed ingredients in conventional chicken feeds?
6. What are the risk factors contributing to mortality and morbidity in on-farm flocks of smallholder farmers?
7. What are the most effective business models for multiplication and sustained supply of improved chicks to smallholder chicken producers?
8. Are there tailored financial service delivery models for smallholder poultry producers? If not, what are the potential business models for smallholder poultry producers in the rural areas?
9. What is the impact of one egg per day per child supplementation on nutritional outcomes of school-age children?
10. What effect do social behavioural change and communication (SBCC) interventions have on household nutrition, especially for women and children under five years of age?
11. What are the most important poultry product marketing challenges and the possible interventions to overcome them along the smallholder value chain?
12. What are the most important technical capacity gaps and the possible interventions to overcome them along the smallholder poultry value chain?

Key partners for the proposed work include the Kenya Agricultural and Livestock Research Organization (KARLO), the Ministry of Agriculture, Livestock, Fisheries and Cooperatives (MoALFC), the Ministry of Education (MOE), the Kenya Institute for Public Policy Research and Analysis (KIPPRA), Kenya Poultry Farmers Association (KEPOFA), local governments/ directorate of veterinary services, universities, private feed processors/companies, and private vaccine, drug and equipment suppliers.

3 Theory of change overview

Since past research has shown that successful livestock development requires integrated packages of productivity-enhancing technologies and innovations along the value chain and in the enabling environment, SAPLING organizes its outputs not as individual 'silver bullets' but rather in innovation packages—'combinations of interrelated innovations and enabling conditions that, together, can lead to transformation and impact at scale in a specific context[1] —that target specific sets of inter-related, context-specific opportunities and constraints.

SAPLING chose to develop the theory of changes (ToCs) at the value chain level to show how the outputs of SAPLING's work packages come together in innovation packages to contribute to outcomes on the ground. ToCs were initially developed in participatory workshops with stakeholders and later updated to reflect changes in programming, to clarify and firm up the underlying logic—via specification of sub-pathways— and to increase consistency across value chains. See here for information on the stakeholder workshop that initiated the development of the ToC for chicken in Kenya.

Going forward, regular review and updating is planned as part of program management and monitoring, evaluation, learning and impact assessment. For more information on how the value chain ToCs fit into the overall SAPLING monitoring, evaluation and learning plan, see the SAPLING MEL Brief. Annex 1 provides additional information on the elements included in the ToCs.

1. Definitions from CGIAR MEL glossary unless otherwise noted.

4 Theory of change for the chicken value chain in Kenya

Figure 4: Theory of change for the chicken value chain in Kenya, showing innovation packages (IP), immediate outcomes (IO), and end-of-initiative outcomes (EOI) in boxes. Linkages to work-package (WP) outcomes are shown inside other outcome boxes. See Annex 2 for full details of all SAPLING outcomes.

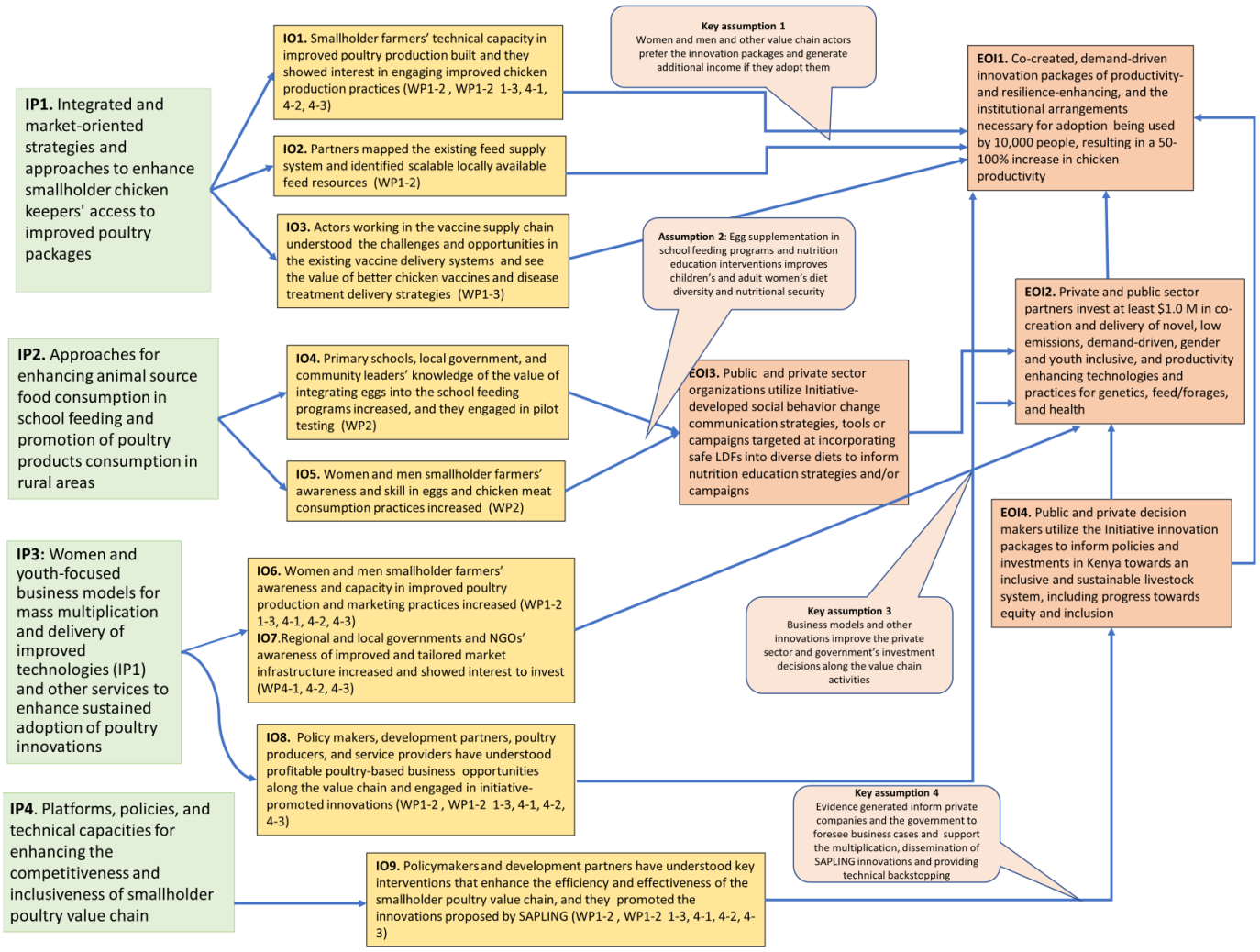


Figure 4 presents the ToC of the chicken value chain in Kenya with target values determined as given here. It contains four pathways, namely (1) delivering integrated technologies, (2) business models for innovation delivery, (3) nutrition interventions, and (4) evidence and decision-making. While the four pathways are mutually reinforcing, especially in the long run, it is useful to describe them separately to clarify how SAPLING expects early interactions and outcomes IP1 mainly to occur. Further details about innovations and enabling elements within each innovation package are given in boxed text.

The **first sub-pathway** refers to delivering integrated technologies and improved practices to smallholder farmers, including improved genetics, best-cost feeds, disease prevention and treatment, capacity building and access to information. As indicated by various empirical studies, delivering a single technology does not result in the expected outcomes in the adoption and use of technologies. Considering lessons from the previous African Chicken Genetic Gain (ACGG) project activities and the first phase interventions, the current work under SAPLING promotes integrated innovations with enabling environments such as capacity building and other technical supports to enhance access to inputs and outputs.

Sustained adoption of improved poultry breeds demands enhancing farmers' access to a package of technologies and building their capacity for production and marketing practices (Birhanu et al., 2022). The innovation packages in this pathway

mainly include **IP1** (see detail in Box 2) and IP3 (see detail in Box 4) to deliver the technologies (the description of IP3 is given under the second pathway). **IP1 mainly** refers to enhancing smallholder farmers' access to and promoting the adoption of locally adapted and high-producing chicken breeds and other allied inputs such as feed and health services through public-private partnership and stakeholder engagement. The proposed intervention in improved breeds mainly includes improving the productivity of local chickens and identifying and promoting productive and tropically adapted chicken breeds.

Three chicken strains will be tested under on-farm conditions with complementary innovation packages. The performance of these breeds will be evaluated with three flock size levels (25, 50 and 75) to examine the growth and egg productivity level and the economic and technical feasibility of keeping different flock sizes across different geographies. Farmers will be trained on basic chicken management practices, organized into groups, and linked with inputs and service providers to enhance their capacity, which is one of the main components of **IP3**.

ILRI will also collaborate with KALRO-Naivasha to support the ongoing chicken breed improvement program. In this program, the lines under development are hybrid strains, namely KC1 and KC2. These lines are meant for smallholder poultry production environments with better performance and adaptability. Selection traits are live body weight at 12 weeks and egg productivity. The meat and egg lines are selected based on body weight (males above 1,000 grams and females above 800 grams). The Dual purpose KC line, however, is selected on live body weight with males above 1,300 grams and females above 1,000 grams.

Sub-activities under this activity may include determining effective population size and selection scheme, increasing the base population, and identifying breeding goal traits in the KALRO (KC1 and KC2) breeding program. Determining effective population size and selection scheme involves developing a selection scheme for the two lines (KC1 and KC2) and defining the effective population size to identify the number of male and female selection candidates in every generation. This would improve the rate of gain per generation and make the evaluation of genetic improvement easy.

KC1 and KC2 will be tested in both on-station and on-farm conditions to identify potential lines with higher genetic gain for meat and eggs. Performance data will be analyzed to identify best performing and adaptive chicken stains through the Genotype x Environment x People (G*E*P) evaluation. 'P' refers to people whose needs, preferences and aspirations are considered in developing and evaluating different strains. The Best linear unbiased prediction (BLUP)technique will be applied to speed up the genetic improvement. Moreover, the KC1 and KC2 selection will be assisted by individual selection techniques, which is only best when the traits under consideration have moderate to high heritability. BLUP is the preferred technique for ranking and selecting chickens based on their genetic worth. Therefore, SAPLING will support the program in applying the BLUP techniques.

In addition to enhancing their access to improved genetics, ensuring smallholder farmers' access to best-cost feed and health services will be an integral part of the genetic innovation package. Potential non-conventional poultry feed ingredients will be identified through a comprehensive desk review/ meta-analysis followed by an experiment to optimize and develop best-cost feed rations and promote them for smallholder farmers. This may involve building smallholders' capacity on feed formulation using locally available inputs. Furthermore, improved chicken breeds delivered to smallholder farmers will be vaccinated for different diseases at the brooding and later stages using different approaches. The type and delivery mode of existing vaccines will also be assessed to identify challenges and develop strategies that enhance the delivery and efficacy of vaccines and other health services in the future. Farmers will also receive advisory and support services in disease prevention and management activities.

This pathway's immediate outcomes target smallholder producers, feed and vaccine suppliers, policymakers, and development partners. Women and men smallholder farmers' technical skills in improved chicken production (i.e. breeding, disease prevention, treatment, feeding and housing) are expected to be built through training and continuous support (**IO1**). Smallholder farmers and feed suppliers will map existing feed supply systems, and their awareness of scalable best-cost feed options is expected to increase; their technical skills in feed formulation will be enhanced using different approaches (**IO2**).

The evidence generated on the existing vaccine and other health services delivery systems will be shared with policymakers and vaccine suppliers to enhance understanding of the challenges and opportunities in

the existing vaccine delivery systems and help value chain actors see the value of better chicken vaccines and disease treatment delivery strategies (IO3). It is assumed that the innovation packages are preferred by smallholder farmers and other value chain actors and generate additional income for households and service providers. It is expected that these integrated technology packages and institutional arrangements will be used by 10,000 people, resulting in a 50–100% increase in chicken productivity at the smallholder level (**EIO1**).

The **second sub-pathway** entails developing and deploying women and youth-focused business models for mass multiplication and delivery of improved technologies and other services to enhance sustained adoption of poultry innovations. The innovation under IP3 (see Box 4) is designed to develop and promote business models that help to enhance smallholder farmers' access to integrated technologies (**IP1**) and outputs markets.

Youth and women-focused business models (i.e. flock-sized based) for scaling integrated technologies will be developed, tested, validated and deployed for further scaling. Poultry keepers will be organized and linked to inputs and service providers. The innovation in **IP3** involves delivering extension and advisory services to smallholder farmers, developing approaches and tools to promote collective actions and market linkages, and identifying marketing challenges and opportunities. This would increase women's and men's smallholder farmers' awareness and capacity to improve poultry production and marketing practices (**IO6**). It also increases regional and local governments' and non-governmental organizations' awareness of improved and tailored market infrastructure, which enhances their interest in investing in the initiative-promoted innovations (**IO7**).

The activities in this sub-way would help policymakers, development partners, poultry producers and service providers to understand profitable poultry-based business opportunities along the value chain and engage in initiative-promoted innovations (**IO8**). Ultimately, these will lead regional and local governments, non-governmental organizations and the private sector to invest USD 1.0 million in improved poultry products, marketing facilities, infrastructures and tools that enhance farmers' capacity to engage in profitable poultry businesses (**EOI2**). This will also contribute to EOI1 for the adoption of co-created, demand-driven innovation packages of productivity- and resilience-enhancing and institutional arrangements. The underlying assumption in these sub-pathways is that business models and other innovation packages improve private sector and government investment decisions that enhance the competitiveness and inclusivity of the value chain.

The **third sub-pathway** focuses on promoting nutrition-sensitive interventions to enhance the consumption of poultry products in rural and urban areas. **IP2** involves introducing model poultry production demonstration farms at selected primary schools to promote small-scale poultry farms and animal-source food consumption in school feeding programs and promoting improved poultry product consumption through integrated nutrition education in rural and urban areas (see Box 3). A model poultry farm is expected to be established in selected primary schools to promote one egg per day per child consumption as part of the school feeding program. Improved vegetable production that uses the manure from the poultry farm as a fertilizer is expected to be integrated with the model poultry farm. Tailored nutrition education and training on improved poultry husbandry practices will also be provided to children in the pilot schools.

The impact of the intervention on the nutritional status of school-age children will be evaluated using experimental approaches (intervention versus control schools). It is expected that the knowledge of actors involved in the school feeding program (i.e. the school community, local governments, development partners, and rural households) on the role of incorporating eggs as an animal source of food would increase (IO4). Moreover, as indicated above in **Figure 2**, beyond low production and productivity of the sector, the limited poultry product consumption could be associated with inadequate perception of livestock source food consumption and cooking practices. Hence, integrated nutrition education at the smallholder household level will be provided to adult female chicken keepers through different approaches, such as social behavioural change communication (SBCC) packages that include conventional and digital tools. The innovations in nutrition education will be overlaid on the on-farm chicken performance testing, and its impact will be evaluated using standard approaches.

Women and men smallholder farmers are expected to acquire knowledge and skills in better egg and chicken meat consumption practices (IO5). Public and private sector organizations are expected to utilize initiative-developed social behaviour change communication strategies, tools or campaigns to

incorporate safe LDFs into diverse diets to inform nutrition education strategies and/or campaigns (**EIO3**). Key assumptions underlying this pathway's logic are that egg supplementation in school feeding programs and nutrition education interventions would improve children's and adult women's diet diversity and nutritional security.

The **fourth sub-pathway** involves strengthening the role of platforms, policies and strategic capacity building in improving the performance of the value chain. **IP4** involves platforms, policies and technical capacities for enhancing the competitiveness and inclusiveness of the smallholder poultry value chain (see Box 5). The innovation packages under this pathway include identifying interventions to support national efforts towards improving policy and regulatory frameworks, identifying national technical capacity gaps in poultry development (namely, genetics, feed, health and extension), developing a roadmap for technical capacity strengthening, and establishing and operationalizing the Tropical Poultry Platform (TROP). Evidence from each innovation component will be synthesized and communicated with decision-makers in the public and private sectors. This will lead policymakers and development partners to understand key interventions that enhance the efficiency and effectiveness of the smallholder poultry value chain (**IO9**).

In due course, decision-makers (government and private sector) are expected to use the evidence from these innovations to make informed policy and investment decisions that promote improved poultry production and consumption practices (**EIO4**). This will also lead regional and local governments, non-governmental organizations and the private sector to invest in improved poultry products, marketing facilities, infrastructure and tools that enhance farmers' capacity to engage in profitable poultry businesses (**EOI2**).

Box 2 IP1: Integrated and market-oriented strategies and approaches to enhance smallholder chicken keepers' access to improved poultry packages

Components of the package

- More productive and adapted indigenous lines from a within-breed improvement program
- Training of breeders from national research institutes in chicken breeding in support of the above breeding activities
- Tropically adapted exotic chicken breeds that meet the needs and preferences of women and men chicken keepers
- Functional partnership among private chicken breeding companies, mother units, feed and health service suppliers and development actors to deliver bundles of innovations (i.e. improved breeds, feed and health)
- Tailored training for building the capacity of women and men smallholder farmers on adoption and use of bundles of technologies
- Guideline and training packages for group formation, creating market linkages, and technical support services
- Strengthened farmer groups or associations and input and output market linkage
- Poultry feed formulation app
- Training module for building the capacity of smallholder chicken keepers to use the feed formulation app
- Optimized feed formulations based on locally available non-conventional ingredients
- Training module for building the capacity of smallholder chicken keepers on feed formulation
- Business model for optimized feed formula
- Training for young entrepreneurs on the production and delivery of optimized feed packages
- Linkage of chicken keepers to feed suppliers via farmer groups
- Delivery strategy for chicken vaccines involving the public and private sectors
- Training package to build the capacity of the public and private sectors on chicken vaccine delivery strategy
- Optimized vaccination strategies at brooding and later stage of chicks' growth
- Training package for brooders and smallholder farmers on the optimized vaccination strategy and health care packages
- Optimized chicken health-care package based on understanding of disease outbreak
- Linkage of smallholder farmers and brooder with health service providers through farmer groups

Box 3 IP2: Approaches for enhancing animal source food consumption in school feeding and promotion of poultry product consumption in rural areas

Components of the package

- Model poultry production farms with integrated vegetable production in selected schools
- Training package on poultry farm management practices for the school community
- Egg supplementation in existing school feeding programs
- Training packages on poultry products and other nutrient-dense food consumption practices for school-age children and the school community
- Social behaviour change communication (SBCC) package for increasing poultry product consumption at the smallholder level
- Training packages on women-centred poultry-based nutrition education through application of SBCC approaches
- Digital nutrition education app
- Training package on digital nutrition education app

Box 4 IP3: Women and youth-focused business models for mass multiplication and delivery of improved technologies (IP1) and other services to enhance sustained adoption of poultry innovations

Components of the package

- Youth- and women-focused business models (i.e. flock size-based) for scaling tropically adapted improved breeds
- Training package for stakeholders and partners on deploying the business model
- App for digital extension and advisory services to support smallholder chicken farmers
- Training of development partners and smallholder farmers on digital extension and advisory service use
- Guideline and training packages for group formation, creating market linkages and technical support services
- Strengthened farmer groups or associations and inputs and output market linkage

Box 5 IP4: Platforms, policies and technical capacities for enhancing the competitiveness and inclusiveness of the smallholder poultry value chain

Components of the package:

- Tools and approaches to strengthen national innovation platforms as a nucleus for the creation of supra-national poultry forums
- Stakeholders' feedback and view on the establishment of TROP
- TROP
- Training packages for stakeholders and partners to enhance their engagement and contribution to TROP
- Guidelines for developing a capacity development roadmap
- Roadmap for technical capacity strengthening in poultry development
- Training packages to build the capacity of national partners to implement the roadmap
- Evidence to support national efforts toward improving policy and regulatory frameworks for policy- and decision-makers
- Evidence on challenges and opportunities in chicken product marketing for policymakers and other stakeholders

5 Next steps

ToCs are living documents that should be developed and updated in response to concrete programmatic needs. This theory of change for the poultry value chain will be reviewed in collaboration with stakeholders annually, with changes made as necessary. The reflection process, changes to the ToC and reasoning behind these changes will be documented as annexes to this report.

6 References

Anyona, D. N., Musyoka, M. M., Ogolla, K. O., Chemuliti, J. K., Nyamongo, I. K. and Bukachi, S. A. 2023. Characterization of indigenous chicken production and related constraints: Insights from smallholder households in rural Kenya. *Scientific African*, 20, e01717. https://doi.org/10.1016/j.sciaf.2023.e01717

Birhanu, M.Y., Alemayehu, T., Bruno, J.E., Kebede, F.G., Sonaiya, E.B., Goromela, E.H., Bamidele, O. and Dessie, T. 2021. Technical efficiency of traditional village chicken production in Africa: Entry points for sustainable transformation and improved livelihood. *Sustainability* 13: 8539.

Birhanu, M.Y., Bruno, J.E., Alemayehu, T., Esatu, W., Geremew, K., Yemane, T., Kebede, F.G. and Dessie, T. 2022. Beyond diffusion to sustained adoption of innovation: A case of smallholder poultry development in sub-Saharan Africa. *International Journal of Agricultural Sustainability*, ahead-of-print, 1–19. https://doi.org/10.1080/14735903.2022.2041235

FAO 2019. *The future of livestock in Kenya: Opportunities and challenges in the face of uncertainty.* Rome: Food and Agriculture Organization of the United Nations.

FAO. 2023. FAOSTAT *statistical database* [Online]. Rome: FAO. (Available from https://www.fao.org/faostat/en/#data) (Accessed October 2023).

Marshall, K., Poole, J., Njehu, A. and Baltenweck, I. 2022. Monitoring, evaluation and learning within the CGIAR Initiative on Sustainable Animal Productivity for Livelihoods, Nutrition and Gender Inclusion (SAPLING). *ILRI Research Brief 117*. Nairobi, Kenya: ILRI.

MoALFC. 2021. Agricultural Policy - 2021. Food: Our health, wealth and security. In: Ministry of Agriculture, Livestock, Fisheries And Cooperatives (ed.). Nairobi, Kenya.

Okello, J.J., Gitonga, Z., Mutune, J., Okello, R.M., Afande, M. and Rich, K.M. 2010. Value chain analysis of the Kenyan poultry industry: The case of Kiambu, Kilifi, Vihiga, and Nakuru districts. *HPAI Africa/Indonesia Team Working Paper 24*. Washington, DC: IFPRI.

Omondi, S.O. 2019. Small-scale poultry enterprises in Kenyan medium-sized cities. *Journal of Agribusiness in Developing and Emerging Economies* 9: 237–254. https://doi.org/10.1108/JADEE-06-2018-0067

Omondi, S.O. 2022. Poultry value chain in two medium-sized cities in Kenya: Insights from cluster theory. *Frontiers in Veterinary Science 9.* https://doi.org/10.3389/fvets.2022.601299

Otieno, W.A., Nyikal, R.A., Mbogoh, S.G. and Rao, E.J.O. 2023. Adoption of farm biosecurity practices among smallholder poultry farmers in Kenya – An application of latent class analysis with a multinomial logistic regression. *Preventive Veterinary Medicine* 217: 105967. https://doi.org/10.1016/j.prevetmed.2023.105967

Annex 1. Elements included in the ToC

The ToC includes three standard elements: outputs (innovation packages), outcomes and assumptions. CGIAR defines an outcome as 'a change in knowledge, skills, attitudes and/or relationships, which manifests as a change in behaviour in particular actors, to which research outputs and related activities have contributed'. In these ToCs, immediate outcomes (IOs)are initial changes in things like awareness and capacity that occur among next-users of the innovation packages. End of initiative outcomes (EoIs) are outcomes that occur further along the pathway and reflect changes in behaviour among target actors and, in some cases, the consequences of that behaviour, such as increases in productivity or the value of investments. EoIs are the same across all ToCs while the immediate outcomes that lead to them are context-specific. In order to see the whole VC ToC in a single diagram, multiple similar outcomes are grouped together in a single IO or EoIs. These could be unpacked in a series of nested ToCs if further detail on sub-pathways is needed.

Just as innovation packages combine innovations from different work packages, IOs and EoIs combine the expected outcomes of different work packages that were specified in SAPLING's result framework. As expected, the mapping of WP to ToC outcomes (IO and EOIs) is not one to one. For example, the use of a gender-aware business model by value chain actors can contribute to the expected outcomes of work package 3 (strategies and approaches for enhancing gender equity and social inclusion) and work package 4 (evidence and approaches for strengthening competitive and inclusive livestock value chains). In Figure 1, each IO or EoI notes theWP outcome(s)to which it maps. Being explicit about how the different types of outcomes relate to each other is intended to facilitate use of the ToC for program-level monitoring and learning and to avoid confusion and duplication.

Assumptions are 'hypotheses about factors or risks which could affect the progress or success of a development intervention… It is useful to distinguish between: (i) theoretical assumptions, about how the intervention is expected to contribute to a process of change based on facts, and (ii) contextual assumptions, about current conditions and the trajectory and risks that could affect the progress or success of a development intervention'. While both types of assumptions are important, these ToCs focus on key theoretical assumptions since these are the ones that programs address as part of their research programs, investing resources to understand and test them.

Annex 2. Initiative and work-package level outcomes from the SAPLING results framework

Outcome code (EOI – end of initiative; WP = work package)	Outcome
EOI1	Co-created, demand-driven innovation packages of productivity- and resilience-enhancing, low emission technologies and the institutional arrangements (including markets) necessary for their adoption are being used by 800,000 people (male and female), including at least 100,000 people using SAPLING-promoted improved forage and food feed crops, in households keeping cattle, chickens, small ruminants, pigs and buffalo in Ethiopia, Kenya, Tanzania, Uganda, Mali, Nepal and Vietnam, resulting in a 30–50% increase in livestock productivity
EOI2	Private and public sector partners invest at least USD 30 million in co-creation and delivery of novel, low-emission, demand-driven, gender and youth inclusive, and productivity enhancing technologies and practices for genetics, feed/forages and health
EOI3	Six public and private sector organizations utilize initiative-developed social behaviour change communication strategies, tools or campaigns targeted at incorporating safe livestock-derived foods into diverse diets to inform nutrition education strategies and/or campaigns
EOI4	Public and private decision-makers utilize the initiative's innovation packages to inform policies and investments in Ethiopia, Kenya, Tanzania, Uganda, Mali, Nepal and Vietnam towards an inclusive and sustainable livestock system, including progress towards equity and inclusion
WP1–1	Public and private sector value-chain actors use promoted genetic improvement programs in smallholder systems, built on the needs and preferences of livestock keepers in seven countries, and incorporating information and communications technology as well as genomic and reproductive technologies as appropriate
WP1–2	Development partners as well as the public and private seed sector use, promote and commercialize improved forage and food-feed crops, and feed companies employ prioritization approaches to improve feed options and reduce livestock feeding gap
WP1–3	Animal health system actors in seven countries promote and use tools and technologies (herd health packages and disease control) to reduce disease burden
WP2–1	Government and development practitioners take up the decision support tools to diagnose and prioritize livestock-derived foods in food and nutrition interventions
WP2–2	Government and development practitioners support and promote social behaviour change communication and market-related innovations that enhance affordability and safety of livestock-derived foods
WP3–1	In four selected countries, policy, the private sector and the development community acknowledge gender- and youth-based discrimination in livestock value chains and co-develop strategies to close the gender and age gap
WP3–2	Community and household members in selected livestock value chains adopt gender-transformative approaches and show more gender-equitable behaviour to enable participation and benefitting from livestock assets and opportunities
WP3–3	Scientists, practitioners and extension agents in animal health, feeds and forages, genetics and environment collaborate with gender scientists to generate gender- and youth-responsive livestock innovation bundles
WP4–1	Government and development practitioners support new business models and interventions that ensure improved competitiveness of the livestock value chains

Outcome code (EOI – end of initiative; WP = work package)	Outcome
WP4–2	Government and development practitioners support and promote SAPLING innovation packages
WP4–3	Market actors invest in profitable and inclusive business models promoted by SAPLING, which provide transparent and efficient markets
WP5–1	Value chain actors are adjusting their investments and practices based on prioritization, trade-off and/or scaling readiness analysis
WP5–2	Public and private decision-makers utilize Initiative-developed tools and recommendations to inform policies and investments in the seven focus countries and beyond (scaling)
WP5–3	Researchers and decision-makers have access to and use improved analytical tools (environmentally and gender-sensitive), evidence and processes to guide livestock master plans (LMP)