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A Case Study:
Uganda Systems Change

How To Use a Systems Approach in Community Development Projects

HEIFER® INTERNATIONAL

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About the Author

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Dr. Amadei is the founding president of Engineers Without Borders-USA, co-founder of the Engineers Without Borders-International Network, and founding director of the Mortenson Center in Engineering for Developing Communities. He is also a recipient of multiple awards and distinctions, and holds seven honorary doctoral degrees.

In 2009, he was recognized with an Award of Excellence from Engineering News-Record. In 2012, Dr. Amadei was appointed as a Science Envoy to Pakistan and Nepal by the U.S. Department of State.

Our Mission

Since 1944, Heifer International has worked with more than 42 million people around the world to end hunger and poverty in a sustainable way. Working with rural communities in 19 countries in Africa, Asia, and the Americas, including the United States, Heifer International supports farmers and local food producers to strengthen local economies and build secure livelihoods that provide a living income.

For information, visit **www.heifer.org**

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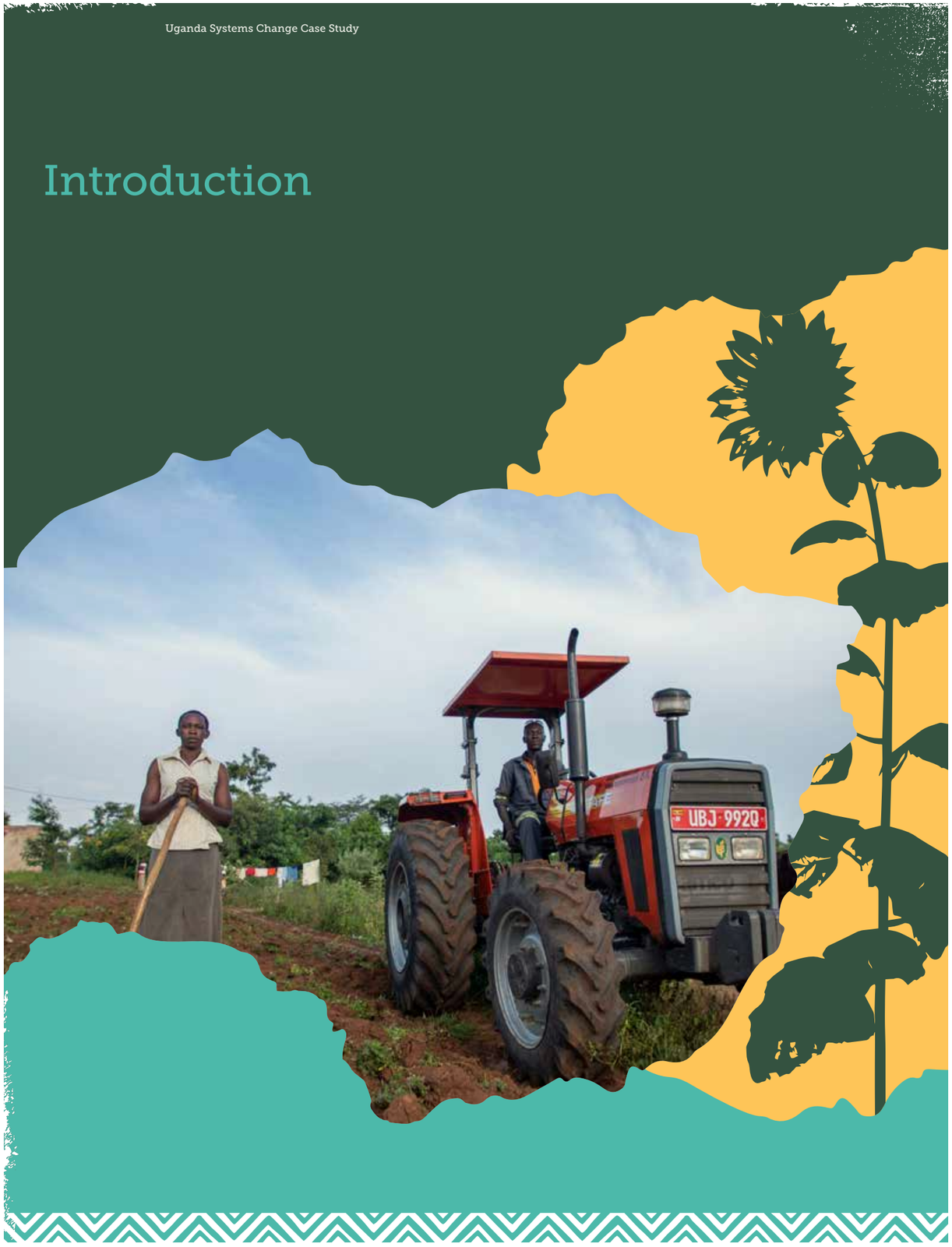


Uganda Systems Change Case Study

During May 20-27, 2022, five cooperative hubs (agri-hubs[1]) in rural areas of Uganda were visited as part of a field site review.

Two of the hubs focusing on the oil seeds value chain had been created under the Learn for Agribusiness (L4AB) project implemented by a consortium of organizations, including Heifer Uganda, Heifer Netherlands and the Edukans Foundation. It also included a partnership with governments (local and national) and the private sector in Uganda. The other three visited agri-hubs were built under the East African Youth Inclusion Project (EAYIP), a regional initiative in Uganda and Tanzania funded by the MasterCard Foundation from 2016 to 2021.

The L4AB project was implemented from January 2018 to May 2021 and was extended until March 2022. It aimed to address vulnerable youth unemployment by empowering uneducated young people in agri-business development and smallholder farming. The project's overarching goal was to give young farmers the skills, resources, and services necessary to improve their livelihood and household living income by introducing sustainable agribusiness practices and sustainable community development. Two cooperatives (i.e., collective business entities) were established to serve as single contact points for farmers to access products and services. Each agri-hub constitutes self-help groups (SHGs), each containing 20-30 young farmers aged 18-30. A farmer field school (FFS) approach (a work-based learning platform, a school without walls) was created for community mobilization, farmers' training and provision of services (social, financial, technical, etc.).

The scope of the L4AB project was established based on the findings of comprehensive baseline surveys carried out by Heifer in 2018. Data was collected on the labor market, agricultural livelihoods, non-farm livelihood activities, household income, household diet, household food provisioning, women's participation in household decision-making, household access to clean water and hygiene, climate-smart agriculture techniques, restored land following degradation, household solidarity, marketing, access to financial services, existing agricultural and vocation training. An average living income benchmark ranging between $4,458 and $4,747 per household per year was established by Heifer for three regions (Northern, Eastern and Central) in Uganda. In comparison, those regions' current average living income ranges between $970 and $1,281.[2]

With a population of 48.4 M in July 2022. Uganda is a country with many natural resources (good soil and favorable weather) and human capital.[3] It has the second youngest population (55% below 18) after Niger (56.9% below 18) and is experiencing high population growth (3.3% per year with 4.78 births per woman).[4,5] Most people live in rural areas (75%) and rely on agriculture for their livelihoods; 73% of the workforce is employed in agriculture.[6] Agriculture is critical to Uganda's economy and represented 24% of its GDP in 2020.[7] Subsistence farming is still dominant, and poverty is rampant in rural areas.

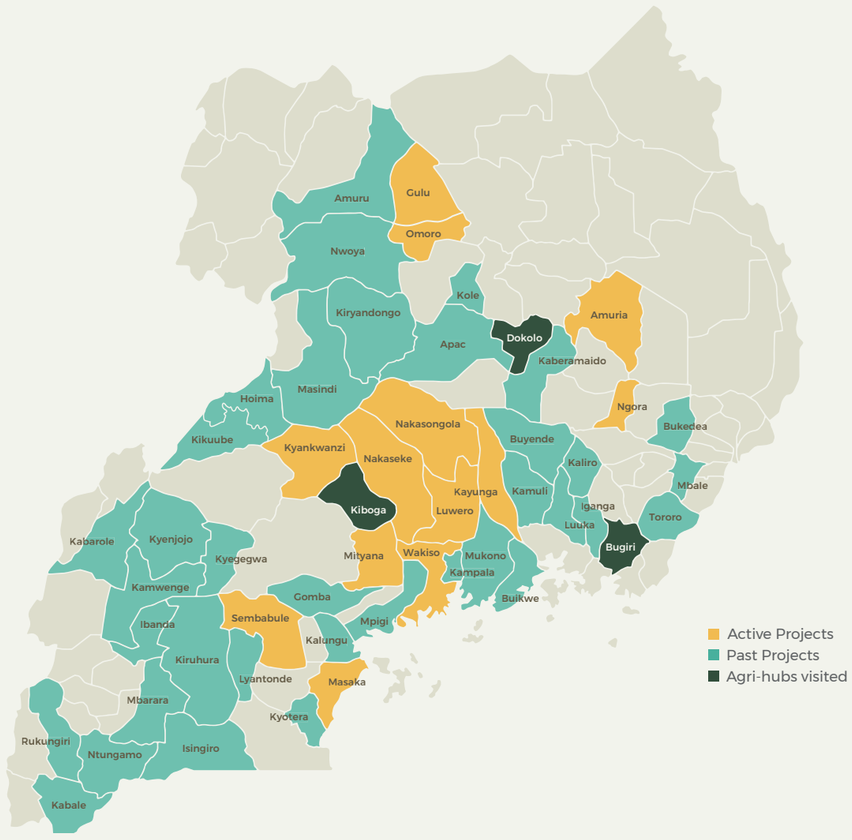
1 An agri-hub is an aggregation centre for bulking of livestock, crop and other agricultural products for onward and backward marketing to processors or agri-hub members. It also serves as a one stop centre for farmers to access inputs, market and other business development services. Hubs are assessed based on a number of indicators including governance, leadership, financial profitability and increased value proposition to members and the wider community

2 Muliika, P. et al. (2020). Living income benchmarks (LIB) validation report. Heifer
3 Uganda, The World Factbook (cia.gov)
4 Uganda Population 2022 (Demographics, Maps, Graphs) (worldpopulationreview.com)
5 30 Countries With The Youngest Populations In The World, WorldAtlas
6 Farm Africa's work in Uganda
7 Uganda, Agriculture, Value Added (% Of GDP), 2022 Data 2023 Forecast 1960-2020 Historical (tradingeconomics.com)

The L4AB project acknowledges that agriculture has a high potential to provide jobs but is limited by the youth's poor education and a lack of entrepreneurial and technical skills. The government of Uganda has been interested in increasing such skills with the help of extension workers, but their budget is limited. It should be noted that most of the youth in Uganda have moved from rural areas to towns and cities. Some have also left to work in the Gulf countries.

The first goal of the May 20-27 visit was to become acquainted with the L4AB project by visiting the Kwera and Dokolo young oil seed farmers' cooperatives. Three EAYIP sites were also seen. The second goal of the visit was to review the project accomplishments to date, provide recommendations for future work, and propose a systemic view of the project. Figure 1 shows the location of the L4AB and EAYIP agri-hubs visited from May 20-27.

HEIFER'S WORK IN UGANDA (BY DISTRICTS)[8] *fig 1*



[8] W. Matovu (n.d.), *Area Yield Index: Heifer's experience with oil seed farmers*, Heifer.

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The Five Hubs:

The Dokolo Young Oil Seed Farmers' Cooperative Society

The Dokolo Young Oil Seed Farmers' cooperative society in Dokolo district. This coop, created under the Learn for Agribusiness (L4AB) project, empowers young farmers in the oilseeds subsector and works with value chains such as cassava, soybeans, groundnuts and sunflowers.

The Bulidha Budhaya Young Farmers' Cooperative Society

The Bulidha Budhaya Young Farmers' cooperative society in Bugiri district (eastern region). The co-op empowers young farmers in maize production, bulking, maize flour, maize value addition, poultry keeping and goat rearing. The agri-hub was built on the success of the East African Youth Inclusion Project (EAYIP), funded by the MasterCard Foundation (2016-2021), and aimed at improving the livelihood of 25,000 youth between the age of 15-24 years in Uganda and Tanzania.

The Kakinzi Youth Development Group

The Kakinzi youth development group is one of 23 self-help groups attached to the Dwaniro Hub in the Kiboga district (central region), a farmer-owned/ managed dairy hub whose primary focus is milk bulking. The group comprises 30 members involved in various businesses related to goat rearing, yogurt making, bull fattening, milk production and small grocery shops.

The Kwera Oilseed Youth Farmers' Cooperative

The Kwera Oilseed Youth Farmers' Cooperative in the Dokolo district. This co-op, created under the Learn for Agribusiness (L4AB) project, empowers young farmers in the oil seeds subsector and works with different value chains such as maize, soybeans, groundnuts and sunflowers.

The GreaterKiboga Youth Grain Farmers Multipurpose Cooperative Society

The Greater Kiboga Youth Grain Farmers Multipurpose Cooperative Society in Kiboga district. The co-op was also built on the success of the East African Youth Inclusion Project (EAYIP), funded by the MasterCard Foundation (2016-2021). The focus is on maize production and bulking, maize value addition, maize flour and collective marketing.

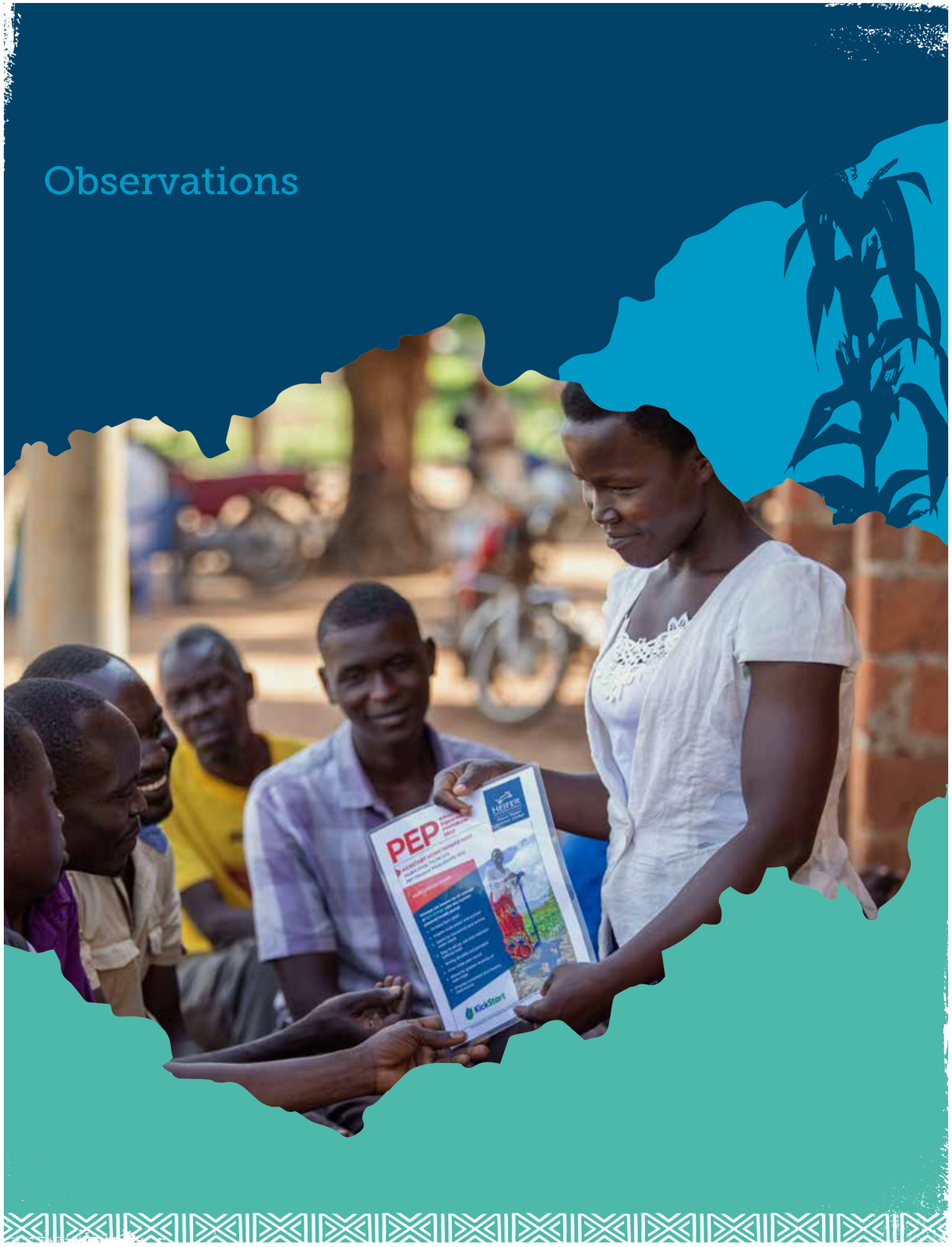
Methodology

Before the field visit, several Heifer reports were reviewed and included:

- Ainemagara, I. (n.d.) Capacity Assessment Tool Worksheet.
- Ainemagara, I. (n.d.) L4A Farmer Field School Model: Learn4Agribusiness (L4AB) project.
- Ainemagara, I. et al. (2021). Learn from the Learn4Agribusiness (L4AB) project: Project completion report for the period January '18-May '21.
- Heifer International-Bangladesh (2019). Farmers Owned Agribusiness (FOAB). Sustainable social and economic transformation.
- Heifer International (2021). Results framework guidelines.
- Heifer International-Uganda (2018). Baseline survey report for the Learn4Agribusiness (L4AB) project.
- Heifer International-Uganda (2018). Labor Market Assessment report for the Learn4Agribusiness (L4AB) project in Dokolo and Kwera sub-counties, Dokolo district.
- Heifer International Uganda (HIU) and Edukans Foundation, Impact Evaluation report, March 2022.
- Muliika, P. et al. (2021). Learn4Agribusiness (L4AB) project in Dokolo district in Northern Uganda.
- Muliika, P. et al. (2020). Living income benchmarks (LIB), Validation report.
- Mutinda, G. et al. (2015). Setting up sustainable dairy business hubs: A resource book for facilitators.
- Shoreline Services (2021). End of the project evaluation report: Learn4Agribusiness (L4AB) project.

During the visit, additional information was gained from interviews with representatives of the five agri-hubs and community members.

Observations



The following observations were made after visiting the five agri-hubs mentioned above and reading the various Heifer reports.

- After three years, and despite the global pandemic, the L4AB project has made commendable achievements. The L4AB project has been successful in creating an agricultural hub structure which has benefited many young farmers eager to reach financial independence. In Dokolo district, The project facilitated the formation of the Dokolo and Kwera hubs from 133 SHGs, trained 3,792 youths, and created six partnerships within the industry.
- The agri-hub inception was done by Heifer, Edukans, and other partners (local governments, vocational training centers) with long-term sustainability and participation. It included: (i) recruitment and training of key staff and stakeholders (farmer field school facilitators (FFSFs); community facilitators (CFs); technical vocational education training (TVET) teachers; and community agro-input entrepreneurs (CAEs), (ii) project baseline evaluation, (iii) value chain analysis of several crops, (iv) market assessments, (v) capacity building, (vi) training (financial, entrepreneurial, health and safety, agronomic practices, group dynamics, literacy, curriculum development), and (vii) partnership with private and public entities.
- Some agri-hubs, more than others, have been able to invest in new ventures, purchase equipment and build infrastructure.
- The main issues in community development at the household level seem to be related to indoor air pollution (burning of wood and charcoal), limited access to clean drinking water (well below the 20-50 liters/pp/day standard), poor child nutrition, and not being able to pay for decent child education.
- All agri-hubs were found to have strong governance, management and leadership structures with a clear underlying mission, vision, and values system.
- All agri-hubs provide community development-related services such as agricultural training, technology transfer, coop activities (bulking), life skills, advisory services, access to financial services and markets, loans, literacy, partnership training, agri-insurance, environmental awareness and affordable transport. The hub leaders often refer to their hubs as one-stop agri-hubs/centers for farmer-related services.
- All visited agri-hubs serve as functioning single contact points for farmers to access products and services and provide connections to the input and output markets.
- All agri-hub leaders recognized that facing challenges such as the effects of climate change, limited access to working capital, a lack of technology, and competition on productivity and how these affect household living conditions. Agriculture provides about a fraction of the revenue necessary to have a decent way of living. There are exceptions, like the Dwaniro hub, which has been successful in cow milk-bulking and is connected with the dairy industry.
- There is too much energy dependency on wood and charcoal for household cooking and on diesel/gasoline for agricultural activities. The reliance on wood contributes to never-ending deforestation.
- All hubs seem to have strong affiliations and partnerships with the private sector. They are eager to continue, grow and improve their collaboration with the industry.
- Mechanization at the farm level is, at a minimum, due to a lack of funding.

Suggestions

Despite Uganda's many natural resources (water, wind, sun, forests, and good arable land) and human capital, agriculture is facing significant challenges that will aggravate soon.

One challenge is rapid population growth. Another challenge is related to climate change. Due to erratic rain events, rain-dependent agriculture cannot provide an adequate livelihood to young farmers' households. Diversifying and exploring alternative income-generating activities related or not to farming is necessary. This approach would require providing additional training through the existing Farmer Field School program.

Technology at the agri-hub level is insufficient to increase local productivity and provide an appropriate household livelihood. Investing in small-scale technology (appropriate technology) is highly recommended as it can create additional employment opportunities for the youths. Examples include:

- Shallow water pumping and storage stations could provide the water necessary for irrigation to clusters of farm plots. Roof water collection systems could add to the storage for homes with a solid roof.
- In farms where animal husbandry is dominant, animal waste combined with human waste could provide biogas sources that can be used for cooking, chilling, and heating.
- Solar-wind-grid hybrid systems could generate additional energy locally. There is currently too much dependency on expensive gasoline and diesel.
- The byproducts of grain/oil production could be used instead of wasted: animal feed, fuel briquettes, etc.
- Improving the living conditions at the household level must be part of any holistic community development. The improvement includes: (i) providing household clean drinking water using filtration systems; (ii) eliminating indoor air pollution using ventilation, efficient cookstoves, and modern fuel instead of wood and charcoal; (iii) addressing WASH issues; and (iv) improving nutrition.
- Small hydro systems could provide electricity at the local level in hilly areas only.

Other suggestions include:

- All agri-hub leaders realize the need to change and adapt to new conditions. But they are confused about how to innovate. A suggestion is to create an innovation sub-committee in each hub to empower creativity at the local level.
- There are local success stories in some of the agri-hubs. These could be brought to the attention of many, replicated and scaled up.
- Consider longer time horizons for the projects. As mentioned in some of the Heifer reports, it takes longer than three years to see the results of project interventions.
- There is a need to learn from other case studies and best practices in the literature. The Heifer signature program framework may benefit from reviewing the community development work done in India by ICRISAT [9] and the agricultural curriculum developed at Earth University in Costa Rica.[10]

In summary, Heifer must envision the attributes of the Ugandan farmers of 2030. More specifically, there is a need to anticipate what should be their management and leadership skills, technical proficiency (low and high tech), and household livelihood.

9 V2i1farmer.pdf (icrisat.org)
10 Academics Earth University (https://www.earth.ac.cr/en/)

A Systems Approach

The agri-hubs created by Heifer as part of the L4AB project are integrated into rural communities, and community development depends on the success of these agri-hubs.

This dynamic takes place in a complex landscape of systems and subsystems. As shown in Figure 2, the systems can be regrouped into four categories: human (social), infrastructure, natural, and economic systems. These four systems groups involve different forms of capital (natural, human, social, financial and physical). In the community landscape of Figure 2, issues arise due to multiple observable and unobservable forces as the systems and subsystems share inputs and outputs. The systems are bounded by (i) constraints and barriers, including those resulting from mutual interactions among their components, and (ii) restrictions created by the environment in which the community development unfolds.

The overall dynamic of Figure 2 unfolds in a specific context (e.g., rural Uganda) over a particular geographic area (e.g., district) and time frame (x number of years) defined by a boundary (e.g., geopolitical boundary). Within that boundary, the community is understood as a whole. Once the boundary has been identified, (i) data and information about the community are collected and analyzed; (ii) constraints and issues are identified; and (iii) decisions are made about possible interventions to address these issues. The selected boundary and its permeability are especially critical since it determines the community development's internal or external constraints. Outside the boundary is the external environment, which cannot be ignored, as it may affect the landscape's dynamic. In the present case study, markets and institutions belong to the external environment.

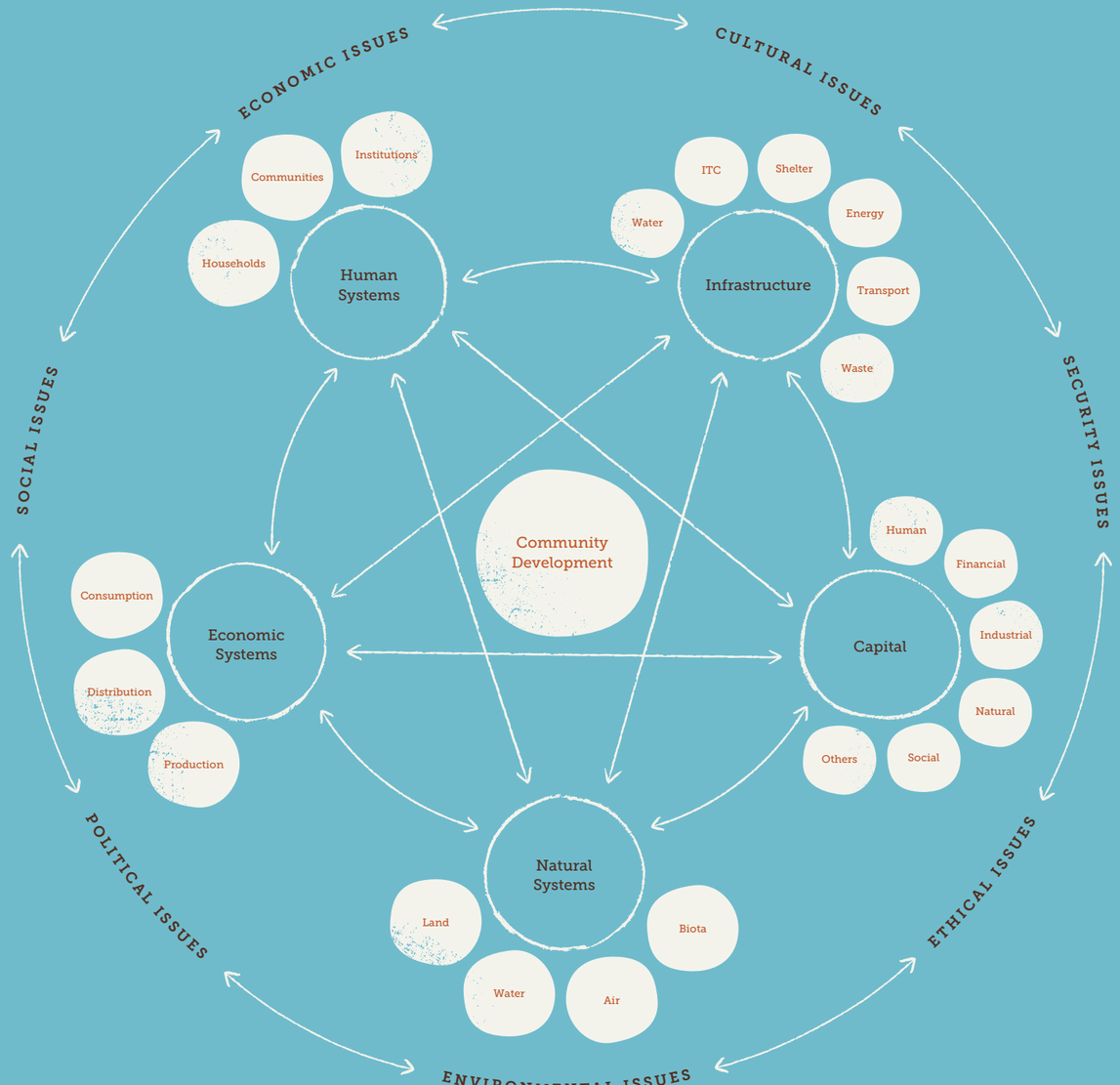
Communities are complex adaptive systems requiring a systems approach.

- They are ill-defined and messy. Complexity and uncertainty are the norms.
- They seldom preserve their forms and constantly evolve, cope, grow and adapt to change (resilience) as they develop and reach new states of normality.
- They self-organize, self-correct, and adapt by changing structure, behavior and rules of interaction through evolutionary and co-evolutionary change.
- They require adopting flexibility and adapt ability in their management.
- Multi-stakeholder participation is key to solving community issues.
- Community interventions must include multiple systems components to increase synergies and reduce trade-offs.
- They retain unity toward a common purpose while experiencing differentiation.

A systems approach to community development projects departs from the traditional approach which looks at communities as consisting of separate units with issues that can only be addressed by specific experts who do not usually talk to each other. It cuts across all sectors involved in the development and multidisciplinary silos, as shown in Figure 3.

Systems thinking represents a better mindset than deterministic and reductionist thinking when addressing the various stages of community development projects and looking at different types of nexus (e.g., water-energy-land-food; water-power-internet). Specifically, systems thinking looks at the components of communities and considers their common purpose or function, the rules they have adopted, and how they interact with each other and their environment.

Community development systems and issues *fig 2*



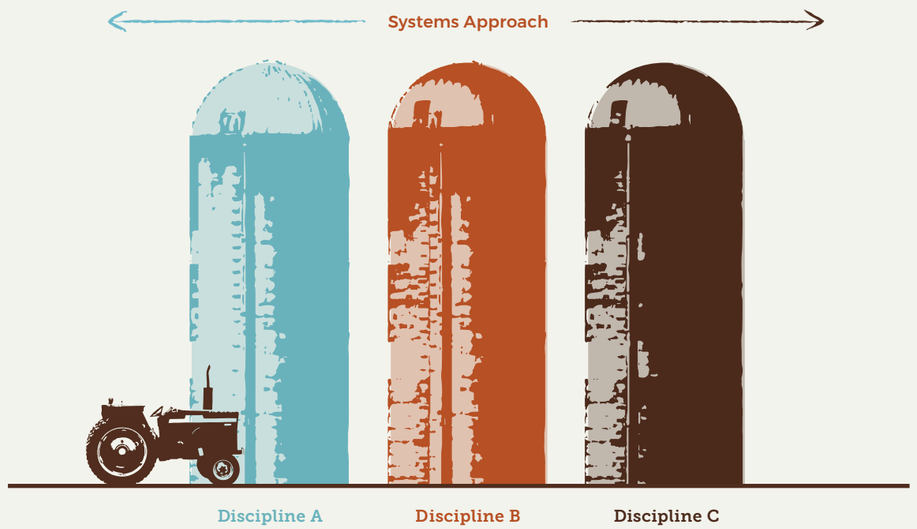
A systems approach to community development helps decision-makers to execute on the following:

- Approach community development in a more integrated manner.
- Adopt a flexible, adaptive, iterative, and participatory approach to project assessment, planning, design, implementation, M&E, scalability, and sustainability.
- Anticipate the consequences (intended and unintended) of interventions.
- Understand possible emerging issues and leverage points.
- Analyze how small events can affect community livelihood.
- Explore the importance of trade-offs and synergies.
- Consider different holistic scenarios of intervention.

A systems approach to community development also requires decision-makers to deliver on the following:

- Adopt a system-aware and complexity-aware project management approach.
- Be systems thinkers and systems-aware.
- Accept that in complex systems, optimum solutions are not possible but good enough solutions are possible.
- Adopt a continuous reflection-in-action practice in all stages of project management and not as an afterthought when projects are unfolding.

A SYSTEMS APPROACH CUTS ACROSS MULTIPLE DISCIPLINARY SILOS *fig 3*



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A systems approach to community development projects recognizes:

1. The need for decision-makers to acquire habits that are different from those more familiar with traditional reductionist/linear thinking.

Some of the habits relate to the general perception of complexity. Other practices are more project-specific. All these habits represent thinking strategies (visual, listening and speaking, and kinesthetic) that decision-makers must follow to address complex problems at the community level.

2. Systems thinking represents a better mindset than deterministic and reductionist thinking when addressing the various stages of community development projects and looking at different types of nexus (e.g., water-energy-land-food; water-power-internet).

Systems thinking overcomes the limitations of deterministic and reductionist thinking by looking at the components of communities and considering how these parts interact, their common purpose or function, the rules they have adopted, and how the parts interact with their environment.

3. The linkages between mental models, community structure, behavior patterns and community issues.

Problems at the community level are related to patterns of behavior controlled by an underlying structure driven by mental models. Mental models are driven by intangible factors such as dominant community preferences, values, habits, biases, priorities, culture, religious beliefs, loyalties, policies and procedures. These often unseen and deeply hidden aspects represent the inward dimensions of community issues, how the problems are addressed, and how reality is simulated. Even more profound at this level is where social-psychological factors that shape human thought, preferences, and behaviors reside. Mental models represent leverage points in community development decision-making.

4. The ability to identify different types of systems and make decisions accordingly.

Systems can be divided into simple (we know the knowns), complicated (we know the unknowns), complex (we don't know the unknowns), and chaotic systems. The dominant modes of intervention for the four systems groups include (i) sensing, categorizing, and responding for simple systems, (ii) sensing, analyzing, and responding for complicated systems, (iii) probing, sensing, and responding for complex systems, and (iv) acting (quickly to establish order) followed by sensing and responding for chaotic systems.

5. The need to embrace complexity when needed rather than always embracing simplicity.

The interaction of the different systems in Figure 2 implies that in community development, (i) uncertainty and ambiguity are the norms; (ii) complex interactions with circular and nonlinear causality take place among the components; (iii) unpredictability in one or several of the components is commonplace; (iv) unintended consequences unfold; and (v) it is not easy to reach an agreement on how to address problems in the landscape since they are interconnected. In the community landscape, the unknowns must be handled as they are discovered. In that context, decision-makers need to make a fundamental and intentional shift in perception—from viewing complexity as an obstacle to complexity as an opportunity, and being constantly and fully aware of that value proposition.

6. Understanding the stakeholders/actors involved in community development and their influence (enablers vs. constrainers) and dependence.

Stakeholders can be regrouped into three categories: (i) community members contributing to bottom-up solutions; (ii) governmental institutions providing top-down solutions; and (iii) outsiders (e.g., NGOs, donors, private sector organizations, civil society, etc.) contributing to outside-in solutions.

7. The need to follow a methodology that reflects the community projects' complex and uncertain nature.

As complex adaptive systems, community issues cannot always be addressed using a linear mindset. An example of a system-aware methodology for community development is shown in Figure 4. All ten stages require a systems perspective.

Community project management ladder with feedback mechanisms *fig 4*

Projects in Uganda

Heifer International's mission: "We work to end hunger and poverty in partnership with the communities we serve. Our programs support entrepreneurs around the world, creating lasting change from the ground up."

To fulfill that mission, Heifer's model is to "*support farmers and their communities as they mobilize and envision their futures, provide training so they can improve the quantity and quality of the goods they produce, and connections to market to increase sales and incomes.*" Heifer works in five key areas: economic development, environmental sustainability, food security and nutrition, risk mitigation and resilience, and women's empowerment and social capital.

Deciding on whether a systems approach is appropriate in Heifer's community development projects depends significantly on the nature of the community problems being addressed and the community context. The reasoning for using a systems approach when confronted with complex issues is summarized in figure 5.

The projects reviewed during the May 20-27 visit indicate that Heifer has already successfully conducted holistic value-based community development projects in Uganda incorporating the five work areas mentioned above. Furthermore, Heifer recognizes the importance of collective and participatory actions in these projects. These two remarks make adopting additional systems tools in Heifer's projects easier.

Suggestions are proposed below on how a systems approach would further complement Heifer's work in Uganda.

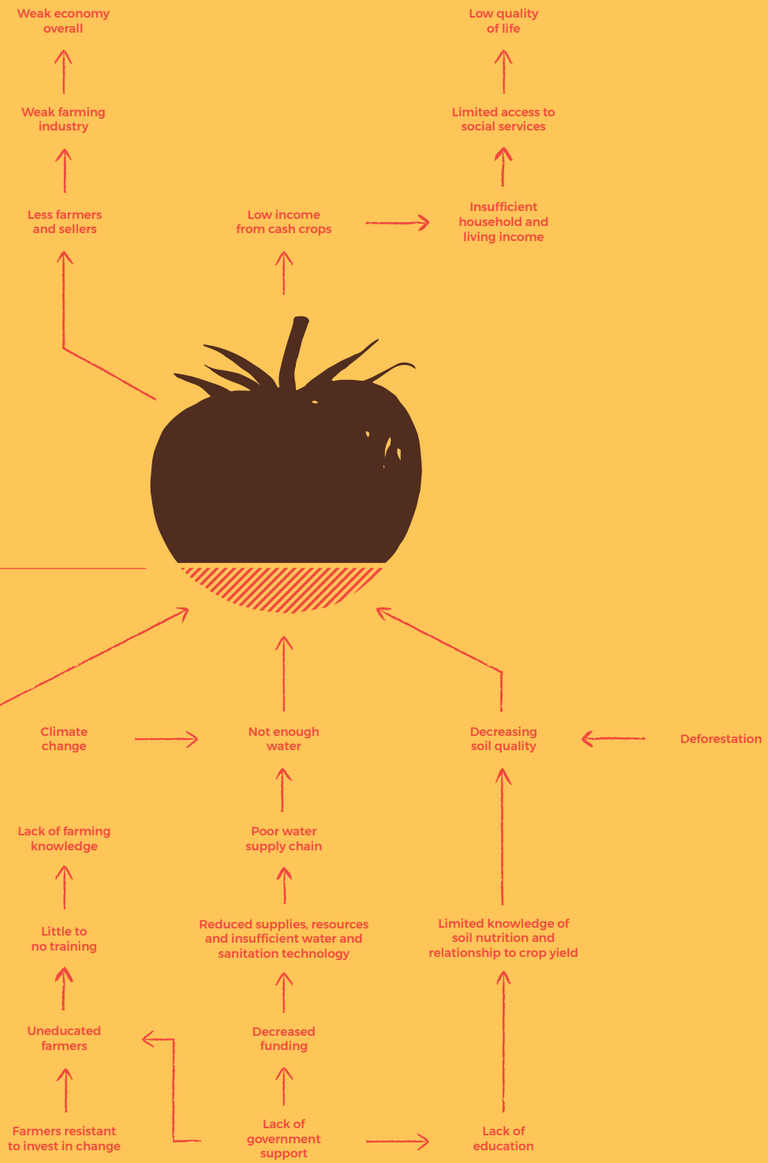
» The term "*holistic*" in what Heifer describes as "Values-based holistic community development" is somewhat vague and needs further definition. Based on the May visit, Heifer's interventions seem to focus more on the agricultural part of community development than on human development issues related to household health, WASH, energy, education, livelihood, conflict, etc. When addressed, these issues seem to be treated in a compartmentalized manner rather than in an integrated way. In each agri-hub visited, there was little explicit discussion on how the agri-hubs consider the livelihood of farmers' households around health, education, water, and energy simultaneously as agri-business development. This is due to the limited resources and expertise at the management team level. It is important to note that agri-hubs affect the community, and the community influences the agri-hubs. Holistic must account for this mutual dependence and requires optimizing and leveraging partnerships that meet farmers' needs in an integrated manner. The new Power-Water-Internet initiative of Heifer represents a step in that direction.

How to decide whether or not systems thinking is the right approach. *fig 5*

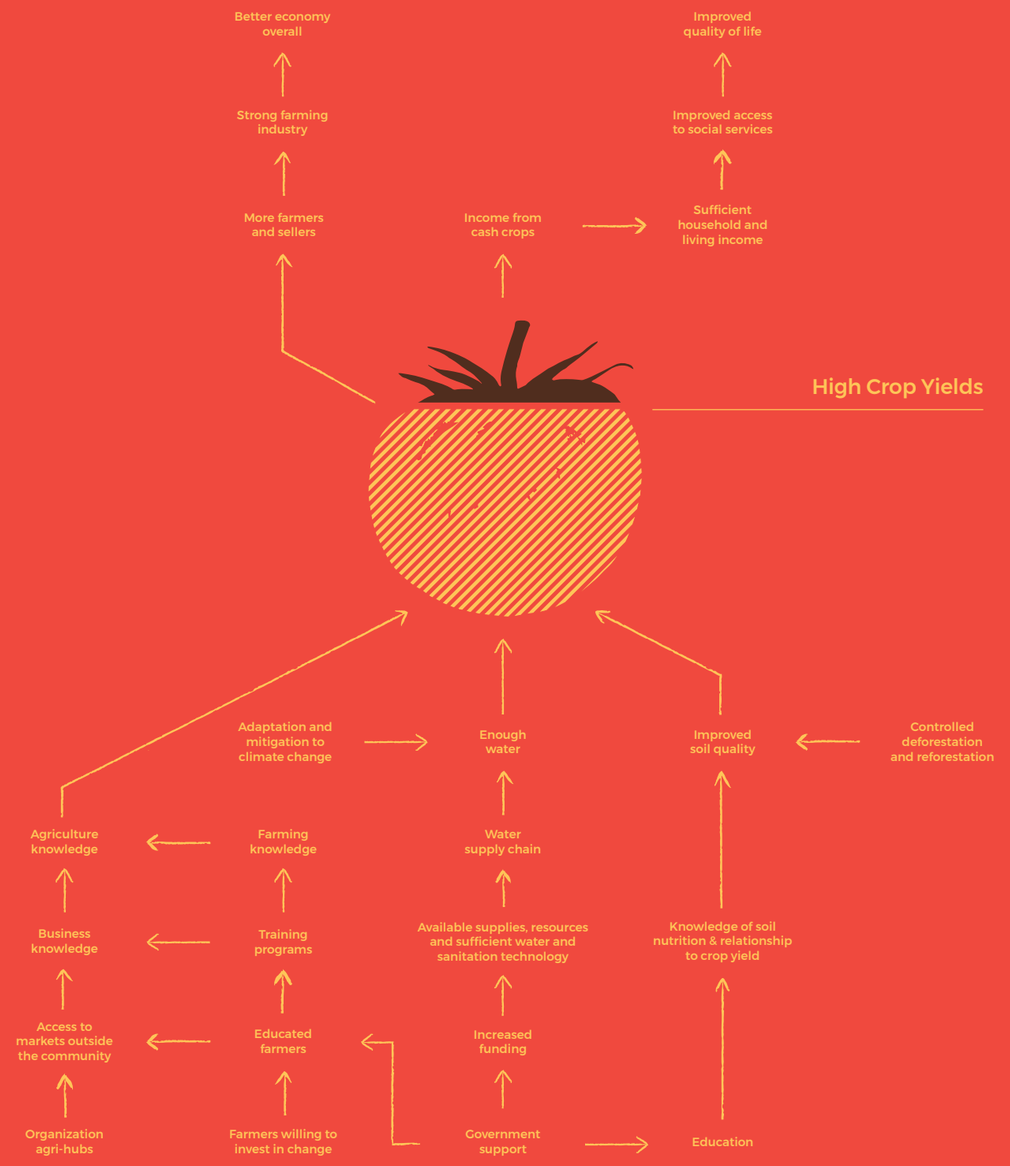
Adapted from Systems Practice by the Omidyar Group and the UK government office for science, 2022.

- A systems practice and evidence-based approach to projects from inception to completion is recommended and includes (i) conducting data collection and analysis, taking into consideration how data are inter-and intra-related, (ii) formulating and modeling issues in an integrated way, (iii) developing and implementing interventions that keep track of how different interventions interact, (iv) leveraging possible trade-offs and synergies around the problems identified, and (v) exploring the intended and potential unintended consequences of interventions. It is also about adopting a learning and adaptive system-aware monitoring, learning, and evaluation strategy.
- A systems approach to holistic development must consider longer time horizons for the projects. It takes a long time for substantive changes (higher-level results) to materialize and emerge; these changes are not known beforehand. This uncertainty requires adopting a more extended learning and adaptive approach (10-15 years).
- A systems approach also helps scale up successful projects like those in the L4AB initiative. Community development involves many nonlinear connections and issues that cannot be easily scaled up from one scale to the next. Adopting a systems approach to community development projects requires decision-makers and community stakeholders to be systems thinkers and to have acquired systems thinking skills. Problems cannot be solved with the same mindset and habits that created them. Heifer should train, coach, and mentor its development workers and decision-makers at all levels to be systems thinkers.
- Existing systems tools available in the systems science literature can appropriately be used within the context of Heifer's project in Uganda. For instance, social network analysis (SNA) could help map how different stakeholders involved in an agri-hub interact or how agri-hubs interact with each other, the industry, and markets. And, more specifically, who controls what and who is left behind. The cross-impact analysis could explore the influence and dependence of water, energy, land, and food security. Problem and solution trees could help lay out the consequences and root causes of several community issues, such as low crop yield, poor water management, or poor household livelihood. Figures 6 and 7 show problem and solution trees around the issue of crop yields at the agri-hub scale. It should be noted that system tools do not preclude using traditional deterministic and linear ones. Both are complementary to each other and should be used as needed and left to the discretion of the practitioners and decision-makers.
- An example of the application of system dynamics is shown in Figure 8. This causal loop diagram shows multiple feedback reinforcing (R) and balancing (B) loops between different domains interacting directly and indirectly at the agri-hub level and the linkages between agri-hub effectiveness and household livelihood.

The root causes and impact of *low crop yields* are outlined in this Problem Tree. *fig 6*



The root causes and impact of *high crop yields* are outlined in this Solution Tree. *fig 7*



- Upon analyzing the causal loop diagram of Figure 8, questions arise about where to intervene in the system and how to identify the leverage points where interventions have significant consequences. Examples include working on the effectiveness of the agri-hub, improving water and energy supply, improving household living income, and improving rural information systems. Specific interventions can then be selected.
- Once an issue has been identified, different types of intervention can be considered and ranked using a multiple-criteria decision analysis (MCDA) based on several critical criteria or objectives deemed necessary in the decision process. In general, the decision process involved in the MCDA method is presented in a tabular or matrix form where various options or alternatives to solving an issue are listed in the top row. Several decision criteria carrying different weights are listed in the leftmost column. In the MCDA performance matrix, a score using an arbitrary scale (between 1 and 3 or higher) is selected by decision-makers to quantify how each criterion is relevant to each option considered. A weighted score is then determined in a linear additive way (sum of scores times weights). The option that tallies the highest weighted score is the one that is the most promising. Table 1 is an example of an MCDA matrix for a project in Nepal where solutions to two issues (insufficient water and energy) were addressed. In this example, addressing both issues gives the highest score.

EXAMPLE OF MCDA MATRIX FOR A PROJECT IN NEPAL *table 1*

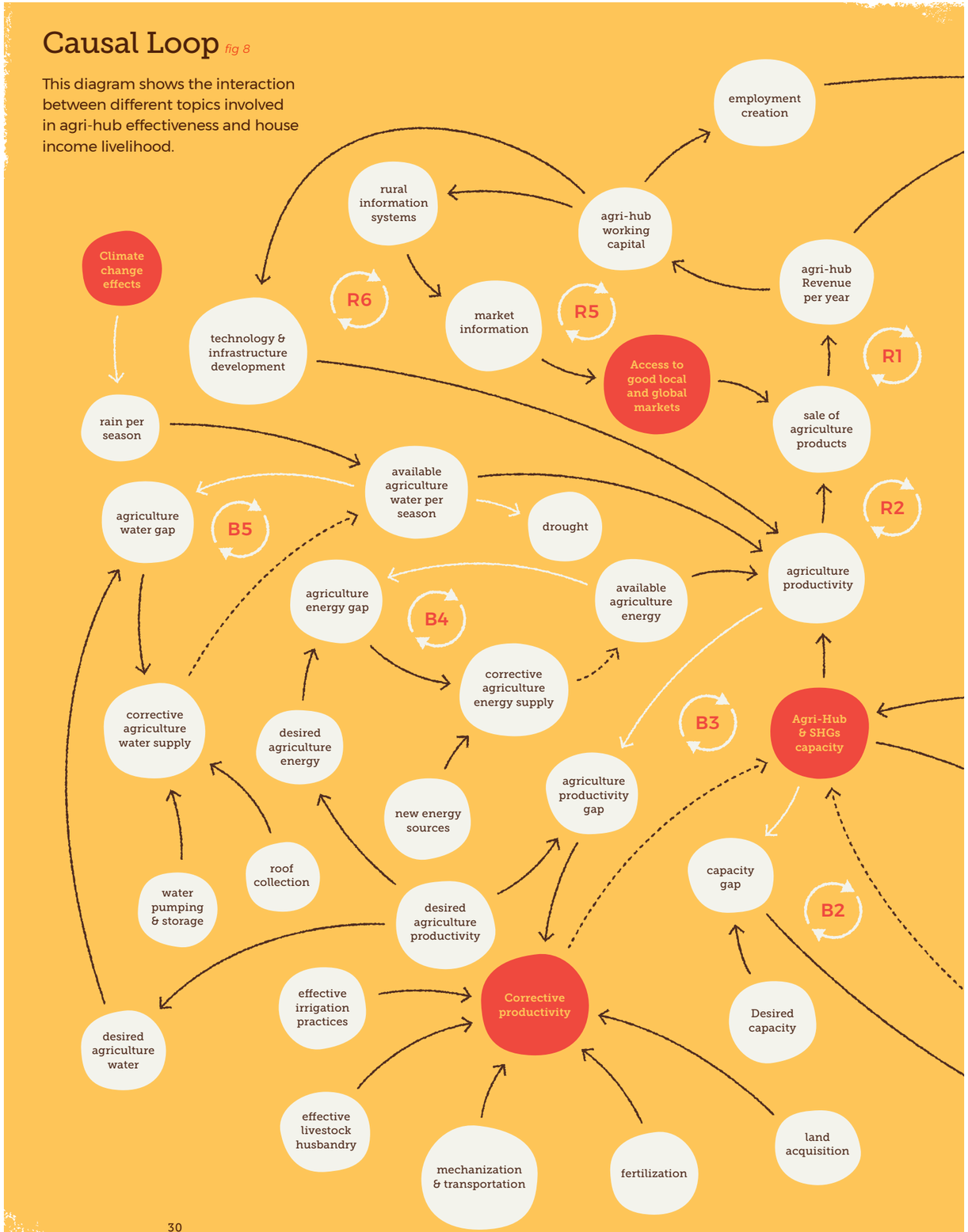
CRITERIA	WEIGHT	New irrigation canals		Drip irrigation		New water storage facilities		New pico hydro plants		Photovol-taic (PV) panels on homes		Combined irrigation canal & pico-hydro	
Cost-effectiveness	3	2	6	1	3	1	3	2	6	2	6	3	9
Social acceptability	5	3	15	1	5	2	10	2	10	2	10	3	15
O&M feasibility	4	2	8	1	4	2	8	2	8	1	4	2	8
Environmental sustainability	5	1	5	3	15	2	10	3	15	3	15	2	10
Community participation	4	3	12	2	8	2	8	3	12	2	8	3	12
Impact on community health	4	2	8	2	8	1	4	2	8	1	4	2	8
Economic impact	3	3	9	2	6	1	3	2	6	2	6	3	9
Number of people impacted	4	2	8	2	8	2	8	2	8	3	12	3	12
Totals			71		57		54		73		65		83

Table adapted from Glover, C., Goodrum, M., Jordan, E., Senesis, C. and Wiggins, J. (2011). Mabu village term project, CVEN 5929: Sustainable Community Development 2, University of Colorado at Boulder.

Weight Score Weight x Score

Causal Loop *fig 8*

This diagram shows the interaction between different topics involved in agri-hub effectiveness and house income livelihood.



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