# Value Chain Laboratory

Alternative evaluation method for assessing value chain dynamics

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Wageningen Economic Research developed a Value Chain (VC) Lab that enables measuring changes in relationships between value chain agents. The VC-Lab consists of three components: Value Chain Analysis (VCA), Value Chain Games (VCG) and a multi-Agent Based simulation Model (ABM). The 2SCALE programme provides in sub-Sahara Africa support for value chain transformation through training, certification, information exchange and market positioning. The development of relationships and mutual trust between value chain agents is considered fundamental for this transformation. Together with 2SCALE, two public-private partnerships were selected as case studies for the VC-Lab, i.e. (1) Sorghum produced around Meru (Kenya) for the Beer industry with a dedicated buyer, and (2) Soy produced in Northern Ghana for the oil industry supplied to a cooperative. We conclude that the VC-Lab enables to get better insights in the behavioural outcomes and dynamic effects of VC development and as a result it is possible to capture key drivers of change in (internal) resource allocation and (external) exchange transactions, including responses to price incentives and non-price effects that arise from different value chain interactions. Moreover, this framework can also be applied for ex-ante simulation of impact. The study offers insights and recommendations for further improvement and design of the VC-Lab. Concerning the two cases of 2SCALE, the overall generic conclusion is that VC agents are mainly still risk-averse although relations seems to be improving, formal (contractual) arrangements are in place and trust has increased. It also shows that resources should be spent on trust building and trustworthiness and that it takes a lot of efforts to maintain or increase trust to a certain level. An important outcome of the VC-lab is that it is crucial to offer producers training on good agricultural practices and that simultaneously increase product quality and quantity of produce and permit to increases trust.

Key words: 2SCALE, IFDC, ICRA, BoP, Sustainable, Inclusive Value Chains, Impact Assessment, Value Chain laboratory, experiments, agent-based modelling, Kenya, Ghana, Soy, Sorghum, trust, risk, transaction costs.

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# Contents


B7
B6

# Preface

Fostering of inclusive business is a recent approach to alleviate poverty in developing countries. Inclusive business is to be understood as sustainable and commercially viable business that involves low-income communities in value chains, in such a way that is benefitting them. NGOs develop inclusive business in public-private partnerships with firms that have interests in reliable local supply. In such partnerships, there are issues to be solved, such as the high transaction costs for firms sourcing from large numbers of small-scale suppliers, the cost of logistics, the firms' trust in the suppliers' capacity and commitment to the relationship, the suppliers' trust that firms will accept their produce and will pay as promised, and the availability of knowledge, capital, and inputs to the suppliers. NGOs and firms are assumed to have complementary capacities and resources to solve these issues.

New impact assessment approaches are required to evaluate public-private partnerships aiming at supply chain development. Topics to be measured include changes in farm income and transaction costs , as well as behavioural change in value chain relationships. This report concerns the development of a value chain laboratory (VC-Lab) for impact assessment of supply development programmes. The VC-Lab developed an operational methodology and progress assessment tool that permits the measurement of behavioural change and scenario development in vertically structured supply-chain relationships. For this purpose, we used a participative gaming approach that identifies changes in mutual trust, transaction costs and risk behaviour that result from VC support. Within the framework of the VC-Lab, the agent-based simulations compare potential performance with outcomes from actual value chain participants, thus following the symbiotic gaming and agent-based simulation interaction as proposed by Tykhonov et al. (2008). Thus, an environment is offered where data can be gathered, hypotheses about cooperative processes can be tested, and alternative regimes can be experimented with.

The research is conducted in the context of a programme called 2SCALE (Towards Sustainable Clusters in Agribusiness through Learning in Entrepreneurship) that is developed in sub-Sahara Africa. The goal of 2SCALE is to improve rural livelihoods and food and nutrition security in nine African countries. To this end 2SCALE forges public-private partnerships, with private partners varying from local producer organisations and SMEs to large-scale companies such as seed companies, processors, and trading companies. The approach is based on (1) formation of agribusiness clusters - local networks between the producers themselves and with service providers - to improve competitive intelligence and bargaining power, (2) integrating the agribusiness clusters in value chains, with backward linkages to input supply chains and forward linkages to food supply chains, and (3) enabling fair business environments with better access to information and finance, in particular for the weaker actors.

This report describes the VC-Lab and agent-based simulation of the assessment of two 2SCALE initiatives: (i) sorghum value chain in Meru County, Kenya and (ii) soybean value chain in Tamale, Ghana. The study provides insights into the trust levels of farmers, their risk perception and collective action strategies, and provides scenarios for maximal impact. Data gathering and analyses took place in 2015 and 2016.

We trust that the findings of this study will help to strengthen the design and evaluation of future VC projects and will inform current and future debates on inclusive and sustainable value chain development initiatives. We are greatly indebted to the farmers for their assistance and the information they have provided us. We express our gratitude towards Shalem for their commitment and collaboration to provide the researchers will all the necessary information and logistical arrangements. We would not have been able to conduct this study without their efforts. We also wish to thank the IFDC team in Ghana and Kenya. They assisted us during the whole process and provided us with all the necessary information. We sincerely hope that this report provides a relevant reference for field staff and stakeholders involved.

The Hague, July 2017

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# Summary

This study was conducted in the context of the 2SCALE (Towards Sustainable Clusters in Agribusiness through Learning in Entrepreneurship) programme running from 2012-2017. The programme is inclusive in character and aims to improve rural livelihoods and food and nutrition security in nine sub-Saharan African countries and is implemented by a three-member consortium: the International Fertilizer Development Center (IFDC), Base of the Pyramid Innovation Center (BoPInc.) and the International Centre for development oriented Research in Agriculture (ICRA). The programme is supported by a grant of the Ministry of Foreign Affairs of the Netherlands. To this end 2SCALE forges public-private partnerships, with private partners varying from local producer organisations and SMEs to large-scale companies such as seed companies, processors, and trading companies.

The intervention strategy of 2SCALE, i.e. fostering of inclusive business aiming to involve low-income communities in value chains, is based on a novel approach to alleviate poverty in developing countries. The approach also requires new impact assessment tools to measure change in farm income and transaction costs , as well as behavioural change in value chain relationships. Current impact assessment approaches face challenges for analysing typical value chain interfaces, where multiple stakeholders are usually involved that pursue different - sometimes even opposing - interests and objectives, and that have to operate within a dynamic (inter)national market environment. In such settings, conventional impact assessments only offer partial insight and sometimes even draw inadequate conclusions, overlooking important behavioural responses and disregarding market interaction effects that may lead to different outcomes. Therefore this study focuses on role and changes in horizontal cooperation and vertical relations of the value chain including trust, loyalty and behavioural change. This study thus aimed to design an alternative impact assessment tool..

As such, the aim of the VC-Lab is twofold:

I) To develop an innovative operational methodology and progress assessment tool that permits the measurement of behavioural change in vertically structured value chain relationships
II) To apply the methodology to two cases of the 2SCALE programme to assess changes in relations between the main actors which can be contributed to 2SCALE interventions.

Within the 2SCALE programme, a Theory of Change (see Appendix 1) was developed that underpins the market transformation interventions' logic and its assumptions. The intervention logic is based on three elements: risk perception, mutual trust and transaction costs s. The selection of these three key variables is based on theoretical insights regarding agency behaviour. The adoption of good agricultural production practices (GAP) and good business practices (GBP) are commonly understood as investment decisions that require capital and labour resources and access to knowledge, information and training. These investment decisions are mainly guided by perceived risk (Barham et al. 2014; Feder et al. 1985). The collaboration and compliance relations within supply chains are considered to be largely determined by mutual trust between value chain partners (Laeequddin et al. 2010; Kwon and Suh 2005). Loyalties in deliveries (i.e. contract compliance) as well as control on free-riding and opportunistic behaviour (side sales) are key factors for optimal capacity utilisation in processing, storage and trade. Procurement relationships between value chain partners and the added value generation in the supply chain are largely governed by transaction costs s. Investments in quality upgrading are facilitated by reduced transaction costs s for search, negotiation and control (Hobbs 1996). Contracts that reinforce reciprocity and reduce default options (simplified compliance) provide a governance structure that reinforces quality compliance. Transaction attributes (such as scale and frequency) and clear contracting rules (specified quality standards; payment systems) permit to reduce search and supervision costs and thus optimise value chain outcomes.

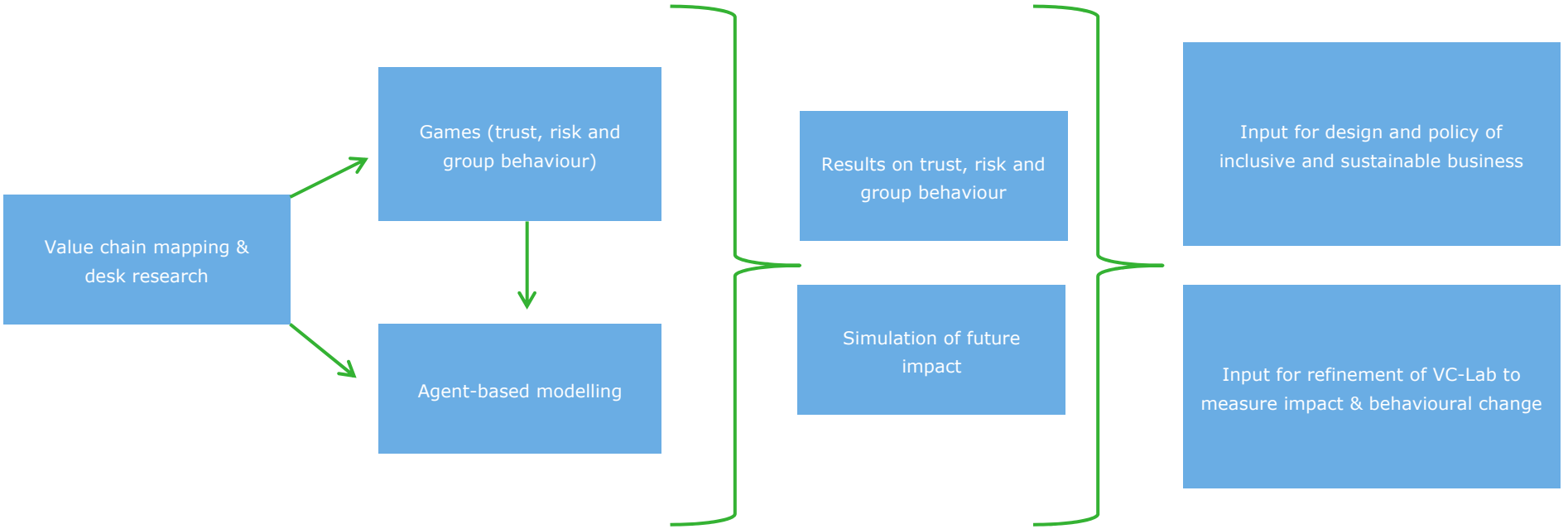


**Figure S.1** Methodology of the VC-Lab

The VC-Lab assesses the effects of 2SCALE on the VC relationships and performance outcomes. The VC-Lab is designed as a responsive assessment and learning framework for analysing behavioural impact of supply chain support programmes. The VC-Lab consists of 3 components (see also figure 1):

- Value Chain Analysis (VCA);
- Value Chain Games (VCG) involving participating farmers and non-participating farmers;
- Multi-Agent Simulation Model (ABM).

In consultation with management of 2SCALE two cases were selected for this study. Both were public-private partnerships, which were supported by the programme: i) sorghum produced around Meru (Kenya) for the beer industry with a dedicated buyer and ii) soy produced in Northern Ghana for the oil industry supplied to multiple buyers through a cooperative structure. For each case a specific VC-Lab was designed according to the value chain logic, its actors and the specific intervention logic of 2SCALE. The two cases are not comparable in the sense that the value chain structure and the approach of 2SCALE are different between the two countries.

Data of the value chain analysis were collected in November and December 2015 via interviews of stakeholders, focus group discussions and desk study. The games were conducted in December 2015 in Ghana and in June 2016 in Kenya. In total three games were played: a risk game, the trust game and a group trust/collective action game. The games were played with participants (treatment group) and non-participants of the 2SCALE intervention (comparison group). In total 256 farmers in Ghana participated in the games and 240 in Kenya. The model was developed during the whole period. The results were validated and further discussed at a dissemination workshop in Kenya in May 2017. The ABM is accessible online and available for IFCD and partners and Shalem in Kenya.

The conclusions are drawn at two levels: the validity of the methodology developed and the empirical effects of the intervention in the two case studies.

Concerning the methodology, the VC-Lab proves to be a promising approach for measuring and evaluating the key assumptions of behavioural change specifically related to trust and risk. The VC-Lab is validated as an assessment and learning method for analysing behavioural impact of supply chain support programmes. The three steps (value chain analysis, games and the agent-based model) follow a logical sequence and are crucial methodological components of the lab. Each step provided important data for the design and customisation of the next step. It appeared though that it is important to gather data over time for some parameters (e.g. trust and risk attitude) and that sufficient resources need to be available to gather those data via games. Another challenge was found in the concretisation of transaction costs. The VC-Lab generated valuable insights for further methodological development. One recommendation for improvement is to include a parameter of decision making of agents regarding the trade-offs between the cultivation of other crops than those under study, taking into consideration weather and changes in market prices. Another important experience is that not all value chain cases are suitable for a VC-Lab and ABM. The Ghana case was less suitable as there are multiple farmer groups and various buyers of their produce. As such, there are different alternative value chains and exchange relations may endure for one season only.

Concerning the 2SCALE intervention in Ghana and Kenya, it can be concluded that the programme contributed to trust development over time. Overall, the farmers participating in the 2SCALE programme show higher levels of trust in their regular buyers and also compared to non-participating farmers. We can confirm that repeated interactions between value chain agents has reinforced inter-agent trust over time. In addition, we identified a positive trust uptake after a positive experience and negative trust uptake after a negative experience. It also illustrates that resources must be spent on trust building and trustworthiness and that it takes a lot of efforts to maintain or increase trust beyond a certain level. An important outcome of the VC-lab is that it is crucial to offer producers training on good agricultural practices and that simultaneously increase quality and quantity of the produce and increase trust.

However, we did not observe major differences in group behaviour between farmers who are part of the intervention and farmers who are not: free riding is common practice in all farmer groups. Also, risk aversion is very high and does not show any difference between farmers in or outside the intervention group. Common attitude against risk is mainly averse although relations seems to be improving; when formal (contractual) arrangements are in place, trust has increased. It also appears that selling part of the produce to another party than the main buyer with contractual arrangement will always be part of the experience of the VC. Even if all conditions are favourable (i.e. high price offered, produce of high quality, guaranteed market, training on agricultural skills offered), it appears that side-selling may occur. The reasons are legitimate and have nothing to do with trust, risk or disloyalty. It is just a matter of urgent need of cash. As long as producers do not have any savings or cannot access loans, it is reasonable to argue that side-selling will occur.

Concerning the interventions of 2SCALE in Kenya and Ghana, the overall conclusions are that:

- It turns out to be crucial for a stable contractual delivery to provide a stable and high contract price against uncertain alternatives;
- Improving skills leads to increased production and higher volumes;
- Horizontal and vertical trust are a key success factors for expanding production and exchange;
- A (good) reputation and trustworthiness are crucial for an effective VC with strong linkages and relationships;
- The approach of 2Scale can lead to improved farm income and a profitable processor.

More specifically per country, the tables A and B provide a summary of the evaluation results:

**Table S.1** Main conclusions Kenya

| Kenya main results on 2SCALE intervention |
|---|
| Trust of farmers is higher in Shalem (processor of intervention) compared to a) other processors and brokers and b) to farmers of comparison group which is a positive result of Shalem and IFDC interventions. Trust in Shalem caused by trustworthiness, offering a good price and training on production. |
| Risk aversion is high and equally high among farmers in the treatment and comparison group. |
| It is crucial for a stable contract supply to provide stable and high contract price against uncertain alternative. |
| Improving skills leads to increased sorghum production and volumes and builds trust. |
| (Good) Reputation and trustworthiness crucial for sustainable, inclusive and effective value chain. |
| Approach IFDC can lead to higher farm incomes and profitable processor. Trust is key success factor. |
| Shalem sorghum case is suitable for VC-Lab approach. |

**Table S.2** Main conclusions Ghana

| Ghana main results on 2SCALE intervention |
|---|
| No differences VCM game: free riding and investing in common pool resources. Low trust levels in other group members and negative behaviour of peers affects individual behaviour. |
| Risk aversion is high and equally high among farmers in the treatment and comparison group. |
| A positive relation between production loan, trust & attitude towards group leadership and risk aversion. |
| If prices cannot be stabilised by price support or contracts offering a good minimum price, collective storage and development of small-scale local processing can be good alternatives, provided that good inputs are available. |
| Ghana soy case is less suitable for VC-Lab approach. |

# 1

# Introduction

# Introduction

## 1.1 Background

Fostering of inclusive business is a recent approach to alleviate poverty in developing countries. Inclusive business is to be understood as sustainable and commercially viable business that involves low-income communities in value chains, in a way that is benefitting them. NGOs develop inclusive business in public-private partnerships with firms that have interests in reliable local supply. In such partnerships, there are issues to be solved such as the high transaction costs for firms sourcing from large numbers of poor suppliers, the cost of logistics, the firms' trust in the suppliers' capacity and commitment to the relationship, the suppliers' trust that firms will accept their produce and pay as promised, and the availability of knowledge, capital, and inputs to the suppliers. NGOs and firms are assumed to have complementary capacities and resources to solve these issues.

Therefore the 2SCALE (Towards Sustainable Clusters in Agribusiness through Learning in Entrepreneurship) programme has been developed. This is a consortium of partners, led by the International Fertilizer Development Center (IFDC), and included the Base-of-the-Pyramid Innovation Centre (BoP Inc.) and the International Centre for development-oriented Research in Agriculture (ICRA). The programme is supported by a grant of the Ministry of Foreign Affairs (through the Directorate-General for International Cooperation, DGIS) of the Netherlands. The programme runs from 2012 to 2017.

The approach in this programme is based on:

1. Formation of agribusiness clusters - local networks between the producers themselves and with service providers - to improve competitive intelligence and bargaining power;
2. Integrating the agribusiness clusters in VCs, with backward linkages to input supply chains and forward linkages to food supply chains;
3. Enabling fair business environments with better access to information and finance, in particular for the weaker actors.

New impact assessment approaches are required to evaluate public-private partnerships aiming at supply development and inclusive value chains. Topics to be measured include changes in farm income and transaction costs, trust and behavioural change in value chain relationships. An impact study using the Difference in Difference approach (DID) is conducted by another party (Research Solutions Africa – RSA - in collaboration with the American Institute for Research - AIR). This impact study focusses on the robust impact, i.e. impact at household level to assess welfare changes on the producer level. The present study focussed on effects of and changes in horizontal and vertical relations of the value chain including trust, loyalty and behavioural change.

In a free market situation, buyer to seller trust is important, but in a value chain it is even more important, because it concerns direct trading partners, not only now, but in the direct future. In contrast to what is called vertical integration, supply chain actors are not integrated in the same company or work under the same management. Most actors are independent, but trade with each other based on formal agreements such as contracts, and informal agreements, such as trust. If farmers do not comply with their formal contract and for example deliver to other buyers or on the open market, we call this side-selling. Reasons for side-selling are numerous, but this can be mainly related to a low trust level or a lack of loyalty towards their usual buyer.

The research has therefore developed a value chain laboratory (VC-Lab) for impact assessment of supply development programmes. The VC-Lab entails three steps: i) value chain mapping and analysis; ii) participatory games on the main indicators here i.e. trust and risk; and iii) an agent-based model. The latter mirrors the games with actual value chain participants, following the symbiotic gaming and agent-based simulation approach as proposed by Tykhonov et al. (2008). Thus, with the VC-Lab an environment is offered

where data can be gathered, hypotheses about the processes can be tested, and alternative regimes can be experimented with.

Since a responsive assessment and learning framework for analysing behavioural impact of supply chain support programmes is missing we developed a new tool, which is developed alongside two 2SCALE cases: 1) Sorghum produced around Meru (Kenya) for the beer industry with a dedicated buyer and 2) soy produced in Tamale (Northern Ghana) for among others the oil industry supplied through various cooperatives and farmer organisations.

## 1.2 Objective

This study has the following objectives:

- To assess the effects of 2SCALE support on value chain relationships and performance outcomes;
- To provide feedback to 2SCALE programme management and partners concerning the outcome and output effects of VC support programmes;
- To identify and support potential improvements in VC support;
- To design and validate the VC-Lab as an assessment and learning method for analysing behavioural impact of supply chain support programmes.

## 1.3 Approach

The project developed a Value Chain Lab (VC-Lab) that supports the understanding of the key behavioural assumptions and will help to assess changes in the agency VC relationships due to 2SCALE.

The VC-Lab is a responsive assessment and learning framework for analysing behavioural impact of supply chain support programmes. The VC-Lab consists of 3 tools: Value Chain Analysis (VCA), Value Chain Games (VCG) and a multi-agent Simulation Model. In addition, some key indicators from the impact study of ARS and AIR have been used as input for this study.

Together with 2SCALE, the following of their ongoing public-private partnerships were cases in this study:

- Sorghum produced around Meru town (Kenya) for the Beer industry with a dedicated buyer.
- Soy produced in Northern Ghana for the oil industry supplied to a cooperative.
- *New potato varieties supplied by a nucleus farm aimed at supplying the processing industry (Ethiopia).*

The potato interventions in Ethiopia faced serious challenges due to political unrest; the stock potatoes were devastated in heavy fire started by protestors in December 2015. Work of numerous years of multiplication/selection of new potato varieties was destroyed. Because of this issue, the project continued only with the sorghum and soy cases. This VCA is described in Appendix 2.

## 1.4 Reading guide

This report gives an overview of the relevant literature and conceptual framework in Chapter 2 and methodology applied (Chapter 3). This is followed by the results of the VC-Labs in Kenya (Chapter 4) and in Ghana (Chapter in 5). In Chapter 6 the main conclusions are presented.


SAMSUNG

# Point of departure: trust, risk and transaction costs in value chains

2

# Point of departure: trust, risk and transaction costs in value chains

## 2.1 The Theory of Change

The VC-Lab approach is based on the theory of change (ToC) that underpins 2SCALE support to market transformations (Figure 3.2). It focuses attention on the verification of key assumptions underlying the VC change pathways (instead of measuring only nominal changes in outcomes).

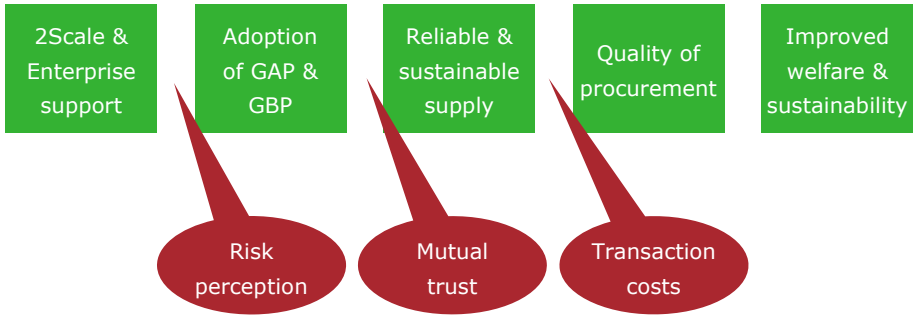


**Figure 2.1** Theory of change that underpins the 2scale support to market transformation

The selection of these three key variables is based on available theoretical insights on agency behaviour. The adoption of good agricultural practices (GAP) and good business practices (GBP) is commonly understood as an investment decision that requires capital and labour resources and knowledge/training. The adoption of GAP/GBP is mainly guided by risk perceptions (which in turn may be influenced by their risk attitudes) (Barham et al. 2014; Feder et al. 1985). 2SCALE support thus intends to influence the mental model (e.g. willingness to invest and willingness to collaborate) of and the social interactions (e.g. knowledge diffusion) between VC agents. Gender, age, education, farm size, wealth and proximity to the market are usually differentiating variables for risky decision making, i.e. influencing the anticipated uptake of improved practices. The analysis can distinguish between risk perceptions for particular types of practices, thus anticipating the likely uptake by specific categories of producers.

Design for the methodology applied follows the value chain (VC) structure and dynamics that govern the interactions amongst value chain agents. These interactions are guided by price and non-price commitments. While the price commitments result in net (expected) value added that each of the agents can capture from the transaction, the non-price elements are of vital importance for the exchange of information between the agents (e.g. commitment, reliability and trust) and the behaviour of the agents (e.g. quality compliance, loyalty in deliveries, etc.). These aspects determine the transaction costs s in the value chain and tend to guide the decisions on input use, technology choice and market outlet choice.

In a free market situation, buyer to seller trust is important, but in a value chain it is even more important, because it concerns direct trading partners, not only now, but in the direct future. In contrast to what is called vertical integration, supply chain actors are not integrated in the same company or work under the same management. Most actors are independent, but trade with each other is based on formal agreements such as contracts, and informal agreements, such as trust. Such collaboration and compliance relations within value chains are considered to be largely determined by mutual trust between VC partners (Laeequddin et al. 2009; Kwon and Suh 2005).

Loyalty in deliveries (contract compliance) and control on free-riding and opportunistic behaviour (side sales) are key factors for capacity utilisation in processing, storage and trade. If farmers do not comply with their formal contract and for example sell to other buyers or on the open market, we call this side-selling. Reasons for side-selling are numerous, but this can be mostly related to a low trust level or a lack of loyalty towards their usual buyer. Committed and collaborative relationships between value chain partners are based on mutual trust. If trust is present, it can increase the likelihood of successful value chain deliveries (reduced moral hazards) and improved value chain performance (reliable and timeliness of deliveries).

Procurement relationships between value chain partners and the added value generation in the value chain bring transaction costs s. Contracts that reinforce reciprocity and reduce default options (simplified compliance) provide a governance structure that reinforces quality compliance. Transaction attributes (such as scale, frequency) and clear contracting rules (specified quality standards; payment systems) permit to reduce search and supervision costs and thus lead to improved VC outcomes (Hobbs 1996).

## 2.2 Inclusion in the theory of change

For smallholder farmers, especially in low and middle income countries, it is a challenge to be included in the value chains. Inclusion means a large opportunity for them. They can have access to financial and agronomic inputs, and have more economic certainty due to more and stable buyers. However, the quality of the product is often a barrier to inclusion, as the smallholders lack the means and skills to produce the required quality (Lee et al. 2012). Contracts are therefore often used as a means to enforce loyalty and commitment, to motivate farmers to comply with minimum quality and quantity requirements. Various incentives can be included into those contracts such as an improved selling price or access to improved inputs.

For a successful inclusion of smallholder farmers in the global value chain, trust is a key factor. Farmers' trust in a new partner, as well as reciprocal trust of the buyer in the farmers is important. Entering a global value chain and getting access to a larger market does not automatically increase these trust levels. On the short run it can even decrease them, because the trading partners do not yet know each other and often a (large) difference exists in size of trading partners. When Ethiopian sesame farmers started to trade with traders of formal networks, with whom they did not have social relations, their trust levels were initially lower than when dealing with informal networks (Siziba and Bulte, 2012). So trust can eventually lead to better market participation, but in the short run this is not necessary the case and it may even run the other way around. That is why vertical exchange contracts that enable and reinforce trust between farmers and their VC buyers is a first central focus in this research.

Producer organisations or farmer groups that congregate and represent farmers, often called cooperatives or associations, are institutes that can help to overcome quality and trust barriers in order to become included in the chain. By being involved in cooperatives, farmers can exchange information on agricultural techniques, and together they have more means to access agricultural and financial inputs. They develop a stronger bargaining position towards their buyers. Cooperatives as such can be included in a value chain, and compete with larger farmers and agribusiness (Stockbridge et al. 2003). But being congregated and included in a value chain is not enough. Again, mutual trust is essential. In this case, trust of farmers in each other, so mutual trust as well as trust in other actors and institutions in charge of (the management of) the cooperative / group is very important. That is why horizontal cooperation and trust between farmers of the same cooperative is a second central focus in this research.


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# Simulating impact via the Value Chain Laboratory

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# Simulating impact via the Value Chain Laboratory

## 3.1 Introduction

The VC-Lab provides an interactive assessment and learning framework for analysing behavioural impact developed alongside the 2SCALE intervention in Kenya and Ghana. The VC-Lab consists of three phases:

1. The first step is a Value Chain Analysis (VCA) in order to understand the structure of the value chain, to identify all value chain stakeholders (from input suppliers to final consumers) and to analyse stakeholder group size and composition, key resources (assets), objectives of stakeholders and key chain dynamics.
2. The second phase is the development of a VC game with real-life VC partners which are observed in a repeated game, i.e. a multi-season setting, actual VC decision making as a result of risk perception, personal and group trust. The results of the games are presented as outcomes of the intervention and as parameter for the ABM (step 3).
3. The third phase of the VC-Lab is the development of a multi-agent VC simulation tool (ABM). In this tool the behavioural characteristics of the VC agents, as derived from the VC game, the VCA and literature, will be captured as 'what-if' rules in the VC simulation model. The VC simulation model allows for the exploration of alternative value chain options at plot level (e.g. alternative contracts or alternative incentive mechanisms).

The results of the games and the simulations in the ABM provide insights to further design and improve the intervention of 2SCALE and similar programmes aiming to improve the inclusive value chains. In addition, the results provide input for further development and refinement of the methodology of the VC-Lab to measure and simulate impact of certain interventions (see Figure 3.1).

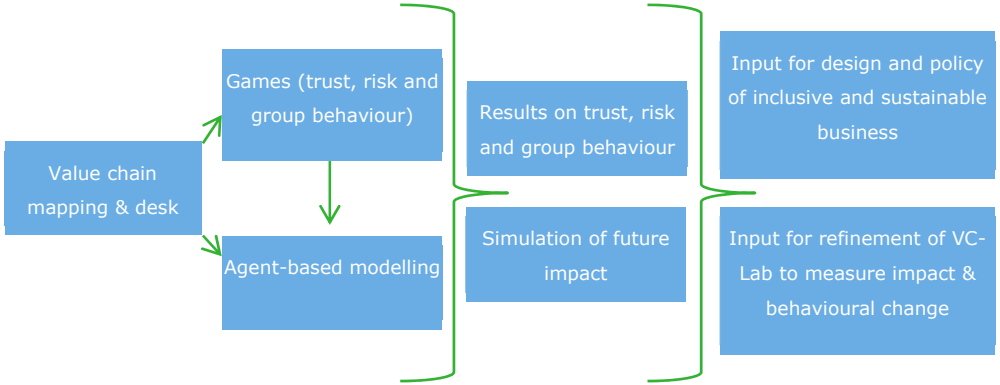


**Figure 3.1** Visualisation of the VC-Lab

An impact study to measure the impacts of the 2SCALE intervention out household level was conducted by Research Solutions Africa (RSA) in collaboration with American Institutes for Research (AIR). A difference-in-difference approach is applied conducting household surveys. The baseline results were shared by RSA/AIR and used in our study. The impact study will be conducted end 2017 and therefore these final impact results are not available at the publication of this report.

### The Value Chain Analysis

The value chain analysis (VCA) is the first step of the VC-Lab approach. For all three public private partnerships we organised a 5-day field mission in order to map the VC. During the mission the relevant key VC actors were visited. These were farmers, traders, input suppliers, and various service providers:

- For the sessions with the farmers we used a Focus Group Discussion (FGD) approach and the meetings took place without presence of IFDC. See Steward and Shamdasani (1990) for more information on the theory and practice of conducting FGDs.

- With other stakeholders (e.g. IFDC staff, extension workers, input suppliers, transporters, banks, processors, traders) we organised semi-structured interviews. For each interview we used a guideline with the topics to be discussed.

Important topics of both the FGD and the interviews were trust, risk, the role of contracts (formal and informal) and how the perceived transaction costs s. During the FGDs and the interviews translation was done by an independent enumerator. For every mission an intensive mission report was compiled.

Prior to the field mission, we conducted a desk review in order to understand the sectors and their dynamics. We reviewed literature and consulted additional data sources in order to collect secondary data on the sectors. This included production statistics but also, if available, figures on cost prices and production seasons.

### The Value Chain Games

Experimental economics offers methods to test many behavioural hypotheses and behavioural experiments have begun to demonstrate the importance of testing the standard assumptions made about decision-makers (Cardenas and Carpenter 2008). An experiment is considered as a potential research method when the necessary information concerns inter- or intrapersonal behavioural attitudes and when this information suffers from hypothetical of self-serving bias (Van Kempen 2009). The information gathered is about the behavioural attitudes trust, reciprocity, cooperation and risk aversion. The experiments were conducted to avoid hypothetical and socially desired answers as much as possible. For this reason, the games were played with real money and every participant gained a certain amount of money while playing the games. The main advantage of experimental games is incentive-compatibility (Hurwicz 1972). Incentives are set in such a way that it is optimal for rational individuals to truthfully reveal private information which means that self-serving behaviour is costly.

In this study we used three behavioural economic games which were customised to the Kenyan and Ghana context:

1. The trust game (Berg et al. 1995);
2. Risk preference game using paired lottery (Holt and Laury 2002);
3. Voluntary Contribution Mechanism (VCM) game to measure group trust (Andreoni 1995).

The trust game is played in pairs, the risk preference game is played individually and the Voluntary Contribution Mechanism as a group.

*Trust game*

In the trust game, a first and a second mover send each other money or tokens that represent a monetary value. The first mover, one of the farmers in the game, receives an amount of money from the game leader to use in a single game. The amount of tokens that the first mover sends is tripled by the game leader before it reaches an anonymous second mover. After this, the second mover can choose how much he or she sends back to the same (but anonymous) first mover. This return is not tripled, and this procedure is explained to everyone. Since both players are anonymous, the Nash equilibrium for a single round trust game is that nothing is sent by the first mover, because the second mover has no incentive to return anything. But the trust in the good intentions of the second mover (the trustee), and so a positive expectation of the return can make the first mover (the trustor) decide to send a fraction of his or her game money to his or her matched but unknown partner. The social optimum is that the first mover sends 100% to the second mover, and the second mover returns half of the received money (Berg et al. 1995). The revealed trust is measured as the fraction of the playing money or tokens, which is sent to the second mover. This will be a value between 0 and 1. Trustworthiness is measured as the fraction that the second mover returns from his or her received money.

This game was chosen to be included in the VC game, because it is simple enough to play with illiterate farmers, and is considered a better measurement than a questionnaire which has a risk of socially desired answers. A disadvantage of this game is it is hard to determine if we measured pure trust, or other regarding preferences, such as altruism, or inequality aversion (Cox 2004).

The outcomes of the trust game are likely to change if a one round game is transformed to a multi round game. Reciprocity, patience, and relation building will then become important. Personal characteristics such as risk attitude and initial trust levels, but also the way a one round game is played influences the

behaviour in a multi round game (Davis et al. 2015). The major change is that the role of unconditional kindness is reduced, and reciprocity is the main factor that determines what the players send to each other. A previous experiment in which a multi-round trust game was used shows that the endowment in a second or later rounds heavily depend on the reciprocity showed in the previous round (King-Casas et al. 2005).

*Risk preference game*
In the risk preference game we used the multiple price list method as designed by Holt and Laury (2002). Participants can choose between a risky option, and a certainty equivalent to determine their risk preference. A multiple price list was used with six choices between option A, 'win a certain amount of money', or option B: 'flip a coin' (head means winning an amount of money, tail means winning nothing). The amounts were customised proposed per countries. The risk preference game was played individually.

*Voluntary Contribution Mechanism*
The most common group trust game is the Voluntary Contribution Mechanism (VCM). In this game, players can contribute a fraction (ranging from 0 to 100%) of their playing money to a public account. The rest is stocked in a private account. Typically, the public amount is then doubled or tripled. The players earn what is left on their private account, and an equal share the public pot account. In this game it can be tempting to 'free ride', but in a social optimum everything is stored on the public account (Croson et al. 2005). This game was played to measure cooperative behaviour, and the trust in the group, of all the players.

The trust game, the risk preference game and the group trust game were played with randomly selected farmer groups participating in the 2Scale programme (treatment group) and where possible compared with comparable farmers who did not participate in the programme (control group) (Table 3.1).

**Table 3.1** Number of farmer groups involved in the games

| | Treatment | Control | Total |
|---|---|---|---|
| Kenya | 10 | 5 | 15 |
| Ghana | 11 | 5 | 16 |
| Total | 21 | 10 | 31 |

*Selection of farmers*
In Kenya the sorghum agent contacted the farmer group leader by phone to arrange the selected farmers and a venue. The research team randomly recruited 15 farmers from the member list to participate in the games with an additional 9 farmers as back-up.

In Ghana the games were played with randomly selected farmer groups in the area of the 2SCALE programme. IFDC selected the farmer groups, based on a list of famer groups and member names. A farmer group consist of approximately 50 persons and only when organised in such a group, farmers can apply for a production loan. In such a group, interpersonal trust is essential, because the default of one of the members affects all of them. Every session was played with 16 people, so within the larger groups there was a random selection to select participants.

After the games, a debriefing questionnaire was filled out by the farmers to obtain gender and age, and ask if they were eligible for a production loan in the last season. Besides, in this debriefing participants were asked to rank their trust in the group, and their trust in the leadership in a Likert Scale from 1-5. At the end, all farmers were paid the amount they had won in the games.

### Multi-agent Simulation Model

In order to capture the value chain interactions, impact analysis should be based on interactive approaches that are able to reveal behavioural drivers and constraints for value chain coordination. The experiments which were explained in the previous paragraphs are supported by agent-based modelling (ABM) to assess possible alternative outcomes (Tykhonov et al. 2008). This approach allows for a detailed assessment of existing systems, and ex-ante assessment of potential future options, which is either impossible or impractically expensive with other approaches. We calibrate our simulation model with primary data collected by ourselves and with detailed household data of the baseline study of RSA/AIR to simulate the functioning of the two selected value chains.

The objective of the ABM is to evaluate the value chain development project with respect to the role of trust and opportunities to hedge risk and reduce transaction costs. Agent-based models are a kind of microscale model that simulates the simultaneous operations and interactions of multiple agents in an

attempt to re-create and predict the appearance of complex phenomena. The process is one of emergence from the lower (micro) level of systems to a higher (macro) level. As such, a key notion is that simple behavioural rules generate complex behaviour. The ABM is implemented as a computer simulation using NetLogo and it is used to test how changes in individual behaviour will affect the system's emerging overall behaviour. As such, the agent-based model is applicable to the intervention of 2SCALE were sustainable long term relations, linkages and mutual trust is to be established. Within the model the impact can be estimated of the underlying but also of alternative intervention strategies. As such, the model can aid in decreasing failure costs of interventions.

The multi-agent simulation model was developed for each intervention to simulate decision making at various stages of the agricultural value chain. Data from the games and data from the baseline survey conducted by ARS/AIR was used as input for the model in addition to data of the VCA and literature. Virtual agents are created with characteristics (role, type of production, production or processing capacity) that resemble the real-life agents in the game session. In the concept of the value chain laboratory, the agent-based simulations mirror simulation games with actual value chain participants, following the symbiotic gaming and agent-based simulation approach as proposed by Tykhonov et al. (2008). Thus, an environment is offered where data can be gathered, hypotheses about the processes can be tested, and alternative regimes can be experimented with.

## 3.2 Timeline

Table 3.2 gives an overview of the activities per country and the VC-Lab project phases. Activities started in Kenya with a field mission in order to conduct the VCA. Directly after that a VCA mission to Ethiopia was organised, at the same time political unrest intensified and potato stock for the treatment group was destroyed. As a result the VC-Lab continued only with the interventions in Kenya and Ghana.

**Table 3.2** Activities and timeline per country

| Intervention | Activity | Description | Period |
|---|---|---|---|
| Kenya | Value Chain Analysis | Literature review, Field mission with interviews | November 2015 |
| | Game Development | Literature review, game development and testing | January - May2016 |
| | Value Chain Games | Playing of the games | June 2016 |
| | Multi-agent Simulation Model | Developing of the model with input from VCA and VCG. Description of the model for a science conference | January – July 2016 |
| Ethiopia | Value Chain Analysis | Literature review, Field mission with interviews | December 2015 |
| Ghana | Value Chain Analysis | Literature review, Field mission with interviews | December 2015 |
| | Game development | Literature review, game development and testing | January-March 2016 |
| | Value Chain Games | Playing of the games | April 2016 |
| | Multi-agent Simulation Model | Developing of the model with input from VCA and VCG | January – October 2016 |
| Project level | Draft report | Draft report shared with IFDC | December 2016 |
| Dissemination | Validation and discussion | Validation and discussion workshop with IFDC (NL) | March 2017 |
| Dissemination | Validation and discussion | Validation and discussion workshop with IFDC (Kenya) and sorghum case | May 2017 |
| Project level | Final report | Final report & closing project | June-July 2017 |

## 3.3 Outputs of the project

The study resulted in the following outputs:

- VCA studies:
  - VCA on sorghum Kenya (Dijkxhoorn and Plaisier 2015)
  - VCA on soy in Ghana (Plaisier 2016)
  - VCA on potato in Ethiopia (Dijkxhoorn 2016)

- VC Games:
  - Report on the outcomes of the games played with 15 farmer groups in Kenya (Dijkxhoorn et al. 2016)
  - MSc thesis describing the VC Games played with 16 farmer groups in Ghana, the thesis includes a literature overview on trust and risk (Oldenhof 2016)
- An agent-based value chain model implemented in NetLogo for Kenya and Ghana.
- Conference paper on a the VC model in Kenya (Verwaart et al. 2016).
- Article on alternative impact assessment tools, Impact assessment of commodity standards: towards inclusive value chains, by Ruerd Ruben (2017).
- Paper on the VC-Lab as an approach to measure impact sustainable and inclusive value chain development (forthcoming 2017).
- Poster and oral presentation at CIRAD Agri-Chains & Sustainable Development, Montpellier December 12-14, 2016 (Plaisier and Dijkxhoorn 2016).
- PowerPoint presentation with methodology, results and conclusions two cases and methodology applied.
- Final report including methodology, results, conclusions and recommendations on two cases and methodology.
- Dissemination workshop IFDC (the Netherlands).
- Dissemination and training workshop IFDC & sorghum case Kenya (Kenya) (for the report see annex 7).

# 4

# Case 1: Sorghum in Kenya

# Case 1: Sorghum in Kenya

## 4.1 The intervention

The underlying results focus on one of the 2SCALE cases in Kenya, Meru County. This initiative aims to increase the production of sorghum and to develop stable and sustainable relationships of farmers with a local sorghum processor, Shalem, which delivers to the beer industry. See Text box 4.1 for information on Shalem and the Theory of Change (ToC) of the 2SCALE intervention itself in Appendix 1.

Text box 1: Shalem Investments

Shalem Investments (Shalem) is a Kenyan trading firm and a buying agent for East African Breweries. It buys sorghum from a network of 9,000 smallholder farmers, offering premium prices to encourage quality and consistency of volumes. The company has bought more than 8,000 tonnes from 2SCALE clusters in the past three years. Shalem is a family-owned company with offices located near Meru town in the Eastern Province and it operates in the upper Eastern region of Kenya, covering all the nine sub-counties of Meru County and one sub-county in the neighbouring county of Tharaka-Nthi. The company does not have field offices but works with small- scale farmers through Community Micro Enterprises for Hope Africa (COMEHA), a non-government organisation whose mission is to improve the social economic status of the marginalised people in Africa. Shalem and COMEHA have eight members of staff at its offices who work for the two organisations. The reputation of Shalem as a reliable buyer is very solid. Farmers have the feeling that Shalem will always take the product. Farmers perceive Shalem purely as a trader and not as a service provider or acting on behalf of them. Shalem in contrary wants to profile as an organisation working with and for sorghum producers by creating a win-win situation: profit for both the company and the producers.

## 4.2 Value Chain Analysis

The value chain analysis resulted in the value chain as depicted in Figure 2. In Meru County, approximately 10,000 smallholders produce sorghum, among other crops. Typically, they grow sorghum on 0.1 to 10 acres in two seasons per year, with harvest in March and September. Productivity, as stated by farmers participating in the supply chain games, varied widely between farmers, ranging from less than 50 kg to over 2,000 kg per acre (average 880 kg per acre). Productivity is relatively low which is partly due to lack of income to purchase (higher volumes and of better quality) inputs, such as high-quality seed, fertilisers, pesticides, packaging materials, and threshing services. The 2SCALE initiative organises collective purchasing of such inputs and provides training and advice to the farmers on Good Agricultural Practices (GAP). Financial services are available to provide loans for input and other services to contracted farmer groups, but loans are not mandatory for a contract. A detailed overview of the sorghum value chain in Meru is described by Dijkxhoorn and Plaisier (2015).

### Production

The annual production of sorghum in Kenya varies between 173,000 tonnes and 254,000 tonnes. The average yield is around 0.57-0.74 tonnes per ha. Interviewed stakeholders indicated that there are an estimated 500,000 sorghum farmers. This means that they produce sorghum on an average area of 0.3-0.5 hectares. This roughly equals 1-2 acres. Most farmers produce twice per year on small plots of land which are rain fed. However a few farmers produce sorghum on larger plots going up to 10-15 acres (4-6 ha). Good farmers are estimated to produce 20-25 bags per acre per season. 1 bag contains 90 kgs of sorghum (Table A4.1).

*Season*
A key area of sorghum production is the Eastern Province. Especially around Meru there are many sorghum farmers. The region around Meru has many different micro climates due to its mountainous character, resulting in large differences in temperature and rainfall. This results in large variations between the yields of the different farmers, depending on the location. There are two sorghum seasons per year. The first one starts in May with harvest in September. The second season starts in October with harvest in March (Table A4.2).

Sorghum is traditionally produced by farmers for domestic use to make porridge and ugali. Nowadays sorghum is increasingly used for the production of beer for the poor (called Senator Keg). For this white sorghum is required and a specific variety is preferred (Gadam). Traditionally, sorghum is a 'poor man's meal', for it is quite cheap to produce and buy. Because of this image, it's a challenge to extend consumption beyond the Bottom of the Pyramid (BoP) target group.

Table A4.3 (Appendix 4) gives an overview of the different costs for 1 acre of sorghum production. This calculation has uses a modest revenue of 18 bags with 90 kg of sorghum and assumes that farmers use certified seed. In case the farmers use traditional seed, the price is only KES 150 compared to a price of KES 800 per acre. The cost price for 1,680 kg of sorghum production is calculated at KES 12 per kg, or KES 19,780 per acre. The yield is expected to be 20% lower (an estimated) 3-4 bags with conventional seed though. And although lower, there is still profit with conventional seed. During the studied season there was a minimum selling price of KES 25 per kg agreed upon with Shalem. If volumes of the farmer group increase the farmers group can get a better price (up to KES 28 per kg).

## Key actors and their roles

The figure below presents a brief overview of the main actors in the value chain. It provides with an overview of the number of actors present. In addition it gives an indication of the selling price of the farmers and the agents in terms price in KES per kg. In general farmers bring the sorghum to the collectors that store the sorghum on behalf of the agents. However from time to time opportunistic brokers come by to buy sorghum from farmers. Often they buy the sorghum for a lower price since the farmers are in need of cash. They sell it again to the agent and make a small profit.

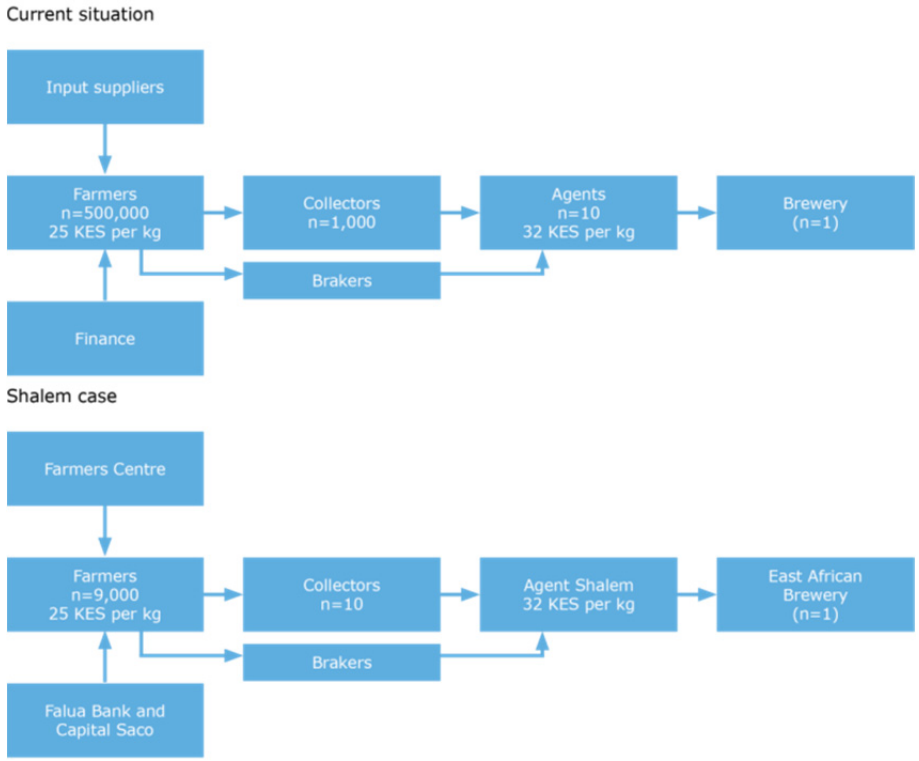


**Figure 4.1** Sorghum value chain in Meru county, Kenya

*Input suppliers*
There are various input suppliers active in the sorghum value chain. They supply seeds, fertilisers (subsidised), agro chemicals and soil analyses. Some provide information and extension services. The government has a service of input provision at a reduced price but it takes very much effort to access these subsidised inputs.

*Finance*
Farmers sometimes need a loan to buy inputs. So the loan will be provided at the time when the inputs are needed. The Bank will not provide the inputs, but they provide loans so farmer (groups) can buy them on credit. Often the finance is arranged via the agent who buys at the input supplier for a large group of farmers at the wholesale price. As a result farmers can benefit from a discounted input price. Banks (including SACCOs) are however hesitant in collaborating with farmers as they know their vulnerable situation, dependency on favourable weather and low/no savings. They prefer to work with official farmer groups so the group members can be co-guarantee of each other. In addition, they do not trust people, they only trust good and strong institutions/systems and strong (inter)linkages. The co-guarantee of farmers in well-organised farmer groups is one condition; the other is a strong linkage and official collaboration with an agent and between agent and producers. SACCOs can reduce their risk a little by requiring lenders to buy shares and to create co-ownership as such.

*Insurance*
One of the main risks farmers face is the weather. To mitigate this risk, there is collaboration with an insurance company. There are links between the trader, the bank and farmers but farmers are very sceptical and insurance is a somewhat sensitive topic. The costs are high and many farmers are not able or willing to pay these. In combination with low trust does not stimulate farmers to insure themselves. In addition, agriculture is a risky sector, in general leading to a low offer of insurances services.

*Producers*
There are 500,000 sorghum farmers. Farmers are often organised in groups ranging from 10 to 100 farmers. This is preferred by the buyers and the bank to reduce the costs of transaction and to reduce the risk. Risk can be reduced because farmers need to stand surety for each other. Capacities and management level of the groups is however low in general and collective memory is that of group leaders cheating and betraying their members.

Farmers have to wait until all the farmers from the group have delivered their sorghum to the collector. When all group members supplied their produce, transport is arranged for via Shalem. It is not possible to supply and receive their payments when they want to. As a result farmers tend to side-sell parts of their sorghum harvest when in need for cash. Often farmers have to pay bills (e.g. school fees) so they sell to other agents or brokers. The price that they receive at side-selling is much lower. Often KES 5-8 lower compared to the current contract with Shalem (this can be viewed as the regular market price).

Price agreement is vocal; there is no official agreement or contract. Only if farmers buy input via the bank/ agent using input finance, will they sign a contract with the agent to commit themselves to take care of the sorghum with their inputs. This is however one way; Shalem does not sign anything. Farmers now use mainly the seed varieties Gadam and Sila. These have higher quality, are requested by the traders and intend to be drought resistant. Other varieties are used for sorghum for own consumption.

*Collectors*
The main agents work with collectors that store and handle the sorghum on their behalf at a collection centre. At the premises of the collector the sorghum is weighed and prepared for pick up by the agent.

*Agents*
There are 10 official agents that buy sorghum for East African Breweries Ltd (EABL). Three key agents are located in Meru. There are three main agents in the area under study and all three are supplying to EABL. One of these agents is Shalem Investment that works with approximately 10,000 farmers. The third company is owned by a former politician that has the reputation to buy at the farm gate for lower prices. The agents arrange the transportation from the collection centre to the Meru. From there on it is further transported to the brewery. The agents pay for the costs of collection, storage and transportation. The agents arrange a formal agreement with the buyer (EABL) that indicates volume and quality of the sorghum. Besides the main agents there are some smaller brokers that are often farmers themselves. They buy and sell from other farmers that are in need of cash. They then sell it to Shalem or another EABL agent.

*Brewery*
East African Breweries Limited (EABL) needs 30,000 tonnes of sorghum per year. Agents have a contract on the amount of sorghum to be sold to EABL. Shalem supplies 5,000 tonnes. If an agent delivers less than agreed, EABL will

pay the agreed price for the amount delivered, but will decrease the contracted amount of sorghum from that agent in the next year. Since the margins are low for agents, the profit must come from the traded amount, so a reduction in contracted amount is a severe punishment.

### Market outlook

Currently various stakeholders are looking to diverse the use of sorghum. For example to replace maize as an input for the production of animal feed. Or the use of sorghum as a low cost substitute for barley for the production of high end beers such as Tusker. However these opportunities are currently in the process of exploration and a change in mind set (poor men's meal') is necessary. The sorghum market is vulnerable for external factors, such as VAT taxation. In 2014 the government started taxation of sorghum beer in order to generate additional tax income. The brewery that produces beer decided to reduce their volumes of beer and stopped buying sorghum since an increase of price would mean reduced demand. Due to a strong lobby by two Members of Parliament from the Meru County, EU-CORD and some breweries the government decided to reverse the higher taxation.

## 4.3 Games in Kenya

As explained in the methodology chapter we conduced three games; the trust game, the risk game and the VCM game. The games were played in groups of 16 farmers. To be able to compare between farmers who are part of the intervention of 2SCALE and between farmers who are not, we also conducted games among farmers not supplying to Shalem. We call these farmers the comparison group while the farmers supplying to Shalem are called the treatment group. In total we conducted games with 144 farmers in the treatment groups and 96 farmers in the comparison group. We played games with 9 farmer groups supplying to Shalem and with 6 farmer groups supplying to another trader. All games were conducted by the Wageningen Researchers in close collaboration of a neutral local assistant to translate. The amounts won were paid in the local currency.

We distinguish results of farmers in the treatment and the control groups, see Table 4. Groups were similar in age and gender. However, last season, treatment groups cultivated more acres with sorghum than control groups. Their productivity per acre was higher, resulting in a larger production volume. This could be a direct result of the intensive training and coaching on good agricultural practices the Shalem farmers received. Treatment groups received more input and production loans than control groups. Finally, farmers in the control groups earned more in the trust games, and farmers in the treatment groups earned more in the VCM games. Total payment was not different between the groups. Table 4 provides the results of the descriptive analysis. We did not do any additional matching of the treatment and control group due to sample size limitations.

**Table 4.1** Descriptive variables of the sorghum farmers in the treatment and control groups in Meru county, Kenya

| Variable | Treatment (N=144) | Control (N=96) | Significant |
|---|---|---|---|
| Age (years) | 41.8 | 42.1 | |
| Sex (1=male, 2=female) | 1.65 | 1.70 | |
| Acre | 5.2 | 3.6 | ** |
| Production (kg) | 2,341 | 1,254 | *** |
| Productivity (kg/acre) | 926 | 613 | *** |
| Received input loan (0=no, 1=yes) | 0.49 | 0.19 | *** |
| Received production loan (0=no, 1=yes) | 0.22 | 0.10 | ** |
| Payment trust games (KES) | 63 | 68 | *** |
| Payment risk preference game (KES) | 36 | 37 | |
| Payment VCM games (KES) | 44 | 42 | ** |
| Total payment (KES) | 343 | 347 | |

*** p<0.01, ** p<0.05, * p<0.1

The position in their farmer group of the farmers is presented in Table 4.2. A Pearson chi-squared test showed a higher number of members with a special position in the group participating in the games in the control group at p=0.054. This is most likely due to the fact that in the treatment groups the participants were randomly selected by the researchers, whereas in the control groups the group leader could choose the participants freely.

**Table 4.2** Position in group of the sorghum farmers in the treatment and control groups in Meru county, Kenya

| | Treatment | | Control | |
|---|---|---|---|---|
| Variable | (N) | (%) | (N) | (%) |
| Member | 119 | 82.6 | 65 | 67.7 |
| Group leader | 9 | 6.3 | 9 | 9.4 |
| Vice group leader | 2 | 1.4 | 4 | 4.2 |
| Secretary | 9 | 6.3 | 6 | 6.3 |
| Vice secretary | 1 | 0.7 | 0 | 0 |
| Book keeper | 1 | 0.7 | 1 | 1.0 |
| Discipline master | 0 | 0 | 1 | 1.0 |
| Missing | 1 | 0.7 | 1 | 1.0 |
| Total | 144 | 100.0 | 96 | 100.0 |

For treatment groups, Figure 4.2 provides the number of perceived years farmers have delivered sorghum to Shalem. Farmers in the treatment groups have been delivering sorghum to Shalem between 0 and 15 years, with most farmers (n=52) for 2 years and 30 farmers for 3 years. 13 Farmers indicated to never have delivered sorghum to Shalem, mostly because they never produced sorghum.

Farmers in the treatment group that delivered sorghum to Shalem, indicated to be delivering sorghum to Shalem for on average 2.4 years (min 0 year, max 15 years, see Figure 4.2). If we exclude the 13 farmers that never supplied to Shalem the average is 2.7 years (min 1 year, max 15 years). Despite being the control group, 29 farmers have supplied sorghum to Shalem in the past. Some of them have supplied Shalem for multiple years.

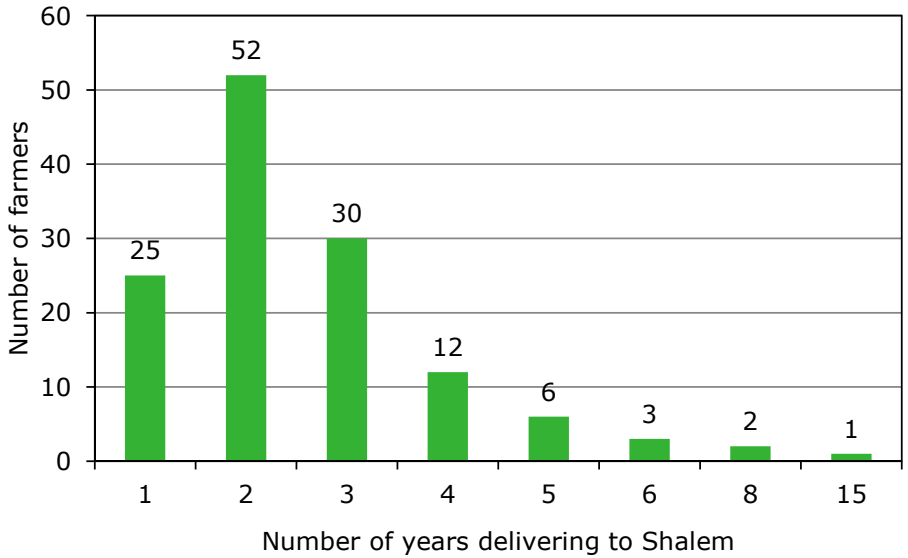


**Figure 4.2** Number of years farmers in the treatment group indicated to have delivered sorghum to Shalem in Meru county, Kenya.

Trust between farmers and in different sorghum buyers was measured in the trust game (Figure 4.3). Trust in Shalem of the farmers in the treatment group was significantly higher ($p<0.000$) than trust of the control group farmers in their normal buyer and trust in new buyers. Trust of farmers in the control group in their normal buyer was significantly higher than trust in a new broker. No significant difference was observed in trust in a new buyer between the treatment and control groups.

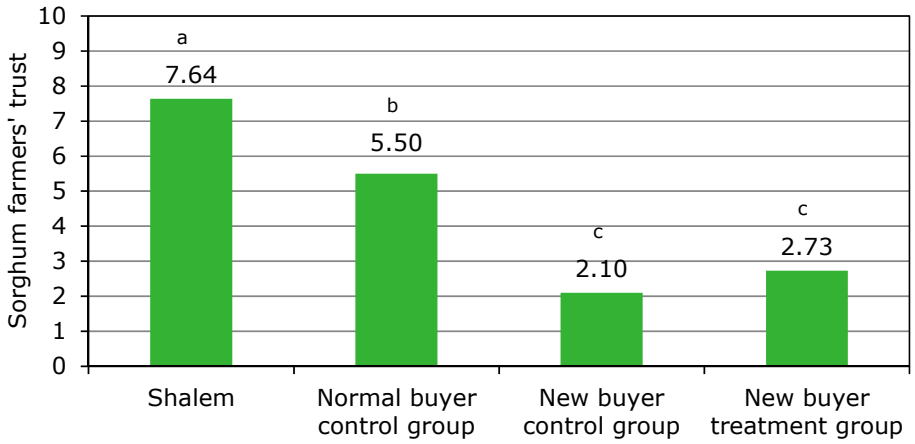


**Figure 4.3** Trust levels of sorghum farmers in different sorghum buyers in Meru county, Kenya (Averages with no letters in common are significantly different at p<0.000).

Trust in Shalem or their normal buyer was asked in the questionnaire during debriefing. Farmers in the treatment groups had an average trust in Shalem of 4.65 (out of 5), which is significantly higher (t=14,698, p<0.000) than the average trust of 2.18 farmers in the control group had in their normal buyers.

In the questionnaire during debriefing, the farmers were asked about the extent to which their trust in their sorghum buyer increased or decreased. Farmers in the treatment groups indicated an average of 4.63 (between 'it increased a little bit' and 'it increased much'), which is significantly higher than the average of 2.15 (between 'it did not change' and 'it decreased a little bit') of farmers in the control groups (t=14.374, p=0.000). When asked for the reason for this in- or decrease, farmers provided multiple reasons (Table 4.1). The most important reasons for trust were i) the buyer keeps his promises, ii) the buyer offers a good price, iii) the buyer provides training and iv) the buyer provides a guaranteed market prior to starting cultivation (Table 4.3).

In the questionnaire during debriefing, the farmers were asked about the extent to which their trust in their sorghum buyer increased or decreased. Farmers in the treatment groups indicated an average of 4.63 (between 'it increased a little bit' and 'it increased much'), which is significantly higher than the average of 2.15 (between 'it did not change' and 'it decreased a little bit') of farmers in the control groups (t=14.374, p=0.000). When asked for the reason for this in- or decrease, farmers provided multiple reasons (Table 4.3). The most important reasons for trust were i) the buyer keeps his promises, ii) the buyer offers a good price, iii) the buyer provides training and iv) the buyer provides a guaranteed market prior to starting cultivation (Table 4.3).

**Table 4.3** Qualitative description of sorghum farmers' trust in their sorghum buyer in the treatment and control groups in Meru county, Kenya (in %, more answers possible)

| | Treatment | | Control | |
|---|---|---|---|---|
| Descriptive aspect of trust | yes | no | yes | no |
| Keeps promises | 24 | 2 | 7 | 22 |
| Offers good price | 29 | 1 | 13 | 34 |
| Good timing of sorghum collection and payment | 6 | 10 | 1 | 6 |
| Certainty of the market | 22 | 0 | 2 | 5 |
| Provided training on farming | 33 | 0 | 3 | 0 |
| Provided inputs (seeds, loans, other) | 14 | 0 | 2 | 0 |
| Trader is honest | 6 | 0 | 1 | 7 |
| No other buyer available | 1 | 0 | 5 | 0 |

## Main findings games Kenya

The majority of the sorghum farmers are risk averse. Most farmers (61%) are very risk averse, and another 24% are risk averse. Only the remaining small percentage of 15 shows risk seeking behaviour. There is no difference between the treatment group and the control group.

Farmers supplying Shalem have higher trust. Trust was measured in the trust game and in the questionnaire during debriefing:

- Trust in Shalem measured in the trust game: Trust of the farmers in the treatment group was significantly higher (p<0.000) than trust of the control group farmers in their normal buyer and trust in new buyers. Trust of

farmers in the control group in their normal buyer was significantly higher than trust in a new broker. No significant difference was observed in trust in a new buyer between the treatment and control groups.
- Questionnaire during debriefing: Farmers in the treatment groups had an average trust in Shalem of 4.65 (out of 5), which is significantly higher ($t=14,698$, $p<0.000$) than the average trust of 2.18 farmers in the control group had in their normal buyers.

The most important reasons for increasing trust were i) the buyer keeps his promises, ii) the buyer offers a good price, iii) the buyer provides training and iv) the buyer provides a guaranteed market prior to starting cultivation. Farmers supply on average for 2.7 years to Shalem.

The development of trust depends on the experience of the farmer with their buyers. Trust levels towards new buyers are low compared to average trust in Shalem. In the three consecutive trust games with a new (unknown) buyer, farmers that were confronted with a negative experience, i.e. they received in return only half of the amount of coins they sent, showed a consistent decrease in trust in the three games, i.e. a negative trust update. In contrast, the farmers that were confronted with a positive experience, i.e. they received in return twice the amount of coins they sent, showed a consistent increase in trust in the three games, i.e. a positive trust update. The farmers with a neutral or slightly positive experience did not show a consistent development in trust.

Trust uptake among all farmers is depending on the behaviour of other farmers. As soon as farmers have a negative experience due to actions of other farmers, trust is decreasing. Trust between farmers was measured with 2 items: 1) group trust with the VCM games, and 2) farmer trust with the trust games between farmers. No significant differences were observed between treatment and control groups in the trust towards other farmers.

Although the transaction costs s are not measured directly, a higher trust level by Shalem farmers is likely to result in lower transaction costs s. Transaction costs s are guided by price and non-price commitments. While the price commitments result in net (expected) value added that each of the agents can capture from the transaction, the non-price elements are of vital importance for the exchange of information between the agents and the behaviour of the agents. Since Shalem is providing a continuous positive trust uptake among the farmers it is likely that the trust will further increase.

## 4.4 Multi-agent Simulation Model of sorghum

### Approach

A simulation of the sorghum value chain as described in the previous section has been designed in NetLogo. This section describes a summary of the simulation following the updated Overview, Design concepts, and Details (ODD) protocol developed by Grimm et al. (2010).

The active entities in the simulation represent plots of land, farmers that cultivate the land to produce a crop, and processors that contract farmers to deliver their produce. The present simulation sets up a single processor. The simulation sets up local collectors and aggregators, but they currently play no active role. The brewery is not represented as an agent. Some farmers are given a role as group head. This is indicated in a state variable. All farmers have a state variable pointing to their group head and a state variable comprising the set of group members. Farmers maintain a list of processors they know and maintain associated trust they have in the processors. Processors maintain a list of the farmers and associated trust, contracts and deliveries with each of these farmers. Farmers maintain trust in each of the other members of their group. All trust is represented as an experience-based subjective probability that the others will comply with the contracts.

Natural conditions affecting the harvest, such as rainfall, temperature, and pests are represented by a single variable for which a different random value is generated for each cropping season. The value of natural conditions is equal for all farmers and thus affects the harvest of the entire cluster. The range of harvest fluctuations due to natural conditions is a parameter that can be set in the user interface. Similarly, market price is a system level variable that is randomly generated for each cropping season. The farmers' temptation to side-sell is modelled to depend on the current market price.

A simulation run typically includes 10,000 farmers (in groups of 16) and a single processor, and typically spans a period of ten years, with a time step of

half a year (one sorghum cropping season). Simulations are run for a period of 20 growing seasons (10 years).

In the basic simulation run the same decision options will be used as in the game session. Decision rules will be deducted from the actual behaviour of real-life subjects in the VC game session, taking into account various context variables such as pricing and transaction costs. Further, agents' traits, such as risk attitude, and changes that occurred during the game session including reputation formation / trust building, changes in risk attitude, and changing price expectations are included in the simulation model. Finally, a goal function (maximum expected value, maximum, minimum regret, two-step e.g. once a certain income level has been attained) has been assigned to each virtual agent. Each simulation run typically includes 10,000 farmers and a single processor, and spans a period of ten years. Figure 4.4 represents a time step in the simulation cycle. The user may set parameters and intervene in the simulation by pressing the 'DEFECT' button to make the processor defect in paying the contracted farmers.

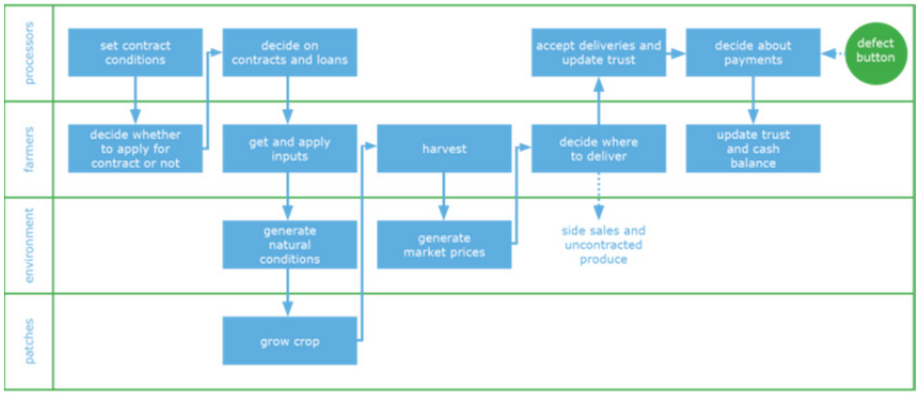


**Figure 4.4** Process overview of a time step representing a cropping season

### Descriptive results ABM Kenya

The agent-based simulation is parameterised with data collected in a value chain mapping mission and a baseline survey for the quantitative evaluation of 2SCALE. Emergent properties to be observed are farm income and the availability of sorghum to the processor. Key results are the following:

- The contract price currently proposed by the processor is sufficient to contract both risk -avoiding and risk-neutral farmers, given the historic range of farm-gate prices.
- If farmers enter into contracts, if they use adequate inputs, and if they are trained to apply modern farming methods, the harvested volumes are sufficient for the processor to deliver to the brewery and the farmers make increased profits.
- In the first season some side-selling occurs by contracted farmers who are in urgent financial need before the harvest is delivered and payments are made by the processor.
- The scale of this initial side-selling is small and does not seriously affect trust.
- Due to opportunistic side-selling by some farmers, both processors' trust and mutual trust in farmer groups vanish after some seasons if market prices exceed the contract price.
- Group members can get in need of cash, and side-sell part of their next harvest, which further undermines trust in the system.
- If the contracts and loans system does not collapse due to opportunistic side-selling in the first seasons of the simulation, the farmers' financial positions develop to a sustainable level where they can source adequate inputs from their revenues, even without loans.
- In the latter situation production remains at the increased level, and the processor can source inputs from the market without contracts, generally at a lower price than the contract price; however, then the farmers' incomes are lower than with the contracts.
- Occasional defection by the processor strongly affects farm income but, since they have no alternative, farmers re-enter into contracts unless the deceit is frequently repeated.

The average results of the simulation are particularly sensitive to the farmers' honesty (their compliance when tempted by high market prices), the negative trust update factor (will deceivers be given a second chance?), and the combination of contract price and farmers' risk avoidance. An extensive sensitivity analysis is included in Verwaart et al. (2016).

### Settings ABM Kenya

Table 4.4 displays the default parameter settings. The 'savings' switch is by default set to false: farmers are assumed to spend their all revenue from a harvest during the following growing season on inputs for the next harvest and on cost of living.

**Table 4.4** Default parameters

| Parameter | Value | Unit | Parameter | Value | Unit |
|---|---|---|---|---|---|
| Farms | 9,216 | | Minimal-natural-conditions | 0.5 | |
| Minimal-farmgate-price | 14,000 | KES/tonne | Savings | FALSE | |
| Maximal-farmgate-price | 30,000 | KES/tonne | Minimal-risk-aversion | 5.00E-05 | 1/KES |
| Local-market-price | 14,000 | KES/tonne | Maximal-risk-aversion | 2.00E-04 | 1/KES |
| Aggregator-availability | 20 | % | Minimal-initial-trust | 0.2 | |
| Optimal-inputs-cost | 14,000 | KES/ha | Maximal-initial-trust | 1 | |
| Labour-cost | 22,000 | KES/ha | Minimal-honesty | 0.2 | |
| Loan-per-ha | 30,000 | KES/ha | Maximal-honesty | 1 | |
| Cost-loan & insurance | 5,000 | KES/ha | Configure-from-game-data | FALSE | |
| Post-harvest-cost-per-tonne | 2,900 | KES/tonne | To-be-delivered | 5,000 | tonne |
| Transaction-cost-market | 1,000 | KES | Farmers-contract-price | 25,000 | KES/tonne |
| Transaction-cost-contract | 0 | KES | Maximal-group-bonus | 2,000 | KES/tonne |
| Basic-expected-yield | 1.2 | tonne/ha | Bonus-lower-bound | 80 | % |
| Improved-inputs-yield | 5 | | Positive-trust-update-factor | 0.05 | |
| Minimal-skills-factor | 0 | | Negative-trust-update-factor | 0.10 | |

### Main findings ABM Kenya

Farmers' characteristics can be initialized in two ways. By default, risk aversion, initial trust, trust update, and honesty are drawn from the specified ranges and the specified trust update factors are applied. When the 'configure-Farmers' characteristics can be initialised in two ways. By default, risk aversion, initial trust, trust update, and honesty are drawn from the specified ranges and the specified trust update factors are applied. When the 'configure-from-game-data' switch is true, the parameter values are drawn at random from the game outcomes. Emergent properties to be observed are farm income and the availability of sorghum to the processor.

Data are comparable for both configurations, except for the stronger decay of the number of loans in the runs with default parameters; the agents with zero trust-update in the game-configured runs maintain their group trust even if group members defect. Dynamics of some outcomes are shown in Figure 4.5. Initially farmers enter into contracts and groups apply for loans. Then the number of loans decreases and after that the number of contracts. As can be seen from the right graphs, in particular the less productive farmers lose their contracts.


**Figure 4.5** Dynamics of some emergent outcomes from a simulation configured with default settings (upper row) and a run with game-based settings (bottom row) (source: Verwaart et al., 2016)

Figure 4.6 presents the causes of the decline of loans and contracts. Figure 4 provides insight into the causes. The middle graph shows side-selling. Farmers side-sell when in urgent need for cash. Group members, who stand surety, must redeem their loans, lose trust in the group, and no longer apply for loans. The middle graph shows opportunistic side-sales by contracted farmers under high market prices (left graph), continuing after the loans system has collapsed. The defecting farmers lose the processors' trust (right graph) and contracts. The results show a decline in harvest volumes and deliveries on contracts over the simulated period, but not to an extent that the processor cannot fulfil its current contract. However, many farmers remain poor and there is no room to satisfy new demands. Sensitivity analysis of the simulation may identify promising interventions. The most promising could be to improve the weaker producers' skills. The sensitivity analysis also shows that a KES 1,000 lower contact price of KES 2,400 strongly affects deliveries to the producer (-11%), side-sales (from 10 to 13%), and farmers' gross margins (-10%). Lower honesty has an effect of +13% on gross margins, but affects deliveries with -16%. As may be expected, variations in the trust parameters affect outcomes up to 10%. In the present setting, sensitivity to risk attitude is weak, but it is stronger with lower contract prices.


**Figure 4.6** Causes of the decline of loans and contracts (game-based settings) (source: Verwaart et al., 2016)

Results of the simulation runs show that in order to establish a stable supply of sorghum on contracts:

- It is essential that the processor provides a stable and (relatively) high contract price against uncertain alternatives for farmers.
- Another key to long-run success is the extent to which individual farmers are convinced to comply, even when market prices exceed the contract price.
- Finally, improving farmers skills is an effective way to increase total sorghum production and volume supplied to the processor.

A limitation of the present simulation is that local harvest and local farmgate price are assumed to vary independently. The relation is known to be complex and dependent on the harvest of other products, such as maize. Sorghum is a rather draught-tolerant product. In dry seasons a bad harvest of maize may cause a great demand for sorghum as a substitute. Such dependencies are not included in the simulation. Appendix 3 describes simulation outcomes for several assumed harvest-price relations. The results indicate that for the processor greater shortages due to side-selling may occur if a strong inverse relation is assumed between total local harvest and local farmgate price. Actual data on the harvest-price relation are lacking. It is recommended that this data is collected. If the relation would be found to be strong, that would stress the relevance of finding ways to convince the farmers to comply with the contracts.

## 4.5 Conclusion sorghum case Kenya

The 2SCALE partner, Shalem collects sorghum as input for low costs beer production. Shalem has a contract with the brewery stating the volume and minimal quality to be delivered. Shalem contracts farmer groups to produce this volume of sorghum of sufficient quality. A fixed contract price is offered prior to each farmer with a relatively attractive price compared to average prices on other markets. In 2015, this price was KES 25 per kg. This lifts the risk of price fluctuations off the farmers. Groups can receive a price premium if they collectively deliver more than what is minimally expected given the natural conditions and the amount of inputs applied (up to KES 2 per kg in 2015). Farmers have several reasons not to deliver (part of) their harvests according to contract. Need for immediate cash may urge them to side-sell part of their harvest to other buyers and side-selling may occur if buyers passing by offering good prices to be immediately paid in cash. Offered prices range from KES 20 to KES 27 per kg. By contracting farmer groups, Shalem aims to hedge the risk of individual farmers side-selling to other aggregators. To control transaction costs s Shalem works with farmers organised in groups. In addition, Shalem has implemented a network of collection points with

storage facilities in the remote villages, where contracted farmers can bring their produce. These collection points are often at the premises of individual farmers being member of the group and collect solely for Shalem. Shalem collects the sorghum from these local collection points, and transfers it to the beer brewery after random quality checks and without further processing.

Trust and risk attitude are assumed central issues in this value chain development initiative. Shalem should trust the farmers to deliver a sufficient volume complying to the minimum quality standards to fulfil its contractual obligations to the brewery. However, side-selling occurs for two reasons: (1) farmers' urgent need for cash and (2), if market price is high, opportunistic behaviour depending on the farmer's honesty. In case of large-scale side-selling, Shalem must buy sorghum form other sources or is not able to comply with the contractual arrangements with the brewer. Contracts on minimum price and guaranteed purchase may hedge the farmers' market price risk, but farmers must trust Shalem to pay promptly after delivery and to pay the agreed price. Farmers must trust their fellow group members to deliver their full harvest of good quality in order to cash the volume premium. Based on behavioural economics insights, games were designed to gather data on trust, honesty (free riding) and risk.

The agent-based simulation is initialised with data collected in a value chain mapping mission, a baseline survey for the quantitative evaluation of 2SCALE, and games played with farmer groups in Kenya. The results of the simulation runs showed that if the sorghum processor can afford to provide a stable and high contract price against uncertain alternatives for farmers, a stable contract supply to the processor can be expected with farmers' income being higher than without contracts. Occasional high market prices resulted in farmers' side-selling and lower volumes supplied to the processor. The extent to which individual farmers can be trusted or convinced to comply, even when market prices are high, is the key to long-run success of the system. Finally, improving farmers skills is an effective way to increase total sorghum production and volume supplied to the processor.

A validation and discussion workshop was organised with Wageningen researchers, IFDC, Shalem and sorghum farmers in May 2017. The programme and report can be found in appendices 6 and 7.

# Case 2: Soy in Ghana

5

# Case 2: Soy in Ghana

## 5.1 The intervention

A large problem for smallholder farmers in Ghana is to get access to the market. The 2SCALE programme intends to support the incorporation of smallholder farmers in a soy cluster or agriculture apex organisation. This is implemented by grouping together in cooperatives (see text box 2 and annex 1 for more information on the intervention itself). A large problem in the functioning of the value chains can be distrust between the partners. The 2SCALE programme aims to include the smallholder farmers in a strong value chain, and reduce distrust.

Text box 5.1: Soy clusters

In Northern Ghana, IFDC supports 4 different clusters (+- 2,000 farmers per cluster) of soybean producers by providing BSS. These services are provided by 2 BSS -providers, in northern Ghana these are 2 NGOs: SEND and EPDRA, both organisations currently serve 2 clusters. The partnership in Ghana started in 2012 with 2 clusters, and in 2013, 2 extra clusters were added. The office of IFDC is located in the northern city of Tamale. Another cluster, in the area of Savelugu is not operational anymore due to a lack of trust between the farmers and the BSS.

In this research, we use the soy clusters in Kpandai and Saboba as treatment areas, and the Zabzugu Tatale cluster as comparison group (see Table 5.1).

**Table 5.1** Soy clusters in Ghana

| Clusters | BSS | Intervention start | Status |
|---|---|---|---|
| Kpandai | SEND | 2012 | Active |
| Saboba | EPDRA | 2012 | Active |
| Zabzugu | SEND | - | Under negotiation |
| Savelugu | - | | Closed |
| Chereponi | EPDRA | 2013 | Active |
| Salaga | SEND | 2013 | Active |

## 5.2 Value chain analysis Soy Ghana

Northern Ghana is relatively poor, isolated, dry, and politically unstable when compared to the rapidly developing and urbanising south. However, in recent years the northern regions above the 8th parallel (the 'SADA North') have received much government and donor attention in the form of agricultural subsidies and social programmes. This so-called Breadbasket Initiative aims to transform the north into a more stable and prosperous area, with a focus on smallholder production of staple grains and legumes, particularly maize, rice, and soybean (EAT-USAID 2012).

The market presents an interesting but limited demand for soy. Currently, modest expansion of local production processed in existing facilities can substitute the imported soybean meal demanded by the poultry industry. Soybean is a relatively new crop in Ghana (Akramov and Malek 2012), but is playing an increasingly important role in the rural economy of farm households in northern Ghana, and especially the eastern corridor of the Northern Region of the country, cannot be neglected. Northern region alone contributes 70% of national soybean area and 77% of national production (SRID 2012). Several soybean demonstrations are established annually in the region by both

governmental and non-governmental organisations with the aim of increasing productivity and production. Etwire et al. (2013) reported that the crop is gaining popularity and acceptance among farmers in Ghana including those of Saboba and Chereponi districts. According to Ugwu and Ugwu (2010), the benefits of soybean over other grain legume (such as groundnut and cowpea) include lower susceptibility to pests and diseases, better storage quality and larger leaf biomass which translates into soil fertility benefit to subsequent crops.

However, widespread smallholder production of soy would be a dangerous venture. When small, targeted support is merited, investors and donors must fully understand the incentives at stake for the smallholders. These producers are inherently risk-averse and unlikely to produce more consistently if the market demonstrates uncertainty. The risk entailed with accepting expensive inputs on credit should not be underestimated, since trends in the market for Ghanaian maize and soy have been intermittently volatile or flat. Export markets may exist, but trade policy is uncertain and the linkages are not currently in place.

Soybeans are not only a valuable source of feed for livestock and fish but a good source of protein for human diet (Masuda and Goldsmith 2009). El Agroudy et al. (2011) reported that soybeans contain 30% cholesterol free oil, 40% protein and contain most essential vitamins required by human beings. Ghana's Council for Scientific and Industrial Research (CSIR), Ministry of Food and Agriculture (MoFA) as well as its development partners have been promoting soybean production because of its potential to increase income and enhance nutritional status of households (Mbanya 2011). In northern Ghana, most agricultural interventions promote the production and use of the soybean crop mainly through value chain improvements.

## Soybean production

Currently Ghana produces between 50,000 to 60,000 tonnes of soymeal and soy protein a year. And a little less than that amount is imported. However, the amount isn't meeting needs that could reach up to 200,000 tonnes (2015, American Soybean Association[1]). Soybean is mostly grown as a cash crop, although there seems to be little or no evidence about its profitability for smallholders. Other crops grown for cash include cotton and cowpea. Maize, rice and cassava are mostly grown for consumption. Yam and vegetables are grown for both consumption and sale. Production of soy is once a year.

The smallholder producers cultivate on average 1 to 2 acres. The loan they access from the bank is maximum for 2 acres. To access high quality soybean seed is a challenge in Ghana. It is not common to buy new seed; producers are used to use their own soybean seed. Newly introduced seed (genotypes) varieties by SARI Ghana are Afayak and Suong-Poung[2]. Some producers in the IFDC programme were introduced to the Afayak seed used at demonstration plots. With the Afayak seed production is estimated to be 8 maxi bags per acre (= 400 kg per acre). With own seed / seed from the local market from colleague soybean producers, production is approximately 3 to 6 bags per acre so 150 to 300 kg per acre.

*Estimation of production costs*

Production loans at banks vary from GHS 300-400 per acre. Maximum to get a loan for is 2 acre. An expert estimation on the costs of production for soy is given by one of the actors in the IFDC programme (per acre, November 2015):

- Tractor fee : GHS 70
- Seed : GHS 59
- Inoculant : GHS 20
- Bags and transport : GHS 50 (transport from farm to house/store)
- Transport : 0 (via apex)
- Dues to apex : GHS 24 (GHS 2 per person per month (on average)

*Production*

According to reports from among others USAID (2012), yield reports range from just 500 kilograms per hectare (208 kilograms /acre) to 2,000 kilograms per hectare (833 kilograms / acre), with a generally agreed-upon average of 1,200 kilograms per hectare or 500 kilograms per acre. The farmers themselves commonly refer to the number of bags per acre. They mentioned 3 to 6 maxi bags per acre, depending on how planting was done (whether in row or not) with own seed/from the local market and without the use of inoculum. The sizes of (maxi) bags vary per region but they meant here a bag of 55

[1] http://www.feednavigator.com/Markets/Better-feed-development-improved-poultry-sector-may-lead-to-agro-economic-boost-in-Ghana

[2] http://savannahnewsblogspotcom.blogspot.nl/2013/02/sari-introduces-new-maize-soybean-seeds.html.

kilograms which means a yield of 165 to 330 kilograms per acre. With the use of inoculum, yields increase with 20-30%.

*Prices*
Marketing experts have indicated the farm gate price of soy in November 2015:
- Salaga: 114.5 tonnes marketed at GHS 153 per 100 kilograms maxi bag.
- Saboba: 362.8 tonnes marketed at GHS 77per 100 kilograms maxi bag.

Salaga: there was a buyer at pre-harvest time who expressed interest to buy soybeans from the farmers at a price of GHS 1.80 per kilograms, but he did not return. The farmers cannot and will not approach a buyer themselves. That's the responsibility of the apex and they leave the responsibility there. Now the farmers received GHS 1.53 per kilograms, and this is a good price but when farmers were promised GHS 1.80 per kilograms, they were counting on that amount and the price appears to be very low at GHS 1.53 per kg.

Price during the visit (November 2015): approximately 4 mini bags = GHS 500 to GHS 600. One mini bag in this situation is 100 kilograms so 400 kilograms yields approximately GHS 500 to GHS 600. This is approximately GHS 1.38 per kilogram. Sometimes prices can be very bad demotivating farmers to continue soybean production. Other prices mentioned are GHS 0.70 per kg or GHS 1 for 2 kilograms. The market price is approximately GHS 1 per kilograms. But scaling is not precise so you never know whether you have exactly 1 kilogram.

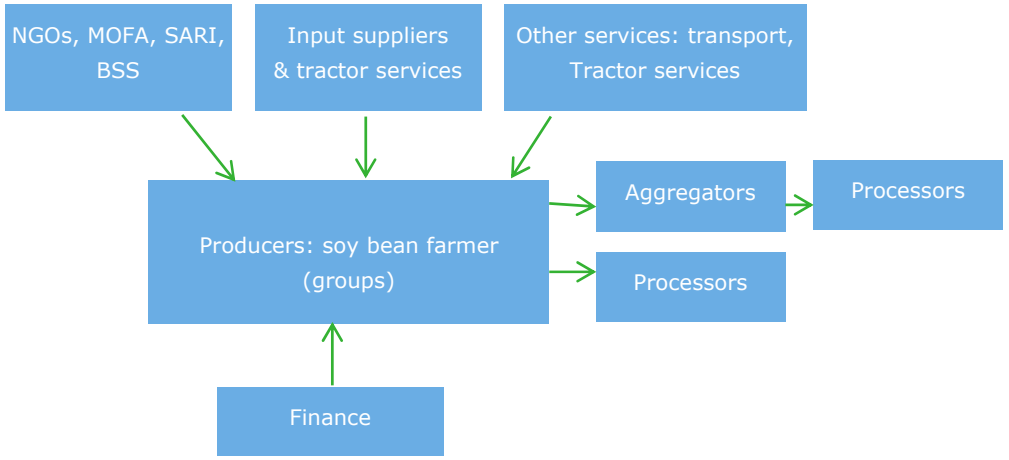


**Figure 5.1** The soy value chain

### Key actors and their roles

Figure 5.1 present a brief overview of the main actors in the value chain. The relations vary per cluster, but in general, (the organised) producers bring the soybeans to a warehouse of an individual in the community. When all group members supplied their produce, the processor or aggregator which agreed upon a transaction with the producers, collects the produce. There are no written or signed contracts at pre-harvest time, only at the time of transaction a contract is signed. They transact and decide on oral agreements. There are some pre-harvest negotiations to express intentions, but no agreements on price and volumes are made. The farmers side-sell if they need immediate cash.

*Facilitation*

Soybean production in Ghana takes place in the northern region and IFDC has a stationary in the northern city Tamale. Field activities of IFDC started in 2012 with 2 clusters built around farmers organisations. The number of targeted smallholders of soybeans is 18,500 with 7,500 women smallholders. The lead partners in the clusters are farmers or producer organisations. The following lead partners take part in the value chain strengthening activities:

- Dodoorifom Akonvi Farmers Association (Chereponoi);
- Bileegnan Soybean Producers Cooperative and apex (Saboba);
- Salaga Farmers' Cooperative & Union (Salaga);
- Banda Borae Soybeen Farmers Association (Banda Borae);

IFDC subcontracted the NGOs *Social enterprise development Foundation* (SEND) Ghana and *Evangelical Presbyterian Development and Relief Agency* (EPDRA) as Business Development Service Providers in the Soy agribusiness clusters. Both organisations have their own approach, methodology and working area. SEND Ghana is responsible for the Banda Borae and Salaga clusters. EPRDA is working in the Chereponi and Saboba soy agribusiness clusters. Main activities of both organisations are:

- Group and leadership development of farmer groups (e.g. mobilisation, organisation, financial education, management, collective action).
- Agronomics: training on GAPs, provision of other varieties of seed, establishment of demonstration plots, post-harvest management trainings, quality improvement training, introduction of inoculants.
- Value chain strengthening: identification and linkage of buyers and producers, facilitate collective aggregation; training on value chain concepts, facilitation in access to loans.

*Input suppliers*

There are various input suppliers active in the soybean value chain. They supply seeds, fertilisers (subsidised), agro chemicals, and soil analyses. Some provide information and extension services. There are however no contracts between producer organisations and input providers and deals are made individually and not as a producer group. Seed provision and delivery of inoculant seems a challenge as availability at country level is very low.

*Finance*

A challenge soybean farmers face is to get credit for their inputs. The major costs are related to the rental fee for the service of tractors. There are contractual arrangements with two banks at this moment: the Bonzali rural Bank in Yendi and the Credit Union in Kpandai. Lately, more banks are established and farmers do not want to 'put all their eggs in one basket'. The farmer groups are facilitated by the service providers to establish new contacts with banks. Banks hesitate to provide credit due to the risk sensitiveness of agriculture. All banks have similar procedures. There is a fixed amount of production loan you can apply for, this amount varies per year. It is only possible to apply as a group and the apex organisation summits a formal application on behalf of the groups. The group of farmers are together responsible for repaying the loan. Negotiations take place every year between the apex body of the farmers' cooperative, the government body of the credit union and a representative of SEND Ghana. It is not very difficult because there are not so many fluctuations.

*Weather insurance*

One of the main risks farmers face is the weather. Farmers do not have formal relationships or contracts with (weather) insurance companies. A weather insurance is not common for farmers and no activities in this field are foreseen.

*Producers*

Soybean is produced in the northern regions of Ghana. The majority is organised in producer groups or stimulated (by NGOs among others) to organise. The number of members varies from 40 to 100 farmers. Producer groups are again organised in apex organisations. Buyers and banks prefer to transact with organised farmers to reach volumes and to reduce transaction costs s and risk. Risk can be reduced because farmers need to stand surety for each other. Illiteracy amongst farmers is high leading to a dependency on farm leaders. Thus, negotiations are done by the apex and cooperative leaders on behalf of the members. Group assets are very low as contribution fees are minimal (e.g. one bowl of soybeans per member). Some groups can make use of an office of an NGO/Business service provider and can afford to pay an office manager, sometimes with a device. Some groups have some savings on a collective bank account.

Farmers have to wait until all the farmers from the group bring their soybeans to the collector, a private warehouse or a warehouse provided by the apex or a NGO. It is not possible to supply and receive payments when they want to. As a result farmers tend to sell parts of their harvest at the local market or to brokers who passes by when in need for cash. Prices vary each year and are very fluctuating. No contracts are established at pre-harvest season. Only expressions of interest are there, but without pre-defined volumes or prices. Sometimes a margin is mentioned but to agree upon prices is very risky for processors. Farmers perceive it is as a risk to agree beforehand on volumes. They face several risks and do not want to commit to one buyer because no minimum price can be guaranteed to them. Farmers have the option to choose between several aggregators and processors. The majority is based in Kumasi. Farmers/farmer groups do not always sell all their produce when the price is very low. Soybeans can be stored for years and sold when prices are favourable but the majority of farmers face urgent financial needs or received credit so they have to sell immediately after harvest.

*Aggregators/collectors*
The Savanna Farmers Marketing Company (SFMC) is established by farmer groups and indicates to act on behalf of the farmers. The company is based in Tamale and geographically close to the producers. Previously SFMC was the one and major aggregator buying from the producers and selling to processors in Kumasi and Accra. SFMC tried to be a strong partner by offering a fair price and other services (such as transport, credit, warehousing). Due to mismanagement and internal problems farmers lost trust in SFMC and the company almost collapsed. At that time, farmers bypassed SFMC and started direct negotiations with processors. The processors interact with the group leaders and have some individual aggregators/brokers in the field. In one cluster the apex organisation acts as an aggregator because they were given storage facility. Soybeans can be stored for several years but because there is a huge need for cash, the maximum period of storage is usually a few months.

*Processors*
Processed soybeans are used as an ingredient to feed for livestock and fish but to a lower extent it is used for domestic consumption. Some local women groups and some small-scale processors make soybean products such as dawadawa or gari (used in preparing local dishes) and soy-kebabs. The farmers in the clusters produce to sell for animal feed because the products for human consumption are not very profitable yet.

Ghana has about 15 commercial feed mills with a total installed operating capacity of circa 1,000 tonnes per day. However, because most buyers are small-scale operators, most feed millers produce only 40-50% of their capacity. Most small and medium-scale operations prefer concentrates as it is cheap, convenient and easier to transport. Yet, the majority of commercial mills produce mash feed and only a few produce high feed concentrates or pelletise feed. A major feed processing plant in the country is Ghana Nuts Limited which has an annual capacity of 60,000 tonnes. It produces its Poultry Master brand, which comprises solvent-extracted soy bean and cotton meal with excellent nutritional quality. Another important feed mill is Kosher Feed Mill which is located in Accra and accessible to many poultry farmers. Other commercial mills in Ghana are Greater Accra Poultry Association, Agricare, Central Feed Mill and Higirifred Mills (2014 RVO).

Commercial poultry farms in Ghana are mostly found in the Greater Accra, Ashanti and Brong Afaho regions. These farms can be categorised in three groups: large-scale (over 10,000 birds), medium-scale (5,000-10,000 birds) and small-scale (50-5,000 birds). At the moment, there are less than twenty large-scale poultry enterprises in Ghana, producing mainly eggs with limited production of broilers, mostly for festive seasons (Christmas, Easter) when Ghanaians normally buy live chickens. These farms are privately owned and some operate their own feed mills, hatcheries and parent stock. The level of bio-security in these enterprises is high and most of these farms follow the vaccination programme recommended by the Veterinary Services Directorate of the Ministry of Food and Agriculture. The vast majority of poultry producers (95%), however, fall into the small- to medium-scale group. Small-scale businesses mainly produce broiler birds, whereas the medium-scale category mainly produces eggs. Both groups practice limited biosecurity, making these operations vulnerable to disease outbreaks such as Avian Influenza. Yet, the Government of Ghana has been vigilant in the prevention of H5N1 Avian Influenza outbreaks and a surveillance system has been put in place to monitor the threat at borders, market places and resting places of wild birds.

Due to the dominance of layer bird production, Ghana’s poultry feed industry is mostly focused on layer feed. The main ingredients used for feeding are maize,

fishmeal, premix, concentrates and soybean. Except locally produced white maize, most feed inputs are imported. Prices of most inputs, except vaccines, have increased over the last years. Controlling animal feed costs is critical as it amounts to 82% of the variable production costs. Therefore, some feed manufacturers are switching to low-cost substitutes such as cotton-seed cake, palm kernel cake, soybean cake, copra cake, fish meal and other by-products of agro-processing. Maize typically forms 50-60% of the total feed formulation. In fact, the poultry industry consumes almost 30% of all white maize in Ghana. Since maize is such an important component of poultry feed, its price is a key determinant of prices of poultry products.

Ghana is almost self-sufficient in its production of maize and import numbers are decreasing: between 2011 and 2013 imports dropped with 70%. However, now that the Government of Ghana wants to expand the poultry sector, more efficient ways of producing maize and soy beans are needed to increase yields. Between December and January, the availability of local maize and soy beans is abundant and affluent farmers buy it at this time to store it for feeding throughout the year. Those without surplus money buy it monthly at higher prices, thus reducing their profits. A problem with local maize reported by poultry farmers is that it can be mouldy and of bad quality, causing farmers to add toxin binders to prevent illnesses.

*Consumption*

The estimated per capita consumption of poultry products in Ghana has increased by 33% from 4 kg meat in 2010 to 6.6 kg in 2012. Beef and poultry meat contributes to 40% of the total animal protein consumption with the rest coming from fish. Ghanaian consumers in urban areas have a high preference for imported frozen poultry products as they are cheaper and are processed as whole chicken or pre-cut. In Ghana local processing of poultry into cut portions to facilitate quick and easy use by consumers is limited. Nevertheless, Ghanaians generally prefer the taste of local chicken over imported chicken as it has more flavour and a better structure. Darko Farms and Cottage Farms have seen this market opportunity and have opened cold stores in Accra selling frozen local poultry products ranging from whole birds to pre-cut chicken legs.

**Market outlook**

The most immediate opportunity for Ghana's soybean industry is the direct substitution of imported soybeans, soybean meal, and soybean oil with locally produced and processed products. The industry imports between 35,000 and 63,000 tonnes of soybean equivalent as processed meal (between 48% and 61% of the total soybean meal market). The challenge is purely about the availability of raw materials, since the crush capacity to meet these volumes of processed meal exists. While current use is 30%, substituting for current imports would increase crush use to approximately 70%. Another challenge making it hard to compete is recent government policy: in 2013, the Government of Ghana removed customs duties on poultry inputs such as feed, additives, drugs and vaccines.

Over the longer term and slightly more complex investment opportunity will be meeting Ghana's increasing demand for chicken meat with locally produced broilers fed with locally produced and processed grains, including soybeans. Finally, longer-term soy industry growth might come from the export of finished soybean products into West African urban markets.

## 5.3 Games Ghana

Like in Kenya, three games were played among soy farmers in Ghana, the trust game, the risk game and the so called VMC game. A comparison group was constructed to be able to compare results between farmers who are part of the 2SCALE intervention (the treatment group) and farmers who are not (the comparison group). The games were conducted in groups of 16 farmers with in total 160 farmers in the treatment groups (i.e. 10 groups) and 96 farmers in the comparison group (i.e. 6 groups). The games were conducted by one Wageningen Researcher and a master student of Development Economics of Wageningen University. They were assisted by local enumerators who translated into the local language of the participants. All participants were paid the amount they won in the local currency. The games were combined with a small survey to collect some relevant data at individual level. The games were customised to the local situation of the soy context in Ghana. That means that the games are different than the games conducted in Kenya. In the current setting of Ghana, group trust and trust in the group leader is very important so games were constructed to focus on these trust levels. There are more than one processors and traders in this case and no multi-annual contracts between farmers (groups) and buyers are in place.

Table 5.2 shows the main characteristics of the participants. Farmers in the control group were on average 39 years old, 41% of them were women. 44% of the treatment group received a production loan, and 56% of the control group received a loan. We did not do any additional matching of the treatment and control group due to sample size limitations.

**Table 5.2** Descriptive variables of the soy farmers in the treatment and control groups in Ghana

| Variable | Treatment (N=160) | Control (N=96) | Significance level p |
|---|---|---|---|
| Age (years) | 39.2 | 37.8 | .129 |
| Sex (1=male, 2=female) | 0.41 | 0.40 | .740 |
| Received production loan (0=no, 1=yes) | 0.44 | 0.74 | .000*** |

*** p<0.01, ** p<0.05, * p<0.1

Table 5.3 provides data of the first gaming round. The average trust of all farmers participating was 4.79 coins out of 10 on average. For the treatment group this was 4.87 and the control group this was only 4.66 which is not significantly different. The group trust game gave a similar score: 4.70 coins were put in the pot on average. For the treatment group this was only 4.51, for the control group this was 4.71.

Trust levels in the group and in the leadership, as derived from the debriefing questions, are quite high: 4.31 and 4.15 out of 5 for the treatment group. So although the participants indicate that they trust each other a lot in the survey, they did not send on average 8 or 9 of their 10 coins to their partner. Most participants chose to send only 3.4 or 5 coins in the first round.

**Table 5.3** Trust and risk determinants

| Variable | Treatment (N=160) | Control (N=96) | Significant |
|---|---|---|---|
| Trust in group (survey) | 4.31 | 4.63 | * |
| Trust in in leader (survey) | 4.15 | 4.46 | |
| Trust round 1 | 4.87 | 4.66 | |
| Trust round 1 farm leader | 5.31 | 4.97 | |
| Group trust game | 4.51 | 5.01 | |
| Risk preference | 1.80 | 1.66 | |
| Consistency in risk game | 0.76 | 0.94 | *** |

*** p<0.01, ** p<0.05, * p<0.1

*Development of trust*

In the four rounds that participants played, the first movers in the trust game adjusted their moves on the outcomes of previous rounds. So, when they had to decide which proportion of their endowment should be entrusted to their partner, the relative return of the previous round had a significant effect on that decision. A similar measurement of satisfaction with the previous round was previous profit, as defined by the amount of coins at the end of a round minus the amount of coins at the start of a round. A negative profit leads to almost a one coin reduction in the next round, and a positive profit almost led to a one coin increase. Interesting is that this effect declines over the rounds, the trust between the two partners stabilised. Also, a very high profit does not lead to significantly more trust in the next round in comparison with a moderate but positive profit. So a good trust relation is rooted in to positive experiences, but super positive returns had no additional effect.

To measure the difference between the 2SCALE programme and the control area, we use the control group dummy in several regressions, controlling for risk preference, production loan, age and sex. All regression tables (4-6) are presented in Appendix 5. Our data does not show significant differences between farmers of the treatment and comparison groups considering trust, trustworthiness, or other in the trust game obtained variables. An explanation can be found in the fact that the comparison group was not an ideal control group. It turned out that the farmers of this group were also influenced by 2SCALE interventions with spill over effects. This is of course a positive

element and indirect effect of the activities but for comparison of data, this is not an ideal situation.

With several regression models we tried to further investigate the determinants of trust. The first round trust game data shows that there is a strong relation between trust, and own trustworthiness (Table A5.5, regression 2, Appendix 5). The coefficient is large because the range of trust is from 0 to 10 and the range of trustworthiness from 0 to 1. Expected return is also a highly significant determinant of trust (Table A5.5, regression 1, Appendix 5). The problem is that these variables are not exogenous. Both Trust and Trustworthiness measure if people are willing to send coins to each other. The Expected Return sheet is filled in most of the time after participants put some coins into their envelope. In fact, the relative expected return is another proxy for the trust in their partner. When including only exogenous variables, and consider Risk Preference and Production loan exogenous, Trust in round one has no significant determinants (Table A5.5, regression 3, appendix 5). So real exogenous predictors of trust levels of individuals cannot be determined with our data. Especially for risk preference this is surprising, and contrary to our hypothesis. In this table, the relation between an agricultural production loan and several trust variables is significant and positive. People who are eligible for a loan tend to send more coins in the trust games, and rate their group and leadership higher. In Table A5.6 (Appendix 5), we further investigate this relationship, with loan as dependant variable. It turns out that almost all variables are significant, and show small but positive effects. This means, that participants with a production loan of the credit union have higher interpersonal trust, group trust or risk preference, but expected less in return (negative coefficient of relative expected return).

Trust decisions of participants were based on their personal preferences, and their estimate of the trustworthiness of their counterpart. But in the second, third, and fourth round they played with the same partner, so then they had information about the behaviour of the other. Because of the multiple rounds in the design of the trust game, we measure the trust update: *The difference between the trust that a participant shows in round two and what he sent in round one.*

Expected was that a negative experience at the end of the first round, would lead to a lower trust next round. We used the variable 'Relative Return' as a determinant of this trust update. This is the amount that first movers received, divided by the amount of coins they have sent. Another relevant measurement of the satisfaction after a round is the profit. This is the amount of coins the first mover receives, minus the coins he sent. A relative return of 1 leads to a profit of 0, which means ending the game with 10 coins. The relative return has a significant positive influence on the trust update in the next round. However, this effect is declining in strength and significance. In the fourth round, the relative return of round 3 is no longer significant. Probably, the amount of coins that a participant wants to entrust has its limits. Or the two players reach a sort of exchange equilibrium. When using profit as a measure for satisfaction, we see hardly a significant influence on the trust update.

### Main findings games Ghana

A large problem for smallholder farmers in Ghana is access to the market. The 2SCALE programme intends to link smallholder farmers to processors in the Apex organisation. A problem in the functioning of value chains is distrust between the actors. The large majority of the game participants showed a high risk-aversion. We did not find a higher trust in the treatment area, compared to the comparison group. However there was also some kind of contamination of the comparison group, in which a similar cooperative support programme was run.

The eligibility of farmers for an agricultural production loan is significantly correlated with the outcomes of the game data. On the field, these farmers are chosen through a personal assessment by their leaders, but it is possibly based on higher trust and risk preferences of these farmers. This same effect could work the other way around, farming on credit affects trust and risk preferences.

With our results we can conclude that for building trust, especially avoiding negative experience is essential, but not enough. Translated to the programme discourse, extra services are appreciated, but a fair price, and no disappointments are the most important for a sustainable trust relation. Combining the intervention analysis with the trust update, we have indications for less feedback sensitivity for the trust update in the control area. Especially after negative profits, the control area showed less sensibility for that kind of feedback. This dealing with feedback of exchange partners can be considered as part of professional business skills.

## 5.4 Multi-agent Simulation model Ghana

**Approach**

A simulation of the soy value chain as described in the Section 5.2 has been implemented in NetLogo. The present section describes a summary of the simulation following the updated Overview, Design concepts, and Details (ODD) protocol developed by Grimm et al. (2010).

Active entities in the simulation represent plots of land, farmers that cultivate the land to produce a soy, an farmers' cooperative (APEX) that sells the produce on behalf of the farmers, another aggregator, and a small-scale local processor as described in Subsection 5.2.2 that contract farmers to deliver their produce. The processors that source soy from the APEX are not represented in the simulation; no data about the negotiations are available and the price is assumed to be aligned with general market prices for comparable volumes.

From each group of 64 farmer agents one is given the role of group head (this is indicated in a state variable). The role of the group head is to decide about requesting loans for the group and distribution of the cost in case members default to redeem their loans. All farmers have a state variable pointing to their group head and a state variable comprising the set of group members. Farmers maintain trust in the other group members. All trust is represented as an experience-based subjective probability that the others will comply with the contracts. This group trust is an important factor in the decision whether or not to request a loan. Farmer agents also maintain trust they have in the suppliers of high quality seed. In case the results attained with high quality seed are disappointing, the trust is reduced and the farmers' propensity to buy high quality seed is reduced.

The APEX can have storage capacity to store soy in case of low market prices. The policy implemented in the simulation is that the APEX will sell a sufficient share of the recent harvest to cover the production cost, including a compensation for labour, and that the remaining part is stored until selling prices are at a satisfactory level. Farmers deliver not only to the APEX. They can also sell to local small-scale processor groups, which buy small volumes, but pay a good price. In addition they may sell on local markets if in urgent financial need, or, depending on their loyalty to the APEX, to other aggregators when they offer a high farm gate price.

The value of natural conditions is equal for all farmers and thus affects the harvest of the entire cluster. The range of harvest fluctuations due to natural conditions is a parameter that can be set in the user interface. Similarly, market price is a system level variable that is randomly generated for each cropping season. Market prices are not correlated with harvested volumes in the simulation, since the world market price is assumed to be the dominant factor for price setting in the downstream value chain.

Figure 5.2 represents a time step in the simulation cycle. The user may set parameters and intervene in the simulation by pressing the 'DEFECT' button to make the processor defect in paying the contracted farmers. For details on state variables, see the simulation programme. A simulation run typically includes 2,000 farmers (in groups of 64) a single APEX, and typically spans a period of twenty cropping seasons.

A limitation of the present simulation is that no data are available about the choices farmers will make to grow soy or an alternative crop. The total area used for soy production remains constant. A further limitation is that no data are available on the negotiations and contracting by the APEX/group leaders with downstream processing companies. The simulations assume that no price regulating contracts are in place and that agreed prices fluctuate in accordance with global market prices.

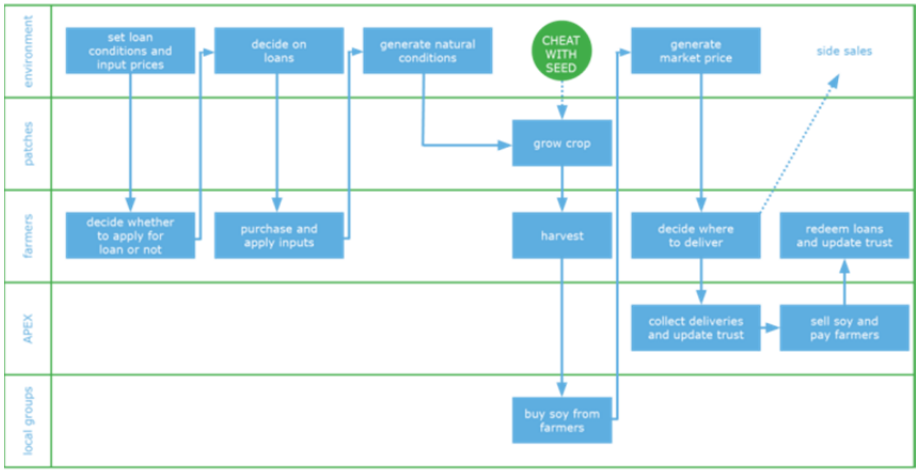


**Figure 5.2** Process overview of a time step representing a cropping season

### Descriptive results

The agent-based simulation is parameterised with data collected in a value chain mapping mission and a baseline survey for the quantitative evaluation of 2SCALE. Emergent properties to be observed are farm income and the supply of soy to the value chain. Key results are the following (Verwaart et al. forthcoming):

- Under the default settings as represented in Table 5.4, the current soy supply and farm income tend to decrease by 20% and 30%, respectively, in the simulations; this is due to reduced group trust when, under bad growing conditions and low market prices, some farmers default in redeeming their loans and group members must support them.
- Reliable supply and availability of high quality seed and inoculant increase soy supply by approximately 30 to 40% in the simulation; farm income is increased by 50% in the simulation, if reliable seed and inoculant are available (parameter settings: inoculant availability set equal to 100% and no cheating with seed occurs).
- A sufficiently high farm income is required for purchasing high quality inputs and redeeming production loans, in order to sustainably realise the aforementioned improvements. The simulations reveal the following options to increase farm income.
- If the minimal farm gate price is raised from GHS 700 to 1,000 per tonne, and the average price to GHS 1,300 instead of GHS 1,150 per tonne over the simulation period of ten years, average farm income increases by another 50%, approximately.
- When such price support cannot be realised, the use of APEX storage capacity to store part of the harvest and wait for high market prices may have a positive effect on farm income of 20%, on average. However, this intervention only has its effect when the skills of the weaker farmers are reinforced, in order to produce a sufficient volume for delayed sales and payments to the farmer, since a substantial part of the harvest must be sold on short term to cover the production cost.
- Increased supply to local small-scale processors who can offer a good price, can, apart from the contributions to local economic development, have an additional positive effect on farm income. This effect is hard to quantify; the current demand of local groups is still small. A price of 4 GSH per kilogram is mentioned in the mission report, but no data are available about potential price evolution when local processing would grow. The price may be assumed to converge to global market prices when larger volumes are sourced for local production.

### Settings model Ghana

Table 5.4 displays the default parameter settings. The ‘savings’ switch is by default set to false: farmers are assumed to spend their all revenue from a harvest during the following growing season on inputs for the next harvest and on cost of living.

**Table 5.4** Default parameters

| Parameter | Value | Unit | Parameter | Value | Unit |
|---|---|---|---|---|---|
| Farms | 2,304 | | Minimal-natural-conditions | 0.5 | |
| Minimal-farmgate-price | 700 | GHS/tonne | Savings | FALSE | |
| Maximal-farmgate-price | 1,600 | GHS/tonne | Minimal-risk-aversion | 0.0025 | 1/GHS |
| Local-market-price | 700 | GHS/tonne | Maximal-risk-aversion | 0.0100 | 1/GHS |
| Loan-standard | 750 | GHS/ha | Minimal-initial-trust | 0.8 | |
| Cost-loan-insurance | 200 | GHS/ha | Maximal-initial-trust | 1 | |
| Optimal-seed-cost | 150 | GHS/ha | Minimal-loyalty | 0.2 | |
| Inoculant-cost | 50 | GHS/ha | Maximal-loyalty | 1 | |
| Other-production-cost | 250 | GHS/ha | APEX-storage | 0 | tonne |
| Labour-cost | 300 | GHS/tonne | APEX-price-advantage | 5,000 | % |
| Transaction-cost-market | 0 | GHS | Local processing groups: | | |
| Basic-expected-yield | 1.0 | tonne/ha | --Number-of-members | 34 | |
| Optimal-seed-factor | 2.00 | | --Soy-demand-per-season | 8 | tonne |
| Inoculant-factor | 1.25 | | --Price-local-groups | 4,000 | GHS/tonne |
| Minimal-skills-factor | 0.5 | | Positive-trust-update-factor | 0.05 | |
| Farm-area | 0.4…0.8 | ha | Negative-trust-update-factor | 0.10 | |

### Main findings Ghana

As illustrated for single simulation runs in Figure 5.3, increased production and farm incomes require availability of reliable seed and inoculant, combined with stabilisation of revenues. The left-hand graphs (a) present results for the default parameter settings, with no availability of inoculant. The graphs in the middle (b) present results with full availability of inoculant. Harvest and income are increased but subject to fluctuations in market price and natural conditions. After seasons with bad revenue, many farmers have insufficient means to redeem their loans and buy new inputs. When the range of market price fluctuations is reduced from GHS 700 to 1,600/tonne to GHS 1,100 to 1,200 per tonne, as in the right-hand graphs (c), total production and average income are significantly improved. The harvest variation over seasons is now solely caused by variation of natural conditions, such as rainfall, temperature, and pests.

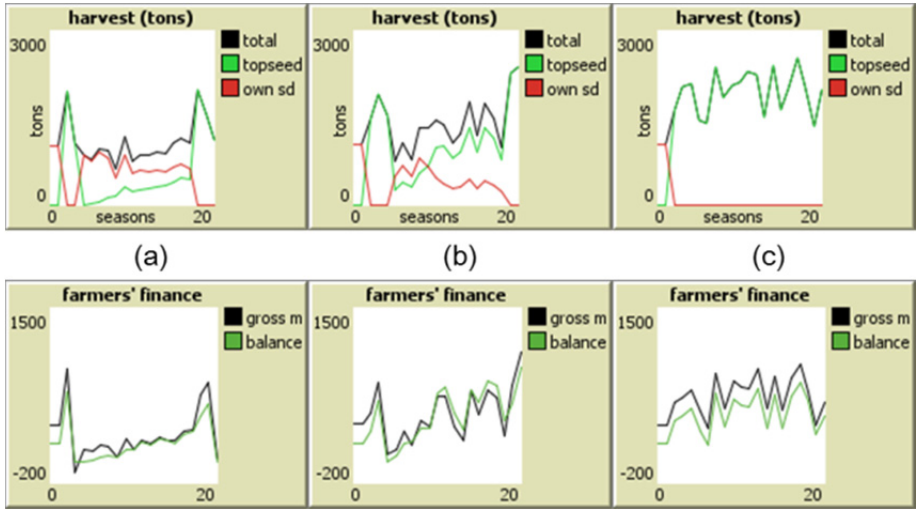


**Figure 5.3** Harvest and financial outcomes with default settings without availability of inoculant (a), default settings with availability of inoculant (b), and with inoculant and reduced price fluctuation of 1100 -1200 GHS/tonne instead of 700-1600 GHS/tonne (c).

Simulations have also been run with APEX storage capacity up to 2000 tonnes, with a policy to limit sales to the volumes required to compensate the farmers for the production cost when market price is low, and postpone sales until market prices have recovered. This intervention has a positive effect on farm incomes only if the productivity of the weaker farmers is extended; sufficient supplies must be in stock to realise this policy.

An effective approach to improve availability of means for purchasing of inputs for the next season is the development of local sales by developing local processing industries that can offer a good, stable price. It must be noted that in the present simulations a price of GSH 4/kg is used, as found in the field

mission. It is questionable if such a high price can persist when local processing industries develop. Figure 5.4 presents results of some simulation runs with local demand set to 100 tonnes, instead of the default of 8 tonnes, with and without sufficient availability of inoculant, and, in the right hand graphs (c), combined with the price stabilisation in other (non-local) channels as in figure 5.4. Price stabilisation in those channels has no additional effects on the average yields, but has a stabilising effect on farm incomes in the simulations (c).

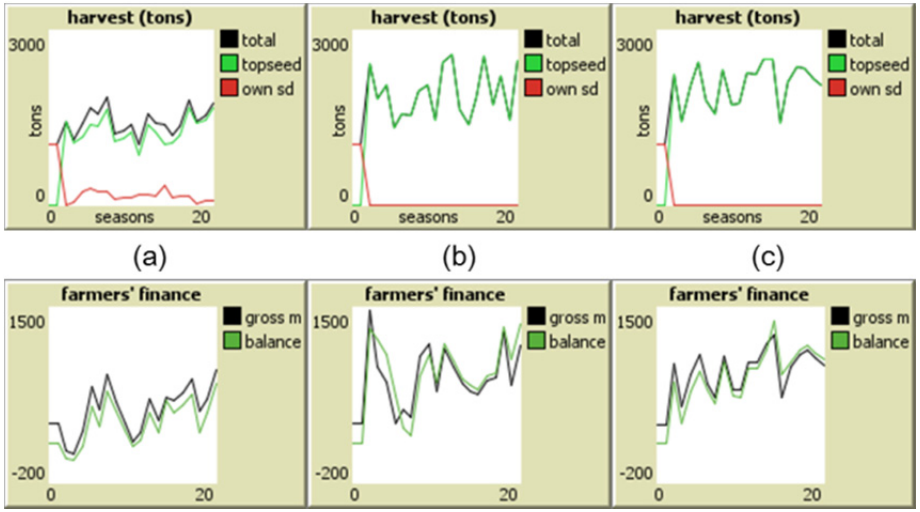


**Figure 5.4** Harvest and financial outcomes with demand from local processors offering 4 GHS/kg, increased to 100 tonnes (default 8 tonnes) under default market price fluctuation of 700-1600 GHS/tonne, respectively without (a) and with (b) availability of inoculant, and under reduced price (c).

To summarise: results of the simulation runs show that it is essential to establish a stable and reliable supply of high quality seed and inoculant. In addition, price stabilising measures would increase average farm incomes. The following interventions have positive results in the simulations:

- Reduction of the market price risk (possibly by price support or contracts).
- As an alternative to price support or contracts: collective storage to absorb market price fluctuations, under the condition that skills and productivity of the weaker farmers are developed to produce a sufficient volume for delayed sales.
- Development of local small-scale processing offering the farmers a good and stable price.

## 5.5 Conclusions Ghana

The games showed that a positive trust uptake after a positive experience and negative trust uptake after a negative experience. The agent-based simulation is initialised with data collected in a value chain mapping mission, a baseline survey for the quantitative evaluation of 2SCALE, and games played with farmer groups in Ghana. The results of the simulation runs showed that if stable and reliable supply of high quality seed and inoculant were available, considerable soy supply and farm income improvements can be realised, under the condition that market price fluctuations can be absorbed. If prices cannot be stabilised by price support or contracts offering a good minimum price, according to the simulation, collective storage and development of small-scale local processing can be good alternatives, provided that good inputs are available.


# 6

# Conclusions

# Conclusions

## 6.1 Conclusion

This study was conducted in the context of the 2SCALE programme which ran from 2012-2017. The programme was created by a consortium of partners and is supported by a grant of the Ministry of Foreign Affairs of the Netherlands. The goal of 2SCALE is to improve rural livelihoods and food and nutrition security in nine African countries. To this end, 2SCALE forges public-private partnerships, with private partners varying from local producer organisations and SMEs to large-scale companies such as seed companies, processors, and trading companies. As such the intervention aims to foster inclusive business aiming to involve low-income communities in inclusive value chains to alleviate poverty in developing countries. The 2SCALE programme specifically focussed on risk, trust and transaction costs as main elements of behavioural change in developing inclusive value chains. This approach requires an new impact assessment tool to measure changes in behaviour and value chain relations. We therefore designed the so called Value Chain (VC) Laboratory: an agent-based simulation model in combination with experimental games on trust, risk and group behaviour. The aim of this study is twofold: i) to design and verify an alternative methodology ii) applied to two cases of 2SCALE for measuring its' effects.

Text box 6.1 summarises the two overall conclusions concerning the 2SCALE intervention and the VC-Lab methodology.

Text box 6.1 Overall conclusions

*The 2SCALe intervention Kenya & Ghana:*
Promising intervention to potentially increase producers' income whereby horizontal cooperation and vertical trust is key driver for success.

*The VC-Lab:*
Promising method for assessing behavioural and relational changes, to simulate decision making of value chain actors and to measure potential impact of VC development interventions. Further development is required.

The main outcome of the VC-Lab is that the 2SCALE programme contributed to trust development over time in the Kenyan sorghum case. It is hard to show a trust development for the Ghana case as we could not compare with a valid comparison group. Repeated interactions between value chain agents ware likely to enforce inter-agent trust over time. In addition, in both cases, we identified in the games a positive trust uptake after a positive experience and negative trust uptake after a negative experience. This is comparable with repeated behaviour in commercial transactions within the value chain.

The use of contractual arrangements and the confirmation to agreements within the public-private partnerships supported by 2SCALE shows a positive effect on the trust level. However, we could not identify whether incentive mechanisms have influence on the importance of contractual arrangements. Contrary to what we expected, the presence of contractual arrangements and higher levels of trust do not always lead to a change in risk attitude; most attitudes remains equally high in terms of risk aversion.

It also appears that selling part of the produce to another party than the main buyer outside the contractual arrangement will always be part of the reality of the VC. Even if all conditions are favourable (i.e. high price offered, produce of

high quality, guaranteed market, training on agricultural skills offered), it appears that side-selling may occur. The reasons are legitimate and have nothing to do with trust, risk or disloyalty. It is a matter of urgent need of cash. As long as producers do not have any savings or cannot access loans, it is reasonable to argue that side-selling will occur.

The results of the simulation runs show that if stable and reliable supply of improved seed and inoculant are available, considerable supply and farm income improvements can be realised, under the condition that price fluctuations can be absorbed by the market. Side sales (qualified as dis-loyalty to the buyer) will decrease as trust develops over time resulting in lower transaction costs, better quality compliance, and an improved value chain performance. In the end this is expected to result in higher prices in multiple stages of the value chain leading to a cycle of improved loyalty. For both Kenya and Ghana, the simulation runs indicate higher average farm income, and in the Ghana case also more stable production, in cases where less side sales occur, i.e. when a greater share of the produce is delivered on contracts (in Kenya), or marketed through a cooperative with storage capacity (in Ghana).

The three tables below summarise the main findings of each case and the conclusions on the VC-lab methodology applied.

**Table 6.1** Main conclusions Kenya

| Kenya main results on 2SCALE intervention |
|---|
| Trust of farmers is higher in Shalem (processor of intervention) compared to a) other processors and brokers and b) to farmers of comparison group which is a positive result of Shalem and IFDC interventions. Trust in Shalem caused by trustworthiness, offering a good price and training on production. |
| No differences VCM game: free riding and investing in common pool resources. Low trust levels in other group members and negative behaviour of peers affects individual behaviour. |
| Risk aversion is high and equally high among farmers in the treatment and comparison group. |
| It is crucial for a stable contract supply to provide stable and high contract price against uncertain alternative. |
| Improving skills leads to increased sorghum production and volumes and offering training leads to higher trust. |
| (Good) Reputation and trustworthiness crucial for sustainable, inclusive and effective value chain. |
| Approach IFDC can lead to higher farm incomes and profitable processor. Trust is key success factor. |
| Shalem sorghum case is suitable for VC-Lab approach. |

**Table 6.2** Main conclusions Ghana

| Ghana main results on 2SCALE intervention |
|---|
| No differences treatment and comparison group (but contamination comparison group).<br>No differences VCM game: free riding and investing in common pool resources. Low trust levels in other group members and negative behaviour of peers affects individual behaviour. |
| Risk aversion is high and equally high among farmers in the treatment and comparison group. |
| Positive relation between production loan, trust & attitude towards group leadership and risk aversion. |
| A positive trust uptake after a positive experience and negative trust uptake after a negative experience |
| If prices cannot be stabilised by price support or contracts offering a good minimum price, collective storage and development of small-scale local processing can be good alternatives, provided that good inputs are available. |
| Ghana soy case is less suitable for VC-Lab approach. |

**Table 6.3** Main conclusions VC-Lab Methodology

| Steps | Pro | Limitations | |
|---|---|---|---|
| Value chain mapping | Precondition for modelling including desk study | Time and budget | Not all parameters for ABM are very clear at this stage |
| Games on trust, risk and voluntary cooperation | Games enable a good measurement of change in trust levels and risk attitude. | No computerised game possible in these contexts; No anonymity, so possible socially desired behaviour; | High costs of psychical presence and real life game setting; |
| Agent-based model | Games provided crucial parameters for agent-based modelling. | Simulation needed of behaviour of VC actors other than producer; | Transaction costs challenging to define for all actors |
| | The agent-based model provided good simulations of trust and risk. | No data over time complicating parameters for the model; Trend data needed | Comparison group is too small or absent or not 100% non-participating |
| | For simulating intervention impacts more data is needed (e.g. climate, other crops, trade -offs) | Decision making on crop cultivation is not taken into account. | |

## 6.2 Discussion

A number of factors will be discussed that could have influenced the outcomes. The data collected during the games served as input for the model. With this approach, a number of constrains are observed since data collection among illiterate farmers can be troublesome. We chose to play simple games to enable farmers to understand. However, already in these simple games, inconsistencies are present and this is likely to increase if the games become more complex. Therefore, the following key points are important to outline:

- The outcomes of the games should reflect the personal risk and trust preferences in an agricultural economic setting. Several validity concerns could be raised, of which the most important: is the behaviour in the game similar to real life, and is this behaviour similar when it concerns large amounts of money? For practical and logistic reasons, we chose to play with plastic coins, and relatively small amounts of money. In a round, a player could earn around USD 1. I
- Data about trust, trust, honesty and risk attitude of sorghum and soy farmers in the areas under study are not available in literature. Therefore, we used trust, VCMC and risk games with a selected number of farmers. However, we could not compare these to trust, honesty, and risk attitude of other sorghum and soy farmers in respectively Kenya and Ghana, because country-wide data was lacking. Thus, results can be seen representative only for the farmers participating in the games.
- It was impossible to collect data on trust, risk attitude and group behaviour over time (i.e. at a baseline and at the end of the intervention). This was due to a limitation in resources and because the design of the VC-Lab was not yet clear at the moment the baseline should have taken place. At the end of this study it is recommended to include various moments in time to measure attitudes. This is preferred to collecting data from a comparison group as they might be influenced by other factors (e.g. spill-over effects or receiving support from another intervention).
- It is also challenging in the local context to guarantee total anonymity, or expel socially desired behaviour. In addition, participants could peek at their neighbour sometimes, and imitate their behaviour. As also discussed in the literature part, the trust game does also not separate pure trusting behaviour, and other preferences such as altruism or inequality aversion may intervene.
- It can be sensitive and jeopardising existing relationships between value chain actors when conducting the games in a real setting. We therefore simulated behaviour of the traders and processors instead of playing the games with them and the farmers in one group. A computerised setting would allow for playing with all the VC actors at the same time but the contexts under study do not allow for playing games with a computer. The participants should behave as natural as possible and the majority is not used to a computer.
- In behavioural research, framing, hinting or steering can influence the results. Because we worked with participants using different local languages, and therefore also different translators, language framing could have influenced the results. For example, for the word 'send' in the trust game, the meaning and implication totally changes when it is translated as 'donate',

'invest', or 'move'. Even while the instructions were typed out word by word, a literal translation cannot be fully guaranteed because many English words have no local equivalent.
- The comparison groups identified in this study have also been exposed to some elements of the interventions. For example, various farmers in the control group in Kenya were already supplying via Shalem. For Ghana, some of the farmers received already support via another programme managed by one of the implementers.
- Selection of farmers in comparison group via the farm leader might have influenced the outcomes at trust level, so it is possible that the farmers in the control already had high levels of trust. Thus, indicating that if farmers were selected random the actual trust was most likely to be lower.
- The results of the multi agent model are only limited to the crop under study (i.e. sorghum and soy). It does not say anything about resource competition at farm level with other crops that might be (more) interesting to cultivate (e.g. when market prices are higher for these crops than the crops under study).
- It was difficult to have a concrete parameter for transaction costs s and measuring change over time. Following the conceptual framework we can draw conclusions on expected transaction costs s following changes in trust and risk attitude. However, we did not have actual figures on transaction costs s as it is challenging to translate these into concrete figures in the contexts under study.

## 6.3 Outlook

There are several reason why our insights into the outcomes and impact of interventions aiming to achieve inclusive sustainable value chains are still rather limited. Most studies focus attention only on the primary production stage, while devoting little attention to changes in relationships and governance regimes throughout the value chain (Lemeilleur 2014). Moreover, implications for intra-household (gender) issues and for value chain cooperation and governance are scarcely addressed (Terstappen et al. 2013). The empirical evidence generated by impact studies remains ambivalent and focusses mostly on directly observable economic effects (prices, yields, wages, sales). Sustainability is usually only considered within farm boundaries (Blackman and Rivera 2010). Far less attention is given to systematic verification of the underlying assumptions for achieving impact, to the secondary effects of certification at farm, village and regional level, and to the possible behavioural implications of certification (e.g. changes in risk attitudes, willingness to invest, bargaining power, trust, etc.). These behavioural and dynamic effects receive key attention in interactive impact assessments.

In order to capture these value chain interactions, impact analysis should be based on interactive approaches that are able to reveal behavioural drivers and constraints for value chain coordination. There are several attempts with experiments designed in a real-time multi agency system environment (including farmers, workers, traders, processors and retailers) and be supported by agent-based modelling (ABM) to assess possible alternative outcomes (Tykhonov et al. 2008; Latynskiy and Berger 2017; Hidayest and Nurhasanah 2014) but without application to a concrete intervention such as 2SCALE. The application of an alternative impact methodology remain scarce and the way the VC-Lab of this study is designed is quite unique. The underlying study concludes that the designed and validated VC-Lab proves to be a good method for measuring and evaluation the key assumptions related to trust and risk underlying the ToC. There are various recommendations for further improvement and lessons to keep in mind:
- For measuring changes over time it is recommended to play the games at the start of an intervention in order to measure trust at the baseline and to play the games after a certain time (midterm) and at the end of the intervention. This will generate a more dynamic overview of risk and trust development over time.
- Some of the input for the multi agent model originates from the quantitative baseline survey by ARS/ IAR. Since they will conduct an impact study among the same farmers, this will give great output for the multi agent model. Therefore, to generate alternative up to date scenarios with these data is recommended.
- The current design of the games only entitles to collect data between the farmers and the buyers. Therefore, the upstream relationships between trader and processor could not be adequately studied. Since there are only a few buyers, and a detailed qualitative case study of these relations is recommended.
- With the model, the impact can be estimated of alternative intervention strategies, such as an incentive system for sorghum quality. Ranking these strategies according to increasing effectiveness, e.g. farmer income or total

supply chain profit, can help in designing potentially effective intervention strategies prior to their implementation. Thus, the model can be helpful in decreasing failure costs of interventions in sorghum production in Kenya. However, the model can be adapted to other commodities and other countries where trust between farmers and processors and mutual trust within the farmers'groups play important roles in the supply chain. In this way, the model is considered a valuable tool for analysing inclusive business approaches in development aid programmes.

- It is recommend for further development of the VC-Lab to include data of the following parameters:
  - Decision making, more specifically: what makes a producer to decide whether to produce and what to produce;
  - Other crops, weather and market prices & certain trade-offs with the crop under study;
  - Payment schedule (when are producers paid, how long after transaction and how);
  - Operationalisation of transaction costs.
- The VC-Lab and specifically the ABM can be used to asses ex-ante impact by simulation interventions and potential impact. It can provide inputs for policy, design of interventions and can feed relevant discussions and decision making processes.

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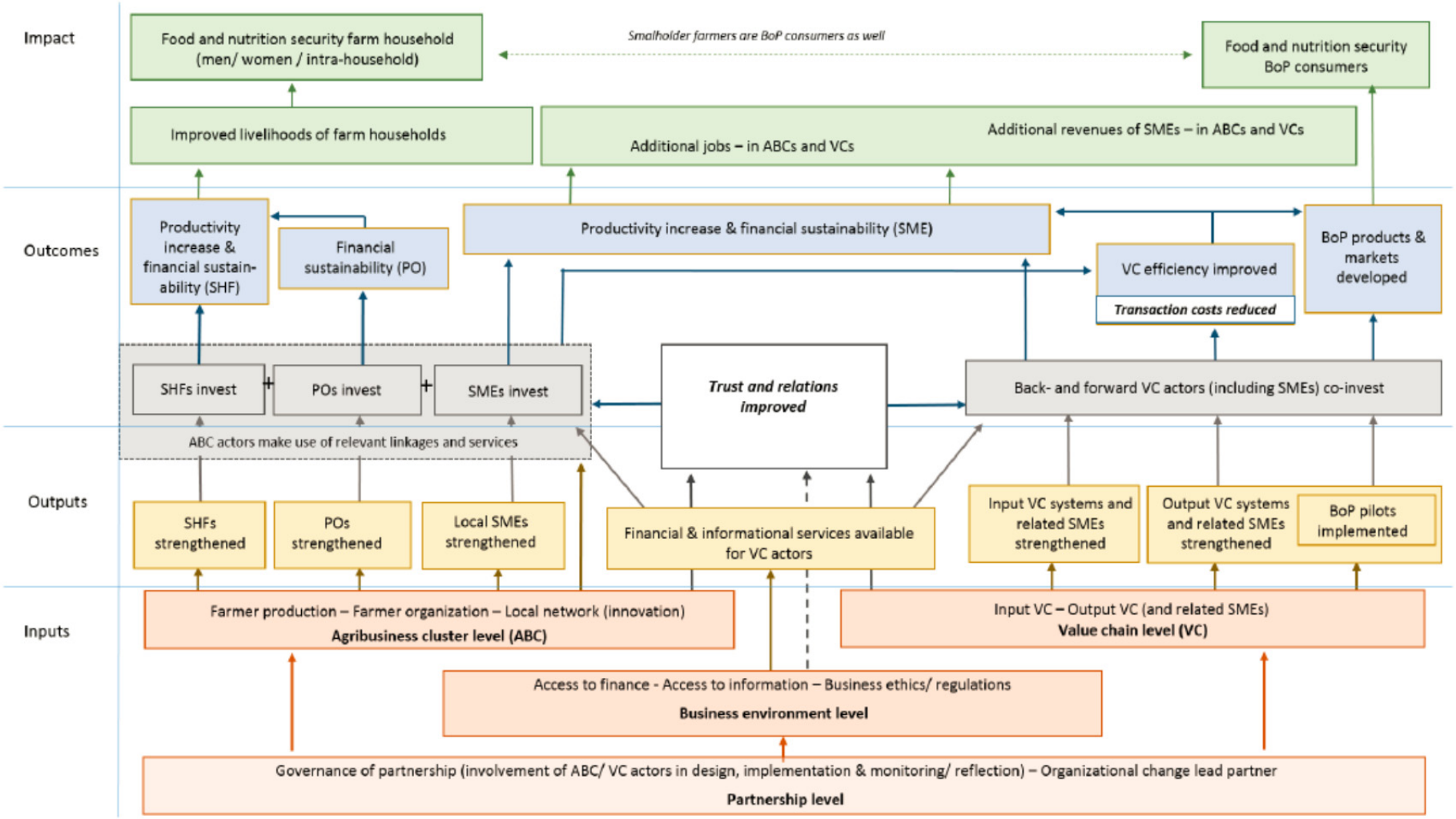
# Appendix 1 Theory of Change 2SCALE



# Appendix 2 (summary) Value chain analysis potato Ethiopia

Figure A2.1 presents a brief overview of the main actors in the value chain and their numbers. In addition it gives an indication of the selling price of the farmers and the agents in terms of price in Birr (ETB) per kg.

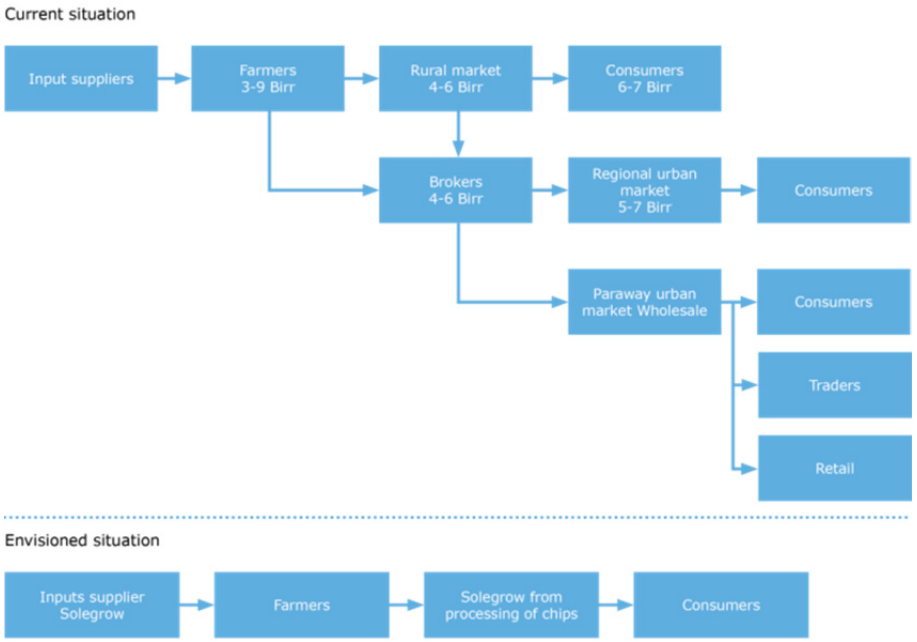



**Figure A2.1** The value chain

## Key actors and roles

The major actors in the potato value chain actors include input (seed, fertiliser, fungicide) suppliers, producers, wholesalers, brokers, retailers and consumers.

*Inputs*

Most farmers in Ethiopia use seed potatoes from their own stocks or these are bought from fellow farmers. Many issues are related to this informal supply chain, such as limited quality measures resulting in poor quality starting material:

- Late blight is common
- Too small tubers
- Damaged tubers
- Unknown origin or variety.

In addition, the Ethiopian Agriculture Research Organization (EARO) has started a seed potato production scheme. This is located in Holeta. The outcome of this scheme is only to provide a limited number of improved seeds to the farmers. As a result, not all farmers are able to use the improved seeds.

For some of the interviewed farmers, an important supplier is Solagrow, which provides inputs, including improved varieties. In Holeta they have stored their stock of improved seeds. The seeds are newly introduced varieties that are suitable for processing.

Fertilisers are normally distributed via the agro shops in each kabede (town level). Farmers are able to buy the fertilisers there and they can make use of input financing. Only a small share of the farmers does this. This service is arranged at Woreda level (sub district) by the local government.

*Farmers*

The next major potato value chain actors following input suppliers are potato growers. They are generally smallholder farmers with different land sizes. USAIDS agricultural sample survey estimated the number of Ethiopian smallholder potato growing farmers at 1,386,670 in the 2006/07 production

year, of whom 430,582 were in the SNNPR. This implies that 31% of potato producers in 2006/07 were farmers in the SNNPR.

Potato growers are the major actors who perform most of the value chain functions right from farm inputs preparation on their farms or procurement of the inputs from other sources to post harvest handling and marketing. The major value chain functions that potato growers perform include ploughing, ridging, planting; fertilisation, weeding, pest/disease control, harvesting and post-harvest handling. The most difficult function according to the farmers is ridge making, since it is labour intensive.

In most of the potato growing areas, the producers transport their potato to the nearby markets be they rural or urban centres. Means of transportation varies among locations but predominately on pack animals (donkey). A donkey costs the farmers about ETB 15. One donkey can take 2 quintals.

The costs are very difficult for the farmers to estimate. But for 1ha per season they think the following is required:

- 100 kg urea for ETB 3,000
- 100 kg DAP for ETB 3,000
- Seeds 20 quintal (2 tonnes) for ETB 8,000
- Total costs ETB 14,000.

The inputs are bought via the cooperation/union. The fertilisers come at a subsidised price arranged by the government. They can get it at the agricultural office at the Woreda (village).

Given the above yield of 80 quintal (8 tonnes) per hectare, we assume a revenue of ETB 24,000. So the farmer can make ETB 10,000 from 1ha of potato production. This excludes labour of the farmer (no external labour is hired) and excludes the costs for pesticides.

Brokers play a crucial role in the potato marketing system of Ethiopia by facilitating potato transaction through the linking producers with traders, a wholesaler with another wholesaler, and wholesalers with retailers. The brokers tend to control and fix prices, creating price symmetry. The brokers often work in an unregulated and informal way. The brokers buy potatoes at rural markets or at the farm gate.

**Table A2.1** Profit per hectare from potato farming using improved seeds

| | Quantity | Old situation | With 2SCALE |
|---|---|---|---|
| | | Amount in ETB per ha | |
| A) Costs | | | |
| Labour | | - | - |
| Seeds | 2,000kg | 8,000 | - |
| Fertilisers | 2,000kg | 6,000 | - |
| Mechanisation service | | - | 1,600 |
| Other costs (transport) | | 600 | 600 |
| Total costs | | 14,600 | 2,200 |
| | | | |
| B) Returns | | | |
| -kg | 80 quintal (8,000kg) | | |
| -price per kg | ETB3 | | |
| Total revenue | | 24,000 | 24,000 |
| | | | |
| Profit (B-A) | | 9,400 | 21,800 |

*own labour, not included in the cost price calculation

*Processor*

Potato is commonly consumed in the form of boiled and cooked meals in different traditional dishes or 'wot'. Recently, consuming potato chips, crisps, and roasted potatoes are becoming common practice, especially in cities such as Addis Ababa, Hawassa, Adama and Mekele. In other urban areas it is also usually consumed mixed with other vegetables as a salad. Large-scale potato processing is non-existent in Ethiopia. Few processors were interviewed during the survey although they could not tell about the volume of potato processed as the product is sold mixed with different products such as vegetables. Hence, it is hardly possible to report on the volume of potato processed in the study areas. Those few processors interviewed said that they prefer large size potatoes for processing. Consistent with other research findings, the Jalene variety is preferred for processing in Hawassa and Shashemene. Supermarkets started to sell potato products such as chips and crisps. In large cities such as Addis Ababa, it is common to see hotels, restaurants and cafes prepare French Fries.

In addition: Solagrow has the ambition to invest in processing. Good varieties are needed to process in descent volumes.

*Retail*
Many potatoes are brought to the urban markets in Addis Ababa. However, the potatoes produced near Wolkite appear to remain in the region. Most potatoes are sold on the markets in the rural areas (twice a week). In nearly every Kabede there is a small market where the farmers can sell their produce. At these markets rural consumers buy their produce. Also buyers come to collect larger quantities of produce for the urban markets in Wolkite and further away.

In Wolkite there is a market twice a week. On this weekend female vendors sell the potatoes. The potatoes are presented on the floor and grouped in bunches of 1 kg. They are sold for ETB 5-7 per kg, depending on the season. The female vendors told us that they buy their potatoes (1 quintal) from the collectors that pick the potatoes from the farm or rural markets.

At the market in Wolkite mainly rural people come to buy their fresh produce, but also shop and restaurant owners come to buy produce. But is also possible that they buy directly from the collectors.

In addition to these markets, Addis Ababa is the main market for ware potatoes. Merkato, Shola and Piazza market are the biggest open air markets in Ethiopia and produce from the entire country is traded here, where also large volumes of potatoes arrive. However, there are only a small number of potato wholesalers on this market. They are said to buy directly from farmers. The place where they buy potatoes differs from season to season. From June to October they buy from the southern part of Ethiopia, which can be Shashemene. Then, from October to February the main sourcing is from the Aselle and from the northern part of the country. These areas are mainly Menagesha and Gojam.
From these markets many potatoes are sold to small shop owners and restaurants. Also some consumers come and buy small quantities of potatoes. Hotels often have a dedicated supply contract with traders that supply the hotel a number of times per week. The hotels use the potatoes as fresh ware potatoes, but they also process them for French fries or mashed potatoes.

In Addis there is also an increasing number of supermarkets aimed at the expatriates or the high-end consumers. Some of them sell potatoes, often sourced from the main open markets, and presented washed and clean. They do not sell any chips from local produce. However, they do sell imported chips imported from the Middle East (such as Lay's ) and the also sell deep-frozen potato fries from abroad.

## Trust, risk and transaction costs

*Trust*
Currently trust is not an issue. There are no transactions between Solagrow and the visited farmers. Solagrow only provides inputs (fertilisers, seed potatoes) and does not provide the market linkage. However, some farmers mentioned that Solagrow was going to buy their potatoes, but that they were not able to buy them yet. For the farmers it was not a problem to sell the potatoes on the local market since they got the inputs for free and only paid little money (ETB 1,600 per ha) for the mechanisation series.

At the moment the farmers are waiting to be supplied with new inputs, but it is not sure if they will get this since the potato seeds have been destroyed during the unrest. As a result, the farmers might start production with the conventional seeds, and will only use the mechanisation services. However, the land needs to be prepared as soon as possible (within the next 3 to 4 weeks), otherwise the farmers are too late. Note that this might affect the credibility of Solagrow).

*Risk*
The main identified risks for the current market are :
- It is not possible to bring the potatoes to the market due to poor roads
- Decreased sales due to lower demand
- There are insufficient volumes of improved potatoes seeds available.

*Transaction costs*
For the farmers the transactions costs are high if they sell at the rural markets. It costs them a full day to go there and to bring 1 or 2 quintals to the market. Rural consumers often only buy small quantities. In addition, the farmer needs to pay for the transport to the local market. This can go up to ETB 15 per donkey ride.

# Appendix 3 Simulation for the harvest-price relation Kenya

To test for the effect of assumed relations between local harvest and farm gate price, additional simulations were run with the following options

- zero correlation between natural conditions and price
- inverse relation between price and natural conditions: minimal natural conditions --> maximal price, vice versa
- with 50/50 mix of the above settings

and two additional observables:

- the accumulated total shortage over seasons in which a shortage occurred, out of twenty growing seasons (shortage of contract deliveries with respect to the volume to be delivered to the brewery)
- the number of seasons in which such a shortage occurred, out of twenty seasons.

90 simulations were run for each of the following scenarios:

1. honesty parameters taken from the games, default skills factor, and 5,000 tonnes to be delivered
2. rather dishonest parameter setting to test for sensitivity to this parameter
3. rather honest parameter setting to test for sensitivity to this parameter
4. honesty parameters taken from the games, increased farmer skills factor, and 5,000 tonnes to be delivered
5. honesty parameters taken from the games, increased farmer skills factor, and 5,000 tonnes to be delivered
6. honesty parameters taken from the games, increased farmer skills factor, and 5,000 tonnes to be delivered

Each set of 90 simulations comprised:

- 30 runs with zero correlation between natural conditions and price
- 30 runs with inverse relation between price and natural conditions
- 30 runs with price determined for 50% by the inverse relation

With respect to the zero correlation case, the results show a relevant increase of the occurrence and volume of shortages if a we assume a 100% inverse relation. These shortage in particular seasons occur despite the increased volume delivered on contracts on average; they are is due to side-selling.

However, there is little difference between outcomes for 50% and 100% randomness. An assumption of 50% dependence of the price on natural conditions makes no great difference in the occurrence and volumes of shortages due to side-selling. A conclusion is that it will be relevant to collect data on the relation between total harvest and farmgate price and include this relation in the simulation only if it the local harvest is the main factor (>50%) determining the local farmgate price.

A point to be noticed is that in the current simulation only two reasons for side-selling are implemented: a farmer's urgent need for cash and opportunism in case of high market prices. There might be other reasons not to deliver the entire harvest on contracts in case of bad natural conditions, such as increased demand for home consumption or some need to keep a fixed volume in stock.

Furthermore, the differences between simulations with rather dishonest and rather honest agents stress the disruptive effects of side-selling on the system, as concluded before.

The results from runs with increased skills factors show that increasing the skills can increase the production and offer opportunities for greater contracts, but that skills improvement as such does not affect the occurrence of shortages due to side-selling.

**Table A3.1** Average results from 30 simulations

| Scenario | Harvest-price relation | Accumulated shortage over 10 yrs | # seasons with shortage |
|---|---|---|---|
| Game data, 5000 tonnes to be delivered, basic skills | No correlation | 1,148 | 2.0 |
| | 50/50 | 1,972 | 2.6 |
| | 100% inverse relation | 2,925 | 4.7 |
| Game data, 10000 tonnes to be delivered, improved farmers' skills | No correlation | 4,046 | 2.9 |
| | 50/50 | 5,161 | 3.2 |
| | 100% inverse relation | 7,737 | 5.0 |

# Appendix 4 Detailed information sorghum value chain, Kenya

The annual production of sorghum in Kenya varies between 173,000 tonnes and 254,000 tonnes. The average yield is around 0.57-0.74 tonne per ha. Interviewed stakeholders indicated that there are an estimated 500,000 sorghum farmers. This means that they produce sorghum on an average area of 0.3-0.5 hectares. This roughly equals 1-2 acres. Most farmers produce twice per year on small plots of land which are rain fed. However a few farmers produce sorghum on larger plots going up to 10-15 acres (4-6 ha).

Good farmers are estimated to produce 20-25 bags per acre per season. 1 bag contains 90 kgs of sorghum.

**Table A4.1** Area harvested, production and calculated yield for Sorghum in Kenya per annum

| | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|
| Area harvested (ha) | 173,172 | 225,782 | 254,125 | 223,799 | 189,442 |
| Production (tonnes) | 99,000 | 164,066 | 159,877 | 166,627 | 138,533 |
| Yield (tonnes per ha) | 0.57 | 0.73 | 0.63 | 0.74 | 0.73 |

Source: FAOstat

*Season*

A key area of sorghum production is the Eastern Province. Especially around Meru there are many sorghum farmers. The region around Meru has many different micro climates due to its mountainous character, resulting in large differences in temperature and rainfall. This results in large variations between the yields of the different farmers, depending on the location. There are two sorghum seasons per year. The first one starts in May with harvest in September. The second season starts in October with harvest in March (Table A4.2).

**Table A4.2** Harvest calendar upper midland zone in the Eastern Province

| Season | Planting period – start | Planting period - end | Sowing / Planting rate seed | Sowing / Planting rate unit | Harvesting period - start | Harvesting period - end |
|---|---|---|---|---|---|---|
| First | 15/03 | 31/03 | 7-10 | kg/ha | 01/09 | 30/09 |
| Second | 01/10 | 31/10 | 7-10 | kg/ha | 01/03 | 15/04 |

Source: FAOstat

Sorghum is traditionally produced by farmers for domestic use to make porridge and ugali. Nowadays sorghum is increasingly used for the production of beer for the poor (called Senator Keg). For this white sorghum is required and a specific variety is preferred (Gadam). Traditionally, sorghum is a 'poor men's meal', for it is quite cheap to produce and buy. Because of this image, it's a challenge to extend consumption beyond the Bottom of the Pyramid (BoP) target group.

Table A4.3 gives an overview of the different costs for 1 acre of sorghum production. This calculation has a modest revenue of 18 bags with 90 kg of sorghum and assumes that farmers use certified seed. In case the farmers use traditional seed, the price is only KES 150 compared to a price of KES 800 per acre. The cost price for 1,680 kg of sorghum production is calculated at KES 12 per kg, or KES 19,780 per acre. The yield is expected to be 20% lower (an estimated) 3-4 bags with conventional seed though. And although lower, there is still profit with conventional seed. This season there is a minimum selling

price of KES 25 per kg agreed upon with Shalem. If volumes of the farmer group increase the farmers group can get a better price (up to KES 28 per kg).

**Table A4.3** Profit per acre from sorghum farming using certified and conventional seeds in KES

| | Item | Activity | Unit | Unit price | Total price with certified seeds | Total price with conventional seeds |
|---|---|---|---|---|---|---|
| Costs | Labour | Ploughing | 5 | 300 | 1,500 | 1,500 |
| | | Planting | 5 | 300 | 1,500 | 1,500 |
| | | 1st weeding | 5 | 300 | 1,500 | 1,500 |
| | | 2nd weeding | 6 | 300 | 1,800 | 1,800 |
| | | Harvesting | 4 | 300 | 1,200 | 1,200 |
| | Inputs | Seeds | 4 | 200 | 800 | 150 |
| | | Fertilizers | | | 3,600 | 3,600 |
| | | Pesticides | | | 1,200 | 1,200 |
| | After harvest | Threshing | 18 | 200 | 3,600 | 3,600 |
| | | Bags | 18 | 40 | 720 | 720 |
| | | Weighing and packing | 18 | 20 | 360 | 360 |
| | Miscellaneous costs | | | | 2,000 | 2000 |
| | Total costs | | | | 19,780 | 19,130 |
| Sales | Yield in kg | | 1,620 | 25 | 40,500 | 32,400* |
| Profit | | | | | 20,720 | 13,270 |

*20% less compared to the estimated 1620 kg is 1296kg.

Source: IFDCs own calculations, 2014

# Appendix 5 Detailed information regressions soy, Ghana

To measure the difference between the 2SCALE programme and the control area, we use the control group dummy in several regressions, controlling for risk preference, production loan, age and sex (Table A5.1 in below). Our data does not show significant differences of trust, trustworthiness, or other in the trust game obtained variables. The risk preference in the control area is somewhat lower, but not significant. As discussed before, relatively more participants had a loan in the control area, and regression 5 and 6 show a significant relation between risk preference and a production loan. This makes sense because taking a loan requires the acceptance of certain risks. The expected effect was: lower trust levels in Zabzugu-Tatale because of not participating in the 2SCALE programme. The however data does not support this. An explanation could be the limited influence that those kind of programmes have on individual trust preferences. Another one could be the so called contamination of the control group. In this control area, the Zabzugu-Tatale district, the 2SCALE is only starting up partnering with local partner SEND Ghana, and only initial meetings have taken place. But SEND Ghana already runs another programme in this area called Food Security through Cooperative in Northern Ghana in which where cooperatives are supported. The 2SCALE programme can build on existing cooperative structures, and it's added value will mainly be external: inclusion in value chains, and brokering with banks and aggregators. For things such as mutual trust, and trustworthiness of farmers inside the cooperative, this was not an ideal control group.

**Table A5.1** Regression between treatment and control group.

| VARIABLES | 1<br>Trust<br>Rnd1 | 2<br>Own Trustworthiness<br>Rnd1 | 3<br>Relative expected return<br>Rnd1 | 4<br>Group Trust | 5<br>Risk preference | 6<br>Production loan last year 1= yes | 7<br>Profit<br>Rnd1 |
|---|---|---|---|---|---|---|---|
| Control area | -0.30 | -0.04 | -0.00 | 0.37 | -0.32* | 0.30*** | -0.01 |
| | (0.27) | (0.03) | (0.17) | (0.33) | (0.16) | (0.06) | (0.38) |
| Risk preference | 0.09 | -0.02 | -0.04 | -0.03 | | 0.09*** | 0.13 |
| | (0.11) | (0.01) | (0.07) | (0.13) | | (0.03) | (0.15) |
| Production loan last year 1= yes | 0.65** | 0.04 | -0.39** | 0.60* | 0.56*** | | |
| | (0.27) | (0.03) | (0.17) | (0.33) | (0.16) | | |
| Age | 0.01 | 0.00*** | 0.00 | 0.01 | -0.01* | 0.00 | 0.00 |
| | (0.01) | (0.00) | (0.01) | (0.01) | (0.01) | (0.00) | (0.02) |
| Sex Female =1 | 0.43 | -0.01 | 0.08 | -0.36 | -0.44*** | -0.02 | 0.34 |
| | (0.26) | (0.03) | (0.16) | (0.32) | (0.16) | (0.06) | (0.38) |
| Constant | 3.68*** | 0.33*** | 1.84*** | 4.22*** | 2.16*** | 0.20 | 0.38 |
| | (0.54) | (0.05) | (0.34) | (0.65) | (0.30) | (0.13) | (0.78) |
| N | 240 | 238 | 238 | 240 | 240 | 240 | 243 |
| R-squared | 0.05 | 0.06 | 0.03 | 0.03 | 0.10 | 0.13 | 0.01 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The influence of peoples risk perception on their decisions in the trust game cannot be derived from this data (see Table A5.2). Age has also no effect on the amount of trust, expected return or risk preference. Female participants do not show lower or higher trust, but have a significant lower risk preference. In table 07 we combine all the first round or single shot variables related to trust and expectation, to further investigate determinants of trust. The first round trust game data shows that there is a strong relation between trust, and own trustworthiness (Table A5.2, regression 2). The coefficient is large because the range of trust is from 0 to 10 and the range of trustworthiness from 0 to 1. Expected return is also a highly significant determinant of trust (regression 1). The problem is that these variables are not exogenous. Both Trust and Trustworthiness measure if people are willing to send coins to each other. The Expected Return sheet is filled in most of the time after participants put some coins into their envelope. In fact, the relative expected return is another proxy for the trust in their partner. When including only exogenous variables, and consider Risk Preference and Production loan exogenous, Trust in round one has no significant determinants (regression 3). So real exogenous predictors of trust levels of individuals cannot be determined with our data. Especially for risk preference this is surprising, and contrary to our hypothesis. In this table, the relation between an agricultural production loan and several trust variables is significant and positive. People who are eligible for a loan tend to send more coins in the trust games, and rate their group and leadership higher. In Table A5.3, we further investigate this relationship, with loan as dependant variable.

**Table A5.2** Determinants of trust

| VARIABLES | 1<br>Trust<br><br>Rnd1 | 2<br>Trust<br><br>Rnd1 | 3<br>Trust<br><br>Rnd1 | 4<br>Own<br>Trustworthiness<br>Rnd1 | 5<br>Relative<br>expected return<br>Rnd1 | 6<br>Trust Round<br>farmer leader | 7<br>Group Trust | 8<br>Questionnaire<br>trust in group | 9<br>Questionnaire<br>trust in leader |
|---|---|---|---|---|---|---|---|---|---|
| Age | 0.01 | 0.00 | 0.01 | 0.00*** | 0.00 | 0.01 | 0.00 | 0.00 | -0.01 |
| | (0.01) | (0.01) | (0.01) | (0.00) | (0.01) | (0.01) | (0.01) | (0.00) | (0.01) |
| Sex Female =1 | 0.13 | 0.50** | 0.43 | -0.01 | 0.08 | 0.49* | -0.37 | -0.15 | -0.00 |
| | (0.24) | (0.24) | (0.26) | (0.03) | (0.16) | (0.28) | (0.32) | (0.10) | (0.12) |
| Production loan last year 1= yes | 0.61** | 0.43* | 0.54** | 0.03 | -0.42*** | 0.65** | 0.69** | 0.25** | 0.25** |
| | (0.24) | (0.24) | (0.26) | (0.03) | (0.16) | (0.28) | (0.32) | (0.10) | (0.12) |
| Risk preference | 0.11 | 0.16 | 0.10 | -0.01 | -0.03 | -0.05 | -0.05 | 0.04 | -0.01 |
| | (0.10) | (0.10) | (0.11) | (0.01) | (0.07) | (0.12) | (0.13) | (0.04) | (0.05) |
| Started as first mover | 0.00 | -0.26 | -0.20 | 0.01 | -0.33** | 0.05 | -0.14 | -0.01 | 0.02 |
| | (0.23) | (0.23) | (0.25) | (0.02) | (0.16) | (0.27) | (0.31) | (0.10) | (0.11) |
| Exp. Return Rnd1 | 0.20*** | | | | | | | | |
| | (0.03) | | | | | | | | |
| Own Trustworthiness Rnd1 | | 4.20*** | | | | | | | |
| | | (0.62) | | | | | | | |
| Constant | 2.43*** | 2.40*** | 3.66*** | 0.30*** | 2.02*** | 4.37*** | 4.45*** | 4.24*** | 4.41*** |
| | (0.52) | (0.54) | (0.54) | (0.05) | (0.34) | (0.59) | (0.66) | (0.21) | (0.25) |
| N | 240 | 238 | 240 | 238 | 238 | 240 | 240 | 239 | 238 |
| R-squared | 0.22 | 0.20 | 0.04 | 0.05 | 0.05 | 0.04 | 0.03 | 0.05 | 0.03 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

A production loan is essential for most farmers in the Northern Region of Ghana to buy agricultural inputs, and to pay for tractor services. Farmers in a community can apply for a loan together with other members of their cooperative. But not everybody applies, and not everybody is eligible. These decision who can apply is mostly made by the cooperative leader, he submits a list of names of members to the credit union. It is interesting to see if there is a relation with the data that is derived from our behavioural games. In Table A5.2 we already analysed the relation of trust values and the production loan.

The question to the participant was: did you receive an agricultural production loan of the credit union last year? Table A5.3 presents the outcome of several Probit regressions displaying the marginal effects. Almost all variables are significant, and show small but positive effects. Participants with a production loan of the credit union had higher interpersonal trust, group trust or risk preference, but expected less in return (negative coefficient of relative expected return).

**Table A5.3** Different Probit regressions with production loans (PL)

| VARIABLES | PL 1= Yes | PL 1= Yes | PL 1= Yes | PL 1= Yes | PL 1= Yes | PL 1= Yes | PL 1= Yes |
|---|---|---|---|---|---|---|---|
| Age | -0.00 | -0.00 | 0.00 | -0.00 | 0.00 | 0.00 | -0.00 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| Sex Female =1 | -0.09 | -0.05 | -0.07 | -0.07 | -0.05 | -0.03 | -0.07 |
| | (0.06) | (0.07) | (0.06) | (0.06) | (0.07) | (0.07) | (0.06) |
| Trust Round1 | 0.03* | | | | | | |
| | (0.02) | | | | | | |
| Questionnaire trust in group | | 0.10** | | | | | |
| | | (0.04) | | | | | |
| Questionnaire trust in leader | | | 0.07* | | | | |
| | | | (0.04) | | | | |
| Group Trust | | | | 0.03** | | | |
| | | | | (0.01) | | | |
| Relative expected return Round1 | | | | | -0.10** | | |
| | | | | | (0.04) | | |
| Risk preference | | | | | | 0.09*** | |
| | | | | | | (0.03) | |
| Own Trustworthiness Rnd1 | | | | | | | 0.16 |
| | | | | | | | (0.17) |
| N | 252 | 251 | 250 | 252 | 249 | 240 | 250 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

# Appendix 6 Programme validation workshop Kenya

Programme Validation workshop 2SCALE – Shalem study
Meru, May 24, 2017

| | |
|---|---|
| 09.00 | Arrival |
| 09.30 | Official start, introduction by Ruth & Christine Kanana |
| 09.45 | Short introduction of all participants (names) |
| 10.00 | Objectives & expectations & programme of the day |
| 10.15 | Presentation: results of the study (games) Youri & Christine |
| 11.00 | Coffee & tea break |
| 11.15 | Group work on trust |
| 11.45 | Presentation of outcomes group work |
| 12.30 | Lunch |
| 13.30 | VCM Game |
| 14.30 | Discussion farmers & Shalem on way forward |
| 15.30 | Conclusions and Recap |
| 16.00 | Closing |

# Appendix 7 Report validation workshop Kenya

**May 2017 Field Report, Sorghum Partnership- Kenya, Activity: Support Activity 4: Monitoring and Evaluation**

**Programme level M&E** – Value chain games feedback session with IFDC, Wageningen Economic Research (WUR), Shalem management and a selected sample of farmer representatives

**Dates:** 23rd to 25th May 2017

**Participants**

1. 10 farmer leaders who participated in the value chain games exercise in 2016 as the treatment groups
2. 10 farmer leaders from other Shalem groups
3. Ruth Kinoti – Managing Director – Shalem Investments Ltd.
4. Christine Kanana – Training Coordinator - Shalem Investments Ltd.
5. Daniel Kisengese – Agronomist- Shalem Investments Ltd.
6. Joy Nkatha – Consultant - Shalem Investments Ltd.
7. Beth Ntinyari - Attachee - Shalem Investments Ltd.
8. Patrick Boro – Capacity Strengthening Specialist - 2SCALE
9. Gabriel Olengo – Partnership Facilitator - 2SCALE
10. Ruth Kamunya – M&E and Database Specialist – 2SCALE
11. Christine Plaisier- Wageningen Economic Research
12. Youri Dijkxhoorn – Wageningen Economic Research

The objectives of the feedback session was to communicate the findings of the value chain games that were conducted in 2016. The games measuring risk attitude, (mutual) trust & collective action were conducted with 31 farmer groups of 16 participants to identify changes in trust and risk attitude. The feedback from the value chain games was planned for the representatives from the 10 groups that participated in the games under the treatment group of farmers, and additional number of farmers who are influential in disseminating the feedback down to the grassroots levels of the groups. The Shalem team was also represented as well as the 2SCALE team so as to discuss the results as a team. Before the start of the session, the farmers had the following as some of their long term goals and objectives as farmers of sorghum;

**Farmer goals and objectives:**

- Increased sorghum productivity at farm level
- Increased sorghum delivery to Shalem
- Improved household income and revenue
- Improved savings and investments
- Improved standards of living cum ensure household food security

The session was conducted through powerpoint presentations and also through group discussions that resulted to the following discussions, guided by selected questions.

**Trust Levels between the treatment and control groups:**

Trust in Shalem by farmers in the treatment group was significantly higher than trust of the control group farmers in their normal buyers and trust in new buyers. Trust of farmers in the control group in their normal buyer was significantly higher than trust in a new broker.

**Reasons for such an outcome are;**

1. Time line- Shalem has natured the group's overtime and they have developed a sense of natural ownership thus high trust.
2. The benefits gained from Shalem as a farmer apex body that organises for transport, aggregation, input provision, credit services and trainings (farmers and coaches). These has increased farmer trust.
3. Assured market irrespective of volume levels also gives the same impact.

**Discussions around the above outcomes;**

1. Farmers using adequate inputs and are involved in trainings are likely to enter into contracts with Shalem Investments due to the trust earned and in return the volumes delivered would be high and of good quality.

2. In the first season some side-selling occurs by contracted farmers who are in urgent financial needs before the harvest is delivered. This doesn't mean absolute mistrust but the pressure to meet their immediate needs.
3. For some seasons, if market price exceed the contract price, new farmers would side sell some of the harvest but deliver some Shalem to preserve the name and trust.
4. In the subsequent seasons side-selling reduces since established farmers show little urgency for financial needs before the harvest is delivered but they can get loans from Shalem and from alternative sources like MFIs.

From the various group activities, the farmer representatives had the following to say as guided by the questions that were given to them;

**Group work on trust;** The farmers working in three groups had the following responses to the various questions posed to them;

**Question 1: What can Shalem do to increase your trust?**

1. Offering sustainable training to farmers through field days
2. Maintain input supplies and discounted prices; e.g offering wholesale prices
3. Production price time utility
4. Regular visits to the farmers through trainings
5. Increase facilitators to cover the many groups
6. Provide inputs to farmers for them to pay after harvesting
7. To be sensitive to market changes i.e. offer reasonable prices depending with the demand
8. Give them seed to plant and pay after harvest
9. Increasing farmers trainings, offering farm inputs on time, increase visits to the farmers
10. Offering good prices which eliminates the brokers

**Question 2: How can farmers be trustworthy to Shalem?**

1. Signing farming contracts with Shalem
2. Agreements on the good quality parameters that are to be used
3. Input soft loans to farmers
4. Adhering to the agreements
5. Supplying quality produce
6. Repayment of seed given to farmers after harvest

**Question 3: What is the worst thing Shalem could do to decrease your trust?**

1. Failure to meet the agreed upon requirements, i.e. prices, onset timing of inputs
2. Offering lower prices than those prevailing in the market
3. Shalem Investments failing to buy or delays in buying of sorghum from the farmers
4. Having untrustworthy agents who cheat on prices or weights and measurements
5. Failure to buy our produce at the agreed prices
6. Failing to pay on time after farmers have delivered their produce
7. Decreasing or lack of trainings to farmers.

**In conclusion, the farmers had the following suggestions on the way forward;**

1. Increase monitoring frequency to farmers by Shalem Investment facilitators
2. Increase the number of facilitators per cluster so as to reach more groups
3. Collect money for the inputs from groups early enough to be used to purchase inputs and not waiting for the last minute when farmers have used their money on other needs
4. Shalem should not organising meetings on the same days of group meetings as this leaves a low attendance in group meetings leading to poor group participation by members
5. Collective group proposal of inputs purchase; indicating what the group has and what is needed to fill in the gap and collectively make purchases.
6. Identifying areas with large acres or groups with more production and send the technical staff to survey the area before the harvest and collection for better planning and execution
7. Agents to visit farmers prior to harvesting to assure farmers of buying from them
8. Increase number of agents to attend to at least all the groups
9. Cooperative coordination during collection of the sorghum to ensure all the aggregated sorghum is collected in a timely manner.

**Briefing session at Shalem offices:**

From the briefing session with the Shalem team at the Shalem offices the following was discussed using the presentation on the agent-based model;

1. The Wageningen Economic Research team presented the agent-based model – ABM, with some assumptions in mind; i.e. single crop
2. Experience-based trust evolution
3. Group trust is lost when group members default - no more loan applications by the group
4. Processor's trust in a farmer is lost after repeated defection - no more contracts for defecting farmers
5. Either independence or negative correlation between natural conditions (→ harvest) and farm gate price

The team was able to understand clearly their role as Shalem and the impact of their contributions so far, and a way forward was discussed as below

1. Strategy – Shalem can incorporate the findings of this exercise into their strategy moving forward
2. Business model- what needs to be reviewed in their current business model?
3. Inputs/training – How will Shalem further the trainings even beyond 2SCALE support?
4. Model of payment/pre-financing – how can this be improved effectively (e.g. financing farmers before planting to adequately prepare them for planting and repay after harvest?
5. Staff turnover is an issue that needs to be addressed
6. The Wageningen Economic Research team will share the updated report with the team after incorporating the discussed changes/comments.

In conclusion, the IFDC team held a final meeting with the Shalem management and planned the seasons activities based on the approved cluster action plan and budget. This activities majorly touching on agronomic trainings and capacity buildings were sufficiently aligned to fit in the period running from June to November 2017.

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