Assessing Food System Governance in Mali using an Conceptual Modeling approach

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“The world was a soup and thought was generally a fork: it seldom resulted in a good meal.”

from The Discovery of Heaven, by Harry Mulisch
Abstract

In Mali, there are two staple food ecosystems for the production and commercialization of seeds. The biggest ecosystem of the two is the peasant seed system, which is a traditional, local-based system for local seed consumption. The other system is the "certified" seed system, which is based on biotechnologically improved seeds that are grown with standards for the certification and make up higher yields. By analyzing these ecosystems using conceptual modeling techniques, among which is the i* Goal Modeling Technique, we try to analyze the ecosystems as well as the governance of these ecosystems. Based on the conceptual models we think that modeling techniques can be used to create a better understanding of the ecosystems and other insights that the modeling techniques are for, such as the value network with an e³Value Model and the governance with an i* Goal Model. We found that the models show differences between the number of conflicting goals in the ecosystems where the "certified" seed system has more conflicting goals than the peasant seed system. This could lead to more disadvantages for the upstream stakeholders who are the actors in favor of food sovereignty compared to the downstream stakeholders who are the actors in favor of food security. Lastly, we also found that it is possible to design conceptual models for the staple food seed ecosystems in Mali, even if the central agents in the ecosystem are non-digital. The exercise leads to interesting observations and a better insight into the ecosystems and their governance.
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Introducing food ecosystems in Mali

1.1 The Peasant Seed Ecosystem and the "Certified" Seed Ecosystem: two competing ecosystems in Mali.

In Mali, two staple food-producing ecosystems exist for the local production and trade of seeds (1). One of these ecosystems is the peasant seed system, which is a traditional ecosystem. The system is based on the exchange of seeds between local farmers and traders of stable food for local consumption. This peasant seed system is not centrally managed and makes up 90 to 95 percent of the seed system market in Mali (2). The other 5 to 10 percent of the seed system market is made up of the "Certified" Seed system. This difference makes a big impact in Mali, while 80 percent of the population is engaged in the agricultural sector (3). Even with an engagement this high in the agricultural sector, over 29 percent of the population in Mali is malnourished. Mali is among the poorest nations in the world, while it is larger than France and Spain combined (4). This malnutrition is by some linked to a lack of governance because only 7 percent of the available soil in Mali is cultivated and 14 percent of that land is irrigated (2). Therefore, in 2010 the certified seed system was entered into force with a common seed legislation framework to create food security (5). The seeds in the "Certified" Seed system are certified by using agrotechnological systems that create a higher yield, but a shorter lifetime. Improved seeds only breed a few generations before they are exhausted. To ensure the quality of the seeds, a certification process for the seed production and trade is put in place that is enforced by law.
1.1 The Peasant Seed Ecosystem and the "Certified" Seed Ecosystem: two competing ecosystems in Mali.

1.1.1 Differences between the systems

Currently, the two ecosystems for staple food seeds that co-exist in Mali both contribute to food production in the country. Whereas the peasant seed system has a decentralized nature and weak governance, the "certified" seed system is governed by strict regulations and carried out by a number of stakeholders. Between these systems, there are also differences in food security versus food sovereignty. The government pushes for the "certified" seed system because they want to create food security, while the farmers in the peasant seed system are mostly looking for food sovereignty. Here, food security means "availability at all times of adequate world supplies of basic food-stuffs... to sustain steady expansion of food consumption ... and to offset fluctuations in production and prices" (6). Farmers want food sovereignty, which is described by Via Campesina as: "The right of each nation to maintain and develop its own capacity to produce its basic foods respecting cultural and productive diversity. We have the right to produce our own food in our own territory. Food sovereignty is a precondition to genuine food security" (7). This means that Via Campesina thinks that food security is not enough to create a fair ecosystem for the farmers, but the food should be secured in such a way that is also fair. In our research, the actors in favor of food sovereignty will be called the upstream stakeholders, and the actors in favor of food security will be called the downstream stakeholders. To give an overview of the systems, the different characteristics are shown in table 1.1.

<table>
<thead>
<tr>
<th>Peasant Seed System</th>
<th>&quot;Certified&quot; Seed System</th>
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<tbody>
<tr>
<td>Decentralized</td>
<td>Centralized</td>
</tr>
<tr>
<td>Breeding continuously</td>
<td>Breeding for certain generations</td>
</tr>
<tr>
<td>Low yields</td>
<td>High Yields</td>
</tr>
<tr>
<td>No clearing of lands</td>
<td>Clearing of lands</td>
</tr>
<tr>
<td>Family farms, traditional production</td>
<td>Commercialized farming, technology driven</td>
</tr>
<tr>
<td>Direct, local trade</td>
<td>Intermediate purchasers and big buyers</td>
</tr>
<tr>
<td>No inputs needed</td>
<td>Expensive inputs needed</td>
</tr>
<tr>
<td>No certification of seeds</td>
<td>Certification of seeds</td>
</tr>
</tbody>
</table>

Table 1.1: List of differences between the food-producing ecosystems in Mali

1.1.2 The relation between the current struggles and governance

Looking at the list of difference between the staple food seed ecosystems, these differences can be explained as different decisions made over time. In an article about "good gover-
nance" the United Nations describe governance as "the process of decision-making and the
process by which decisions are implemented (or not implemented)" (8). When looking for
example, at the centralized versus decentralized nature of the ecosystems, this could be
called by the decisions made by the government of Mali, which is part of the governance
of the ecosystem. In order to analyze the differences and current struggles in the ecosys-
tems, we try to get to know who has the decision power and is therefore important in the
governance of the ecosystems.

1.1.2.1 Research questions

In this thesis we use conceptual modeling as a scientific method to analyze the two ecosys-
tems in Mali. We try to better understand the ecosystems, as well as the relationship
between the stakeholders in the ecosystem, and the relationship between ecosystems. Next
to that, we try to understand the decision-making power via governance and information
flows of these non-digital platforms. We assume that conceptual modeling, even when this
is a tool used to analyze and model digital platforms, should be able to map non-digitized
ecosystems. In order to address these problems, this research attempts to answer the
following research question:

RQ1: How can we analyze the governance of low-resource environment ecosys-
tems with conceptual modeling?

RQ2: To what extent can we design conceptual models for staple food seed
ecosystems in Mali?

1.2 Outlook of thesis structure

This thesis begins with a research context that is the related literature reviewed in the
context of the research. This is done to first learn more about the context and coherent
theories, followed by going into a smaller more specific context. This research is conducted
from an ICT4D viewpoint, but also multiple references are made to the current research
of W4RA1, which is the research group that is doing research in, among other countries,
Mali. The research context is ended with the contribution our research can have to the
existing literature and ongoing research.

1http://www.w4ra.org
1.2 Outlook of thesis structure

After that, the research strategies, design, and methods section will explain how we try to answer the research questions. This chapter is divided into the different executed strategies. This is then followed by the identification of stakeholders in the ecosystem, where we show the stakeholders listed by doing a stakeholder analysis. With the stakeholders listed, the next section will show the i* Goal Models of both staple food ecosystems. One is the goal model for the Peasant Seed System and the other one is for the Certified Seed System. This section will also include the connection of the Goal Model with the e³Value Model. After that, we discuss the first research question. The second research question is then answered by discussing to what extent we can design conceptual models for staple food seed ecosystems in Mali, while the conceptual models are evaluated. Lastly, the thesis will finish with a discussion and conclusion on the results.
2 Research Context

In the research context, first, the context of low-resource environments and the seed value chain in Mali is looked at. Here the existing literature about rural Mali is discussed. After that Governance and conflicting goals are discussed followed by the food security versus food sovereignty struggles. Lastly, the scientific and practical contributions of the research are discussed.

2.1 Low-resource environments

When looking at the development of ICT in low-resource environments, successful deployments are scarce (9). So when using trying to help analyze and decentralize the governance of an ecosystem, the researchers should look at the environment in which the governance is implemented. Next to that they could create an understanding of who the intended users of the ecosystem are and what their circumstances are like. Bon et al. stated in 2016 that successful deployments of ICT projects in low-resource regions are scarce (9). They also stated that end-used involvement is uncommon in ICT4D projects. When such a user-centered approach is not used, the differences between high-resource environments and low-resource environments are not taken into account, which can lead to unsustainable development. One of these differences, for example, is the low literacy in low-resource environments compared to the high literacy in high-resource environments (10). When developers of an ICT implementation do not take these situational circumstances into account, there is a chance the users can not use the implementation as it was intended to be used. When they can not use it like it was intended, there is a bigger chance the implementation does not feel user-friendly and the implementation will be less likely to be used. These cultural and social differences combined with a non-user-centered approach can lead
to ignorance of opportunities for ICT development in low-resource environments. Only when developers have a good understanding of low-resource environments, they could be of value when developing ICT implementations that could help the problems within that environment.

2.2 Context of the seed value chain in Mali

Literature shows that in rural Mali, there is still much digital inequality between actors in the cereal seed value chain (11). With problems like that existing, this could indicate that local concerns are an important factor to include when designing digital implementations in low-resource environments. Research about the use case and requirements analysis in rural Mali shows how these local concerns are weighted as an important factor (12). When looking at the seed market in Mali there are two different types of seed systems, namely a certified seed system and a peasant seed system (1). Hagglade et al. stated in 2015 that the certified seeds take up a small percentage of the market, while about 90 to 95 percent of the seeds in Mali are sold uncertified by trading instead of a monetary transfer (2). To sell certified seeds, farmers need to get their seeds certified. This process of certifying seeds by carrying out field controls is done by an organization called Labosem (11). They act as a central role in the process of certifying the seeds in the certified system. With this centralized role, some problems arise within the ecosystem concerning the evident unfairness. One of these problems, for example, is the non-transparency of the market which leads to high inefficiency (11). Another example is the lack of communication between actors in the low-resource environment, which can lead to underproduction or overproduction of seeds. These situations, and especially overproduction create a situation of unfairness for the farmers, where they were not given the possibility to adjust their effort and production to the right sales margin and have a loss they could not prevent.

2.3 Governance and conflicting goals

During this research, among other things, we will try to analyze the governance of the staple food ecosystems of Mali. As stated in the introduction is governance "the process of decision-making and the process by which decisions are implemented (or not implemented)" (8). This process applies to all stakeholders in an ecosystem. When looking at the governance, we will also try to analyze the centralized or decentralized nature of that ecosystem. The decentralization of the governance in an ecosystem is not the same
2.4 Food Security versus Food Sovereignty

as the decentralization of the ecosystem itself (13). When the governance of a system is completely centralized, a small group of stakeholders that do the decision making enjoy exclusive governance control, which makes it possible for them to shape the governance and all decision outcomes (14). When the governance of a system is completely decentralized, a big group of stakeholders collectively enjoy full governance control, which makes it possible for a bigger group to represent their perspectives and leverage their local information through governance (15). So, in order to create an ecosystem that is really decentralized, the governance of that ecosystem should be decentralized too (16).

2.4 Food Security versus Food Sovereignty

The "certified" seed system currently has a centralized governance, which brings problems for the stakeholders that are not represented in the decision making when looking at food security versus food sovereignty. With the centralized stakeholders aiming for food security, they want to achieve that every child, woman, and man has enough to eat each day (17). However, Via Campesina state that this does not say anything about where the food the people have is coming from or how it is produced. They state that the meaning of food security has been stripped of its real meaning. Instead of this food security that the centralized governance of the "certified" seed ecosystem is pleading for, they believe that people have the right to define their own food and agricultural production, which is food sovereignty (17). When involving more stakeholders, including farmers, in the governance, a decentralized governance is achieved which could lead to food sovereignty, where domestic agricultural production and trade could be done to achieve sustainable development objectives (17). Food security and food sovereignty are used in this research to create a difference between the upstream and downstream stakeholders. Here, the upstream are all stakeholders that are in favor of food sovereignty, and the downstream stakeholders are all stakeholders who are in favor of food security.

2.5 Scientific and practical contributions

With this research, we try to contribute to the insights and understanding of the governance of the staple food ecosystems in Mali, which is one of the poorest countries in the world. We aim to contribute to the Sustainable Development Goals (SDGs), especially SDG 2, which is the goal to end hunger, achieve food security and improved nutrition and promote sustainable agriculture (18). On a smaller scale, this research is also part of the W4RA
2.5 Scientific and practical contributions

program (19). A comparison between the between two staple food seed ecosystems in Mali is conducted by using conceptual modeling. With the results we try to create new insights in the staple food ecosystems and their governance in Mali, which can lead to new questions and further research about the seed value chain, the analysis of governance in low-resource environments, the i* Goal Model, or other aspects that are discussed during this research.
Research strategies, design, and methods

This research tries to answer the research questions about analyzing the governance with conceptual modeling and to what extent the conceptual models can be designed. By doing this, we hope to gain more insight into the seed production ecosystems by using a conceptual modeling technique called i* Goal Modeling which is introduced in this section, together with the research strategies.

3.1 Design Science Research

During this research artifacts are be designed that can be used by people to solve practical problems, which is a form of design science research (20). By creating an artifact and coherent knowledge in form of analyses, we use design science research for the conceptual modeling techniques. To answer the research questions, information about the ecosystem is needed, but the seed systems in Mali are not systems with a vast amount of documentation available from the Netherlands. While we try to answer how to analyze the governance of two food production ecosystems, we should know how the governance of that system is in the current state. We try to gather this information with a different set of techniques, which are given in the following sections.

3.1.1 Document Analysis

For problem investigation, firstly, we use document analysis. By analyzing the existing literature we aim to identify, evaluate and interpret the most available relevant research possible (21). The gathering of information is done with a systematic review following
the steps of the identification of research, and selection of primary studies. The content analysis of the gathered data follows up the systematic review of the document analysis with the following steps: study quality assessment, data extraction and monitoring, and data synthesis.

3.1.2 Interviews

Next to that interviews are conducted for problem investigation. To gather information from the actors in the domain semi-structured interviews are conducted with information experts who provide informative qualitative data. Two of the interviews are conducted with an information expert on the seed systems in Mali via Zoom. To create iterative research where feedback from the stakeholders is implemented throughout the process, a second interview with that Malian information expert is conducted. In order to use this information for the stakeholder analysis, this data is analyzed with an inductive approach. The form of semi-structured interviews is chosen, because of the exploratory nature of the research. While we tend to focus on the governance of the systems via conceptual modeling, we are also interested in other difficulties and pitfalls in the ecosystems, and the semi-structured interview option makes this possible. By asking follow-up questions we hope to get closer to the root of different problems that the interviewees encounter in their work within the systems. It is, however, important to note that with this qualitative data, followed by qualitative analysis, the personal knowledge of the researcher of the social context where the data is collected can be a contributing factor (22).

During the research, multiple Zoom sessions with an information expert on the DECENT Ontology and the i* Goal Modeling technique are organized to talk about the i* Goal Model and her research about the DECENT Ontology. These semi-structured interviews can help with looking at the seed systems from the perspective of the conceptual models. During the sessions, the current updates and struggles of the goal modeling method are also discussed. The information expert states that you can use three angles to look at an ecosystem. The first is from the angle of value, with an e³ value conceptual model. The second is from the angle of processes, by using BPMN modeling. The third angle is from the goal and governance perspective, modeled by an i* Goal Model.
3.1 Design Science Research

3.1.3 Workshops

During the research, with some exceptions, every Monday a workshop is conducted with Anna Bon, Hans Akkermans, and other students working on ICT4D projects. During these workshops, the progress of the research is discussed, but mainly the research topics are discussed. By coming together in a group we learn about the ICT4D projects the VU worked on, combined with information about the ecosystems where these projects were done. This way we gather a lot of information about the circumstances and this made us aware of the importance of social interaction during research. While Anna Bon and Hans Akkermans can be seen as information experts on the subject of ICT4D in Mali, they cooperate as such. This way information about the ecosystem that is not available through previously documented resources or the internet could be gathered. Via these workshops, we also got in contact with Mohamed Coulibaly, who researched the legal situation regarding the peasant seed system in Mali (1). While researchers from the VU such as Anna and Hans do have a good knowledge of the situation in the ecosystem, there is not yet a lot of official documentation for all of this knowledge. This research will also try to contribute to formally documenting the known information about the seed systems in Mali. During the workshops, the layout of the seed systems in Mali, including identifying most of the actors in the system, such as the farmers, OP, UNIONs, Labosem, agrodealers, different types of buyers, and lobbying companies are discussed.

3.1.4 Collaborative design sessions

Next to creating an understanding of the different seed systems, the workshops also function as iterative design sessions where the progress of the models and other sections of the research can be discussed. In the collaborative design sessions iteration is used to design conceptual models. Another part of the collaborative design sessions is the Developing ICT Services Framework that is used as a guideline for the created models (23). This Developing ICT Services Framework is a framework based on extensive field research Anna Bon, Hans Akkermans and Jaap Gordijn created a framework that covers the full lifecycle of ICT service innovation (23). This framework will be used throughout this research, not only to create models but also in the context and document analysis.
3.2 Conceptual Modeling

Modeling in low-resource environments, such as the staple food seed ecosystems in Mali, has something paradoxical. If there is not enough information it is hard to create a model, but if there are no models, it can become hard to find new information or insights. In order to break that cycle, a conceptual modeling technique with a exploratory nature could be used. One of these exploratory conceptual modeling techniques is i* Goal Modeling. Therefore, during our research we use the i* Goal Modeling technique to try to understand and model the food-producing ecosystems in Mali.

3.2.1 The i* Goal Modeling Language Guide

Conceptual modeling is used as an analyzing tool during our research. The specific conceptual modeling tool used in our research is the i* Goal Modeling tool. This tool is chosen to explore, among other things, the actors, goals, conflicting goals, and governance in the two food production ecosystems. The i* Modeling technique allows users to capture high-level social requirements, including qualities of these requirements and alternatives (24). Chen et al. state that most current existing i* modeling tools use a graphical manner to conceptualize i* Goal Models, which can cause a steep learning curve and scalability issues. This is especially the case for large-scale models in industrial settings (25). During our research, we will try to evaluate if this is the case by creating an i* Goal Model in a graphical manner.

3.2.1.1 Differences between the i* Language Guide and the piStar modeling tool

In a paper by Dalpiaz et al. the language guide of the i* Goal Modelling language is given (26). This guide can be used as a guideline for modeling an i* Goal model. However, for this research, the piStar modeling tool is used to model the i* Goal Model [1]. With this modeling tool, some different elements or different meanings of the elements for the goal models were implemented compared to the language guide. This section will explain the modeling choices made based on the guideline and the modeling tool.

What is the same for both techniques are the elements used to model the actors in the system. This can be seen in figure 3.1 where the actor, agent, and role of the i* Goal Model are shown. An actor is an active autonomous entity that wants to achieve its goal

[1]https://www.cin.ufpe.br
3.2 Conceptual Modeling

by exercising its know-how in collaboration with other actors \(^{26}\). To distinguish actors that need a specific naming, next to the actor element, also an agent and a role were created. The agent is an actor that is a physical being, like a human, a company, or a travel agency. A role, on the other hand, is a characterization of the behavior of a social actor within some specialized context, for example, an employee of a company. However, these definitions of the different roles do not make a hard difference between the modeling possibilities for the actors. Whenever it is not relevant to distinguish the type of actor, the generic actor symbol can be used. Only when it is important to specify a special type of actor, then a different type can be used.

Another similarity between the language guide in the research by Dalpiaz et al. \(^{26}\) and the piStar modeling tool is the use of intentional elements. These intentional elements model what the actors want in the system, which can be seen in figure 3.2. The included elements are a goal, quality, resource, and task. A goal is an objective the actor wants to achieve which can be made into something measurable. Quality is something for which the actor desires some level of achievement. An example of this could be the quality of land for a farmer. Most of the time these qualities achieve a connected goal. A resource is something that the actor needs in order to perform a task, so a resource should always be connected to a task. These tasks represent actions that need to be done mostly to achieve a goal. So they can or must be done to achieve a goal. They are modeled explicitly because this way the importance of the tasks can be shown.
3.2 Conceptual Modeling

Next to similarities are there also some differences between the language guide and the piStar tool. An example of this is that Dalpiaz et al. use actor boundaries where intentional elements are modeled inside the boundaries of an actor, whereas in our research all intentional elements are modeled outside of the boundaries because they are always modeled with a dependency \(^{26}\). So instead of showing the intentional elements that an actor has within their boundary, the intentional elements of the dependencies are modeled. These dependency elements can be seen in figure \(3.3\).

![Dependency Elements of the i* Goal Model from the piStar Modelling tool:](https://www.cin.ufpe.br)

**Figure 3.3:** Dependency Elements of the i* Goal Model from the piStar Modelling tool: https://www.cin.ufpe.br

In the i* Goal Model the dependencies model the social relationships between the actors. The half circles in the model show what way the dependency is going. The flat side of the white element shows where the dependency is coming from and the convex side shows where it is going. When one actor has a lot of dependency elements on another actor, this could mean that this actor is very much depending on the other actor. The other way around, if one actor has a lot of dependencies on multiple different actors, this could mean that this actor is important in the system.

Next, there is a difference in modeling between the language guide and the modeling tool when looking at conflicting goals. In the language guide Dalpiaz et al. do not include a possibility to model conflicting goals \(^{26}\). However, in our research, the conflicting goals can be of help when identifying unfair situations. Therefore, we use the possibility in the piStar modeling tool to change the color of the conflicting goals so that it becomes clear which goals are conflicting. So when a goal is the normal green color this means there are no conflicts, but once the color is changed, this means that this intentional element conflicts with all the elements with that same color. An example of this can be seen in figure \(3.4\).
3.3 Ethical and Legal considerations

Throughout the whole research project, ethical and legal considerations are followed. During interviews, the information experts are asked if they give consent to being interviewed and for us to use the information they give during the research. The workshops are only recorded with consent from every participant and the data will not be shared with third parties.

Next to that, the GDPR (General Data Protection Regulation, in Dutch: AVG) rules and regulations are followed. This includes the protection of personal data, and we did not...
3.3 Ethical and Legal considerations

save, share or use data if it is not necessary for our research. By conducting interviews with information experts, the name as a reference is important to acknowledge them as a source for statements or information. Therefore during our research, we name the information experts that we interviewed. Lastly, after the research is done, all data from interviews and workshops that are not necessary for future research will be deleted.
Identifying stakeholders in the ecosystem

This section will shortly discuss the acquired information from the described techniques from the methodology, after that the main focus of this section is a Stakeholder Analysis. This Stakeholder Analysis is based on the information from the literature, the workshops, and the interviews and shows all actors in the different food production ecosystems that we think are important for our research.

4.1 Stakeholder Analysis

Based on the research context, the workshops, and the interviews two lists of stakeholders in the seed systems are formed. With two different seed systems in Mali, a stakeholder list per system is made. This is done with the idea that this stakeholder analysis is the base of the $i^*$ Goal models, and to model the systems also two goal models are needed. While the seed systems in Mali consist of a vast amount of participants and stakeholders, the stakeholders used in this research are supposedly not all stakeholders that exist within the systems, however, we think that these stakeholders are most important to look at while looking at the governance of the systems within our possibilities. In figure 4.2 the stakeholders of the certified seed system are shown, and in figure 4.1 the stakeholders of the peasant seed system are shown.
### 4.1 Stakeholder Analysis

#### 4.1.1 Stakeholders in the Peasant Seed System

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Description</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer</td>
<td>Farmers who produce seeds that can be sold or traded.</td>
<td>Trade seeds.</td>
</tr>
<tr>
<td>Peasant Organisation</td>
<td>United association for farmers that helps them to own and manage their lands according to their customs and traditions.</td>
<td>Land Management and unionize farmers.</td>
</tr>
<tr>
<td>AOPP</td>
<td>A peasant network composed of more than 250 peasant organizations and agricultural trade unions.</td>
<td>Improve peasant conditions and achieve food sovereignty.</td>
</tr>
<tr>
<td>CNOP</td>
<td>Above the AOPP, the federation of national and/or regional peasant organizations that covers all the subsectors of agriculture, livestock, fishing, and forest.</td>
<td>Promote family farming.</td>
</tr>
<tr>
<td>COASP</td>
<td>West African Peasants’ Seeds Committee, civil society network engaged in the promotion and protection of peasant seed varieties.</td>
<td>Protection peasant seed variety.</td>
</tr>
<tr>
<td>NGO</td>
<td>Supports programs and farmers, and buys seeds.</td>
<td>Program support, buy seeds, and sell seeds.</td>
</tr>
<tr>
<td>ROPPA</td>
<td>Réseau des Organisations Paysannes et de Producteurs de l’Afrique de l’Ouest, regional farmers’ association of West Africa.</td>
<td>Being a tool for the defense and promotion of family farming.</td>
</tr>
<tr>
<td>Private Seed Company</td>
<td>Do seed propagation, distribution and commercialization.</td>
<td>Receive seeds and promoting peasant seeds.</td>
</tr>
<tr>
<td>Buyer</td>
<td>People, companies, or organizations that buy the seeds by trading money or other goods for them.</td>
<td>Trade seeds.</td>
</tr>
<tr>
<td>Interprofession</td>
<td>(Desired) cooperation between farmers and agrodealers, physical office where both are represented to promote the transparency of the seed systems.</td>
<td>Cooperation for more transparent contracts.</td>
</tr>
<tr>
<td>Government</td>
<td>Government of Mali that is in the peasant seed system, among other things, responsible for the legislation in the agricultural model.</td>
<td>Achieving food security, monitor agricultural process, and legislation</td>
</tr>
<tr>
<td>Via Campesina</td>
<td>International Peasant Movement, fighting for food sovereignty and for climate and environmental justice.</td>
<td>Food sovereignty and climate and environmental justice.</td>
</tr>
</tbody>
</table>

*Table 4.1: List of stakeholders in the peasant seed system*
4.1 Stakeholder Analysis

When looking at the stakeholders in the peasant seed system 12 stakeholders are included. The farmers are specified as all farmers who produce seeds that can be sold or traded because trade is an important facet of the peasant seed system. Farmers can be active in both the peasant seed system and the certified seed system. Next to the farmers that produce the seeds, some organizations help the farmers within this system, such as the peasant organization, UNION, the AOPP, the CNOP, the COASP, and ROPPA. The farmers are united through the peasant organizations, which in their turn are united in unions. These unions are also united into the AOPP, which is a network of more than 250 agricultural trade unions. Above this AOPP is the federation of national and/or regional peasant organizations, which is called the CNOP. The interprofession is an idea of the AOPP, which can be seen as a physical office where both farmers and agrodealers are represented to promote the transparency of the seed systems. Next to that is there the Via Campesina which is a transnational agrarian movement that is fighting for food sovereignty for farmers and climate and environmental justice. This shows that the peasants are unified from a national level up to a local level.

While NGOs are operating in the certified seed system, to less extent, they also buy seeds or trade in the peasant seed system. Additionally, there are private seed companies that sell or trade the seeds with the farmers and who commercialize the system. These private seed companies are also active in the certified seed system, but they do not have to offer the same seeds for both systems. The buyers in the peasant seed system can be seen as one stakeholder because there is no difference made between big batches of seeds and small batches of seeds. They buy the seeds mostly directly from the farmers, with trade as an important means of transaction, because the buyers can pay with other means than money.
## 4.1 Stakeholder Analysis

### 4.1.2 Stakeholders in the Certified Seed System

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Description</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer</td>
<td>Farmers who produce seeds that can be sold</td>
<td>Sell certified seeds, get seeds certified, achieve food sovereignty.</td>
</tr>
<tr>
<td>Cooperative</td>
<td>United association for farmers. They buy the seeds from farmers so that they can store, certify and sell the seeds.</td>
<td>Buy certified seeds from the farmers and sell them.</td>
</tr>
<tr>
<td>UNION</td>
<td>United association for the cooperatives. They promote the production and marketing of the farmer seeds.</td>
<td>Unionize farmers.</td>
</tr>
<tr>
<td>LABOSEM</td>
<td>Independent company that is responsible for the quality control of seed batches.</td>
<td>Fraud prevention and Seed Control.</td>
</tr>
<tr>
<td>ASSEMA</td>
<td>Association Semencière du Mali, an association that organizes private actors, individuals, and cooperatives on the production and commercialization of certified seeds.</td>
<td>Sell seeds to farmers.</td>
</tr>
<tr>
<td>ROPPA</td>
<td>Réseau des Organisations Paysannes et de Producteurs de l’Afrique de l’Ouest, regional farmers’ association of West Africa.</td>
<td>Being a tool for the defense and promotion of family farming.</td>
</tr>
<tr>
<td>Private Seed Company</td>
<td>Do seed propagation, distribution and commercialization.</td>
<td>Certified seed distribution.</td>
</tr>
<tr>
<td>Interprofession</td>
<td>(Desired) cooperation between farmers and agrodealers, physical office where both farmers and agrodealers are represented to promote the transparency of the seed systems.</td>
<td>Cooperation for more transparent contracts.</td>
</tr>
<tr>
<td>IPR</td>
<td>Institut Polytechnique Rural, a public research body responsible for seed selection and varietal innovation.</td>
<td>Seed selection and varietal innovation.</td>
</tr>
<tr>
<td>IER</td>
<td>Institut d’Economie Rurale, a public research body responsible for seed selection and varietal innovation.</td>
<td>Seed selection and varietal innovation.</td>
</tr>
</tbody>
</table>
### 4.1 Stakeholder Analysis

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>CGIAR</td>
<td>A global network of research centers working on emerging development issues.</td>
<td>Prevent development issues.</td>
</tr>
<tr>
<td>DNA</td>
<td>Direction Nationale de l’Agriculture. Directorate of Agriculture, checks, supports, and assesses national seed needs every year.</td>
<td>Assess national seeds.</td>
</tr>
<tr>
<td>SSN</td>
<td>Service Semencier National, national seed service, assessment of DNA goes through SSN.</td>
<td>Assess national seeds.</td>
</tr>
<tr>
<td>Government</td>
<td>Government of Mali that is in the certified seed system, among other things, is responsible for the legislation around the certification.</td>
<td>Increase agriculture productivity and promotion of &quot;certified&quot; seed system.</td>
</tr>
<tr>
<td>Small Buyer</td>
<td>Mainly farmers that want to produce food or plant and resell the seeds.</td>
<td>Buy certified seeds.</td>
</tr>
<tr>
<td>NGOs</td>
<td>Intermediate buyers. They want to buy seeds and sell them for a very low price or give them away for free to the poorest.</td>
<td>Buy certified seeds.</td>
</tr>
<tr>
<td>Agrodealer</td>
<td>Big Buyers. Agrodealers are seed traders that buy seeds in big quantities and mostly sell them in other countries.</td>
<td>Buy certified seeds.</td>
</tr>
<tr>
<td>Icrisat</td>
<td>International Crops Research Institute is a non-profit organization. They perform scientific research in low-resource areas.</td>
<td>Achieve food security.</td>
</tr>
<tr>
<td>Lobbying companies</td>
<td>Mostly foreign companies that have an economical interest in the certified seed system, which is why they exert pressure on the system.</td>
<td>Return on Investment.</td>
</tr>
<tr>
<td>Via Campesina</td>
<td>International Peasant Movement, fighting for food sovereignty and for climate and environmental justice.</td>
<td>Food sovereignty and climate and environmental justice.</td>
</tr>
</tbody>
</table>

Table 4.2: List of stakeholders in the certified seed system

The stakeholder analysis for the certified seed system shown in table 4.2 shows that there are 21 stakeholders included. Some of these are the same stakeholders as in the peasant seed system, for example, farmers, UNION, Private Seed Companies, and Buyers. However, not all of these stakeholders act alike in the two systems. Farmers in the certified
4.1 Stakeholder Analysis

system do not trade their certified seeds within that system. If they get their seeds certified they will sell their seeds most of the time to a cooperative. These cooperatives act as an association for farmers and will handle further transactions with the unions. The unions in their turn will sell the certified seeds to either small buyers like farmers that want to produce food with the seeds, intermediate buyers which are mostly NGOs, or too big buyers which are agrodealers who buy big quantities of seeds and resell this mostly in other countries. The farmers can buy the seeds that they want to get certified from ASSEMA, which is a private organization consisting of several private actors, individuals, and cooperatives that handle the production and commercialization of certified seeds \textsuperscript{[1]}. Next to that is the organization Via Campesina active in the certified seed system, they fighting for food sovereignty for farmers, but also climate and environmental justice.

There is a difference made between the buyers in the certified system because they can have different needs and intentions with their purchases. For example, NGOs will buy seeds with the intent to sell or give them to the poor. While the differences between these buyers may not look like a big deal directly from the use case or even the goal model, it is important to keep these stakeholders apart for potential further research or scope changes. In the certified seed system, there is an important stakeholder that, together with the government, can be seen as one of the most central roles in the system, namely LABOSEM. This is a company that does the certifying of the seeds and therefore a lot of actors are dependent on their approval. They act as an independent actor, however, there is a lot of governmental involvement in the process of certifying seeds. Furthermore are there some associations and organizations active in the certified system such as ROPPA and OAPI. These associations are focused on supporting the farmers with for example training on the topic of certified seed production and marketing.

With the certifying of seeds, research for that process is needed which brings more stakeholders. Icrisat is also supporting the farmers as a non-profit research institute. This international crops research institute helps by performing scientific research in low-resource environments, which gives information that the farmers can use to grow better seeds. The IPR, IER, and CGIAR are research bodies that are responsible for seed selection, varietal innovation, and working on development issues. These are all public research bodies. DNA is the Directorate of Agriculture in Mali and they help with checking and assessing the national seed. This assessment of the DNA goes through the SSN which is another stakeholder in the system. Lastly are the lobbying companies which are a merged group of
mostly foreign multinationals that have an economic interest in the certified seed system. With money invested or legislation interests, they are exerting pressure on the system to keep it or reform it in a way they can profit from it.

4.2 First step for Conceptual Modeling

In this chapter, we have acquired knowledge about the different stakeholders in the two staple food seed ecosystems in Mali. This is the first step in creating the conceptual $i^*$ Goal Models with which we try to analyze the governance of the ecosystems. Next to that did we make the goals of the stakeholders concrete, which are interwoven with their interests in the ecosystems. These goals could be of value when analyzing conflicts in the system.
With the stakeholders listed, this section will identify the relationships of the stakeholders in the systems by modeling two i* Goal Models. This is done to find correlations within and between the ecosystems. One conceptual model is created for the peasant seed system and the second model is created for the "certified" seed system and the i* Language Guide discussed in the methodology will be used for this. First, the model of the peasant seed system is given, followed by a description of the figure and the conflicting goals. After that the certified seed system model will be given, also followed by a description of the figure and the conflicting goals. Next, the connection between i* Goal Modelling and e³Value Modelling will be discussed. Lastly, an analysis of the governance is given.

5.1 i* Goal Model Peasant Seed System

The first model that was modeled with the help of the goal modeling language explained in the last section is the i* Goal Model of the Peasant Seed System, which is shown in figure 5.1.
5.1 i* Goal Model Peasant Seed System

5.1.1 Description of Peasant Seed System Goal Model

Looking at the goal model of the peasant seed system shows that the model is created with a central agent, namely the Peasant Seed Ecosystem. This is the case because when looking at the ecosystem, the actors are depending on trading their seeds with other actors in the system. Here, the Peasant Seed Ecosystem acts as an agent instead of a non-specified actor, because it is the physical manifestation of the whole system. By specifying this as an agent it is clear that this is a different role than just a normal actor. When looking at the ecosystem, there are no big dependencies of actors on each other, which means there is no strong centralized or even a decentralized system. Farmers can grow their own crops without too much interference from the government or other parties. While we focused on creating the peasant model from the perspective of the Peasant Seed Ecosystem, more
dependencies exist in comparison to what we show in the model.

When comparing the stakeholder list of the peasant system with the i* Goal Model, the LVC, ROPPA, and Interprofession are not included in the goal model. This is done for the reason that the LVC and ROPPA organizations do not interfere a lot in the system when looking at it from the farmer’s perspective. Without this interference, we think it is best to leave out these stakeholders so that the model is easier to read and understand. The Interprofession is an actor that is included in the stakeholder list, however, it is a desired cooperation of the AOPP and it is not yet fully implemented. Therefore, we chose to not include it in the model.

5.1.1.1 Governance in the Peasant Seed System

When looking at governance in the peasant seed system, we try to analyze the governance itself, as well as the centralized or decentralized nature of the system. As stated in the research context is the centralized or decentralized nature depending on the number of included stakeholders (14) (15). When looking at the governance itself, the conflicting goals in the peasant seed system can be analyzed. Two different colors from the standard green can be seen, namely pink, and blue. The pink conflicting goals are conflicting in terms of the government of the system. Here in the system, the legislation is done by the government while the farmers have a goal to the regulation of the system. These goals can conflict while the farmers who want to do the regulation can have different goals and interests in the system than the government who does the legislation. When looking at the centralized or decentralized nature of the governance in the peasant seed system, the actors can also be split up into two parties, namely the ones in favor of food security which are colored pale green, and the ones in favor of food sovereignty which are colored bright green. In the modeled system, there are 7 upstream stakeholders, compared to 3 downstream stakeholders. This leads to the blue goal dependencies of, among other things, the protection of peasant seed variety by COASP, achieving food self-sufficiency by AOPP, and climate and environmental justice by Via Campesina, conflicting with modeled goals from the government, namely monitoring agricultural practices with which they want to achieve food security. In this system, the upstream stakeholders are the majority of the stakeholders. In combination with all the conflicting goals between the upstream and downstream stakeholders, this means that, together, they have decision power to enforce a decentralized governance where all stakeholders are included in the governance.
5.2 i* Goal Model "Certified" Seed System

The goal modeling language explained in the methodology was used to create two i* Goal Models, with first the goal model of the Certified Seed System which is shown in figure 5.2. What is important to note is that the certified seed goal model is modeled after how we think the current situation is, based on the existing literature, workshops, and interviews.

Figure 5.2: i* Goal Model of the Certified Seed System

5.2.1 Description of "Certified" Seed System Goal Model

The first thing that stands out when looking at the certified seed system model is the "Certifying" Seed Ecosystem as a central agent. Same as for the peasant seed system, there is an agent instead of a non-specified actor that acts as a central role. Even with
the final certifying done by Labosem and most of the governance done by the Governance in the "Certified" Seed System, the whole certifying process is not limited to only these two actors. All stakeholders in the process are modeled with a dependency on the central system. This does create a stronger centralized system, where the actors are dependent on Labosem and the Government. However, it is important to acknowledge the fact that the actors have more intentional elements to them of which some are dependencies between each other. Nevertheless, to keep the model clear and readable, we chose to only model the dependencies from and towards the system.

When comparing the stakeholder list with the goal model, it can be noticed that not all stakeholders are included in the model. LVC, ROPPA, DNA, ASSEMA, SSN, IER, IPR, and CGIAR are in the stakeholders list but are not modelled as such. This choice was made because LVC and ROPPA are overarching organizations, which makes them stand further away from the system than other organizations they are overarching. DNA, SSN, and CGIAR are involved in the certifying process but act on such an overarching level that the inclusion of Labosem is enough to represent the certifying process from that point of view. ASSEMA, IER, and IPR are also not included in such a way that they are key elements for the goal model, because with a lot of stakeholders in the system, and to keep the models as clear as possible, we chose to not include these stakeholders in the model. Another reason for this is that these actors did not play a big role in conflicting goal dependencies, and while one of the goal models’ intentions is to look for conflicting goals, these stakeholders could be left out of the model.

5.2.1.1 Governance in the "Certified" Seed System

When looking at the governance in the "certified" seed system we can also look at the governance itself and the centralized or decentralized nature of the governance. When looking at the governance itself the conflicting goals in the "certified" seed system can be analyzed. In these conflicting goals, multiple colors can be identified. The orange goals are all conflicting goals in terms of buying and selling certified seeds. This is not a financial conflict, while a sale is always an agreement on a price, but rather on the contractual conflicts around the sales. Agrodealers and farmers reach contracts in order for farmers to know how many certified seeds they need to grow, but in practice, the agrodealers do not always follow up on these contracts, which creates a conflict around these sales. The pink goals can all be traced back to conflicting goals around fraud within the
system. Farmers can try to commit fraud in order to get their seed certified, while Labosem and AOPI try to prevent this by doing fraud prevention and defending the intellectual property rights of the seeds. The blue conflicting goals are based upon food sovereignty versus food security issues. This is where the centralized nature of the "certified" seed system becomes clear. The upstream actors who are in favor of food sovereignty are colored bright green, while the downstream actors who favor food security are colored more pale green. The actors are grouped together to see which actors have the same ambitions for the certified seed system. On the left, the lobby companies want to make a return on investment that does not take the farmers’ working conditions into account, but only the results of the system. Next to that does the government have the goals of increasing agriculture productivity and promoting the Certified Seed System. Both these goals which are depending on the certifying system, are pushing food security by going for a steady expansion of food production and consumption, instead of achieving sustainable development objectives (17). Lastly, Icrisat is doing research on crops to create more food security. On the other hand, when looking at the right side of the model, there are the upstream stakeholders. NGOs want to help farmers by buying their seeds and giving them away or selling them for a very low price. UNIONs want to create food sovereignty by unionizing the farmers which can help them to protect the cultural and productive diversity to produce their own food instead of adopting the commercialized ways of the certified seed system. Lastly, there is Via Campesina, which is an international organization that fights for the food sovereignty of peasants but also for Climate and Environmental Justice which is not looked at in the agricultural model of the certified seed system. In this system, the downstream stakeholders are the majority of the stakeholders. In combination with all the conflicting goals between the upstream and downstream stakeholders, this means that the government, together with Labosem and other companies working with or for the government, has decision power to enforce a centralized governance where only a small group of stakeholders is included.

5.3 Connection with e³Value Model

To model an ecosystem, you can look at that ecosystem from different perspectives, for example: (i) The Value Network by using an e³Value Model (ii) Information processes by using BPMN (iii) Governance by using an i* Goal Model (27). In our research we focus on creating an i* Goal Model, but we also make use of a Value Model created by another Lucas de Lange (11). In research about uncovering food security value networks in West
5.3 Connection with e³Value Model

Africa using a value modeling approach, Lucas de Lange created e³Value models of Mali’s seed value chain which can be seen in figures 5.3 and 5.4.

Figure 5.3: e³value model for the certified seed system. From Uncovering food security value networks in West-Africa using a value modeling approach (p. 32), by Lucas de Lange, 2021
5.3 Connection with e³Value Model

For this research, he focused on the certified seed system and the peasant seed system. The e³Value Model gives, in contrast to the i* Goal Model, the value network of the ecosystem [28]. It shows all the actors or market segments in a system that have a value transaction with other actors or market segments. Here, the value objects that are transferred during the value transaction can be money, but also other objects as long as it holds value for the actors. When looking at the process of certification from LaboSem, the value object they offer to the cooperative is the certification of the seed, which they trade for money. Another example of a value transaction is between the farmer and the cooperative where the farmers pay money for a subscription to a cooperative. Lastly, the e³value models show the value transfers and give answers if the stakeholders will (financially) benefit or not.

The goal of making an e³Value Model, in the end, is not only about modeling a value network. It is also done to analyze the ecosystem and question where the decision power within the system is, which is the same as for the i* Goal Modeling Technique. e³Value is also about making the value network more transparent and therefore discovering where the power is located within the system. By looking at the actors and marked segments you
5.4 Governance, Conflicts, and Differences

could trace important relevant decisions in the system. During the research Lucas and the VU team did find that cooperatives have different pricing schemes for different customers, which creates an imbalance in the system (11). This shows that the e³Value Model can also be used to out how certain actors are treating or interacting with each other. Lastly, they concluded that the e³Value modeling tool proved useful to concertize and formalize process-related knowledge, which is also the goal of the i* Goal modeling tool.

5.4 Governance, Conflicts, and Differences

This chapter tries to answer the research question of how we can analyze the governance of low-resource environment ecosystems with conceptual modeling. By looking at the conflicts between the upstream and downstream stakeholders, we found that the peasant seed ecosystem is a decentralized system because there is a majority of upstream stakeholders that, together have the decision power to enforce a decentralized system. This can be seen in the model by looking at all the conflicting goals between the upstream and downstream stakeholders. These conflicting goals also exist in the "certified" seed system, however in that system the downstream stakeholders form the majority. This means that the downstream stakeholders here can force a centralized majority where the farmers are less included in the governance. Lastly, we also found that
Evaluation of Conceptual Models

With an analysis of the governance of low-resource environment ecosystems with conceptual modeling done, we try to evaluate the designed conceptual models in this research. This section will try to answer the second research question, by first looking at the conceptual modeling techniques itself, followed by an evaluation of the i* Goal Modeling technique how it has been helpful with analyzing the ecosystems and their governance.

6.1 Conceptual Modeling Techniques

To answer the research question of to what extent we can design conceptual models for staple food seed ecosystems in Mali, we first look at the i* Goal Modeling technique and the e³Value Modeling technique itself,

6.1.1 i* Goal Model

During the process of designing an i* Goal Model for the staple food seed ecosystems in Mali, we found that the ecosystems are not very transparent or the information is not easily accessible from other countries like the Netherlands. With the information that is hard to access or not well documented, the intention of the i* Goal Model is to create a better understanding of the governance of the systems by modeling the actors, their goals, and the dependencies of these goals. The i* Goal Model proved useful for modeling the stakeholders, their goals and the conflicts in these goals. By doing this we could design two fairly extensive i* Goal Models, where the models point out differences between the systems. For our research, we used non-digital systems as centralized agents instead of digital systems for which the i* Goal Modeling Technique is intended. This did not turn out to be a problem in the scope of our research.
6.2 Conceptual Model Evaluation

6.1.2 e³ Value Model

The e³Value models shown in figures 5.3 and 5.4 created by Lucas de Lange are divided into an improved ("certified") seed system model and an unimproved traditional (peasant) seed system [11]. In his research, he concludes that, due to difficulties partly belonging to low-resource environments, the e³Value model was not quantified [11]. However, the intention of the e³Value Model is to model and to better understand the value network of the ecosystem. For the context of the staple food-producing ecosystems in Mali the models were designed successfully to do this to a certain extent, where even without exact quantification, the models could be used to calculate with fictitious numbers to explore the value network of the ecosystems. Therefore, we think that you can design conceptual models for the staple food seed ecosystems in Mali for analyzing the ecosystems as well as the governance in these ecosystems.

6.2 Conceptual Model Evaluation

The process of creating these i* Goal Models for both ecosystems during our research did not only produce two conceptual models, but also more insights in the ecosystems. This section will clarify how the i* Goal Models as well as the process of designing the i* Goal Models provide insights in the ecosystems when designing the models.

6.2.1 Visualization

First, the i* Goal model proved useful to visualize the ecosystems. With ecosystems in Mali that are not documented extensively, visualization could help to better understand the ecosystem as well as the relationships between the stakeholders in the ecosystems. This can be of help for researchers, but also for stakeholders in the system to better understand the environment they are operating in. With different stakeholders having different perspectives on the ecosystems, a visualization of the ecosystems could help to create an objective view where the stakeholders all have the same perspective [29]. Next to that does the visualization make it easier to reason about the ecosystems and to find correlations between goals of stakeholders.

6.2.2 Insight in Governance

One of the subjects to reason about when looking at the visualization of the ecosystems via the i* Goal Modeling Technique is the government of the ecosystems. The i* Goal Modeling
6.2 Conceptual Model Evaluation

Technique is used to analyze the ecosystems including their (in the case of Mali) current centralized governance in the "Certified" Seed Ecosystem. For analyzing the governance in an ecosystem, the conflicting goals can be of help when looking at the centralized versus decentralized nature of the governance. When creating the i* Goal Models in the different ecosystems the goals of the stakeholders have to be clarified, which gives more insight in the interests of the stakeholders with which it is easier to find, if existing, conflicting goals. It is hard to directly derive the type of governance from the visualized models, because of the way the i* Goal Models are modeled, with a central digital, or non-digital, system. However, while it is hard to directly see the type of governance directly back in the models, the conflicting goals show which stakeholders are conflicting and which stakeholders have the same goals and interests.

6.2.2.1 Upstream versus Downstream

With these conflicting goals showing the conflicting and matching stakeholders goals, the i* Goal Model proved useful for visualizing and analyzing the upstream and downstream stakeholders. In the staple food seed ecosystems in Mali, the upstream stakeholders are the actors that are in favor of food sovereignty in the ecosystem, while the downstream stakeholders are the actors that are in favor of food security. By clarifying the goals of the stakeholders, the i* Goal Modeling technique, in the seed ecosystems in Mali, can help with identifying if a stakeholder is upstream or downstream. By creating these two types of stakeholders this, again, helps with analyzing and creating more insights in the governance of the ecosystems.

6.2.3 Right to seeds and legal mobilization

Lastly, the conceptual models could hopefully be of help in the discussion around the legalization of the peasant seed system in Mali, which is discussed in research by Coulibaly et al. They state that the peasant seed is not yet officially recognized by the government, which is not only the case in Mali, but also in other African countries. By analyzing and visualizing the seed ecosystems in Mali, a new perspective on the importance of the decentralized peasant seed system could be created, which could hopefully be of help in the process of legalizing the peasant seed system in Mali and other countries.
6.3 Usefulness of the design Conceptual Models

In this chapter we answered the second research question by looking at the i* Goal Models and analyzing to what extent these models proved to be of value for the seed ecosystems in Mali. We stated that the models are useful to visualize the ecosystems which can be of help for researchers as well as for the stakeholders working in the ecosystems. We also think that the models are useful for new insights in the governance of the ecosystems based on the conflicting goals and the differences between the upstream and downstream stakeholders where the peasant seed system shows a decentralized governance and the "certified" system shows a centralized governance. Lastly do we hope that the models could be useful for further action in legalization of the peasant seed system in Mali and other African countries by showing the importance of a decentralized system for food sovereignty.
7

Discussion

This research has tried to analyze the staple food seed ecosystems in Mali by using the i* conceptual modeling technique. The exercise in this research leads to interesting observations and a better insight into the ecosystems and their governance. In this section we will first discuss the observations about the staple food seed ecosystems in Mali, followed by observations about the i* Goal Modeling Technique. Lastly do we discuss possibilities for future research based upon our observations.

7.1 Observations on the Seed Ecosystems in Mali

By using the conceptual i* Goal Modeling Technique, we analyzed the staple food seed ecosystems in Mali. This showed that in Mali the different ecosystems of the peasant seed system and the "certified" seed system have different quantities of upstream and downstream stakeholders. The "certified" system, which is pushed by the government, has more downstream stakeholders which makes it possible for these stakeholders to create a centralized governance where a small group of actors have a lot of decision power. In the peasant seed system, there are more upstream stakeholders. With that majority the upstream actors have the power to keep the governance of the ecosystem decentralized so that every party has some decision power in the ecosystem. With that decentralization of the government food sovereignty is easier to achieve with a centralized governance where the stakeholders in power push for food security.

7.2 Observations on i* Goal Modeling

We observed that the i* Goal Model is a suitable conceptual modeling technique for the staple food seed ecosystems in Mali, while it has exploratory intentions and the ecosystems
7.3 Future Research

In our interview with the information expert of the seed system in Mali, he mentioned that the problems that are currently going on in Mali also happen in other (African) countries. Currently, not a lot of African countries have officially recognized their peasant seed system. By looking at the upcoming approved seed policy in Mali as a pilot, the same process of analyzing the peasant seed system and its governance of that system could be done in other countries too. In collaboration with Malian researchers, such as Mohamed Coulibaly, the level of understanding and documentation of the seed systems in Mali could be improved. By doing this the models could be improved, as well as the insights into more possibilities. Lastly, we think that further research could look at the possibilities of the conceptual modeling techniques to help decentralize the governance of a system. The models we created are based upon the current situations in the ecosystems, but by using the models in the right way they possibly could also be used to show how the governance of an ecosystem can be, for example by decentralizing centralized governance.
Conclusion

This research tried to answer two research questions about the staple food seed ecosystems in Mali. The first research question we tried to answer is: "How can we analyze the governance of low-resource environment ecosystems with conceptual modeling?"

Based on our findings, we think it is possible to analyze food production ecosystems and their governance in Mali by using conceptual modeling. Using the conceptual models to visualize the ecosystems could help to better understand the ecosystems as well as the relationships between the stakeholders in the ecosystems. We think that modeling techniques can be used to create a better understanding of the ecosystems and other insights that the modeling techniques are for, such as the value network with an e³Value Model and the governance with an i* Goal Model. We also found that the modeling techniques can also be helpful to uncover and analyze the staple food seed ecosystems in Mali, while during the process of modeling a system, information about that ecosystem is also acquired and documented. We found that the differences in food security and food sovereignty can influence the governance of an ecosystem, while the models show differences between the number of conflicting goals in the ecosystems. More conflicting goals in the "certified" seed system compared to the peasant seed system can lead to disadvantages for the upstream stakeholders in relation to the downstream stakeholders, where the upstream stakeholders are the peasants and other actors in favor of food sovereignty and the downstream stakeholders are the government and other actors in favor of food security.

The second research question we tried to answer is: "To what extent can we design conceptual models for staple food seed ecosystems in Mali?"
We found that it is possible to design conceptual models for the staple food seed ecosystems in Mali. With information that is hard to access or not well documented in the seed ecosystems in Mali, the intention of the i* Goal Model is to create a better understanding of the ecosystems and the governance of these ecosystems by modeling the actors, their goals, and the dependencies of these goals. The i* Goal Models created during this research were extensive to the point that the governance decisions of the ecosystems could be derived from the models where the differences in upstream and downstream stakeholders combined with the conflicting goals showed where the decision power within that system was. The models did show some differences between the systems, and by adding new features such as variable sizes for actors to show the differences in quantity the i* Goal Model could be able to visualize these differences even better.
References


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Appendix

8.1 Interview Mohamed Coulibaly, 14-4-2022

Q: Are you okay with me recording the interview? A: Yes
   Q: Are you ok with mentioning your name in the thesis? A: Yes, no problem you can use my name.
   Q: Do you want to receive the final version of the thesis? A: Yes
   Q: I read the research you were working on together with some other people about The Right to Seeds and Legal Mobilization for the Protection of Peasant Seed Systems in Mali. I think it is really interesting and wanted to ask some questions about it. The research says there is a disconnection between the local context and the legal and policy frameworks. What does the governance look like now? Is there a big difference between the peasant seeds and the certified seeds?
   A: Yes, I think it is quite the same, since we have published this paper there hasn’t been any big progress. The only development that happened was the validation of the new (peasant) seed policy that has not yet been adopted. So it’s not official yet, it’s still in a draft format. But at least in this draft now the peasant seeds are recognized. And this is the beginning of the kind of formalization of these peasant seeds.
   Q: How are these seeds recognized?
   A: Well, first of all the seed policy mentions a seed policy system as a component of the Malian seed system in general, because before we used to have one single vision for the seed system which is only recognized on the commercial seeds system. Meaning the formal seed system. Somehow the peasant system was set aside, not criminalized like in other countries but at least not mentioned in the law or supported by the government. All the focus was on the formal, commercial seed system. So now with the push of the peasants and the support, we have in the making a new seed policy that formally recognizes the seeds and seeds system and the rights for peasants to produce their own seeds and share in their own networks. This is a big step for peasants in Mali.
Q: There were problems that arose because there was no governance? Did farmers have problems with selling their seeds because there were no rules?

A: No in practice there was no application or restriction of peasant seeds of sharing and selling. This can be explained by looking at two main things. The first thing is that we had a seed law that dated from 1995. That was quite the first seed law which indirectly prohibited the production of peasant seeds. Since then from 95 to 2009 when the new seed law was adopted, there has been no restriction or prohibition even if the law said so. Peasants could do as they wanted. But in 2009 a new law was adopted which kind of moved the restriction. This was the beginning of the recognition of saying the traditional seed belongs to the national heritage. It’s free for anyone and anyone can use it. But at the same time they were not concretely recognized as seeds per se, because the formal system has the standards and the criteria to meet. Besides that, peasants continued to do whatever they wanted with their seeds. So they wanted to go out of this informality, they didn’t want the tolerance anymore but an official recognition and based on this recognition, some support from the state, the same as the commercial system gets support from the state. So this is the new turning point now in the seed ecosystem in Mali.

Q: If they acknowledge the peasant seed system, do you think there should also be laws specially for this system?

A: That’s a good question, because there are two tendencies even within themselves. Some want just the recognition and the permission for farmers to do what they want. But some are saying let’s have a law that clarifies all the laws, the do’s and the don’ts so that they get enough flexibility to organize the way they want. I think the majority including legal experts are saying that the second option is the best. At least a form of law in the existing law that clarifies all that farmers can do or what others can not do to protect the farmers. So a clear legal ruleset would do.

Q: Is there a clear legal framework for the certified seeds?

A: Exactly there is, and this is exactly why we said there should also be one for the peasant seeds. Even if it is not developed the same way. It should clarify the key elements of the seed system and the key elements of what is prohibited.

Q: Do you think that the legal framework of the certified seeds could be of help to create a legal framework for the peasant seeds, especially when looking at the things that go wrong now in the certified seeds like power imbalances?

A: Exactly, a current initiative of the AFSA (https://afsafrica.org/) , this is not in Mali, but it will come to Mali. AFSA is the Alliance Food Sovereignty Africa. They are developing a legal framework for the protection of the peasant seeds systems. The
methodology of the approach was to take the already available legal system of the certified seeds and see the architecture of this law and see if they can use this to fill the peasant seed legal system. I have participated in this endeavor and I think this is a good approach. They have changed a lot in the legal framework but they used the existing one of the certified seeds. So now we have sent this to all organizations throughout Africa for their own advocacy and for the activism of the legal framework for the peasant seed system. Mali was kind of the precursor in that we inspired others with the case in Mali, including this legal framework.

Q: And who makes the laws in the legal system? Is it the government or do the farmers have some say in it?

A: I want to say the government makes the law. They have the monopoly or leadership on it, but it is participatory and everybody participates. The main stakeholders are farmers, but I think there is a subquestion in your question. You speak of the law, but I think there also developed standards and rules. These can be determined by farmers. How to circulate the seeds, how to guarantee the quality of the seeds, who can access and who can not. So these are the two levels of intervention. The first one is the law, the second the framework where people can now undertake their own activities. Yes we want the involvement of the state, because they can be a duty bearer. But the second level is the development of rules and standards.

Q: And also the regulation of these rules and standards?

A: Exactly, this is something that these farmers can do for themselves. And I think the law should also recognize this autonomy of the farmers. For example for AFSA, they say that the definition of the peasant seed system is the set of rules that farmers developed autonomously. If the state recognizes this as the definition, it means that it is possible to have autonomy in the hands of the farmers.

Q: And then the farmers work together to set up these rules?

A: Yes, farmers across the country can join regional communities or groups, and each region could have its own small autonomy. But at some point, there could be national gatherings to share the initiatives and rules to list and set up a national standard. The state could attend these meetings but only to accompany and support them, financially and with research. We want more interaction between farmers and the national research institutions. This support from the government helps with food security and food sovereignty. We also try to use some international standards in the laws, like the declaration of peasants’ rights and also the plant seed treaty, and biodiversity conservation.

Q: And there are also unions that support the farmers, right?
A: Yes there are different types of organizations that support the farmers’ rights. There are unions, associations, and cooperatives and all could find themselves in a way on the national level. They are all participating, although it depends on the product and what type of organization you find. They work together for the adoption of the law or the policy.

Q: We think that with the creation of laws and decentralizing the governance there could be a less unfair ecosystem. We know there are unfair situations between farmers and agrodealers where agrodealers make contracts with farmers but do not follow up on these contracts. Do think there are unfair situations in the current ecosystem?

A: I’m not sure I understood the Agrodealer and farmer relationship but I know at least the law that will be adopted will make it fair for everyone. It will also give some power to farmers to organize themselves. It will venue for complaints and awareness and it will make it discussable on a national level so that the agrodealers are not that powerful anymore if the framework is in place. But at the same time, the buying and selling of seeds depend on the quality of the seeds. So farmers among themselves may share their seeds. There could be issues of catastrophes or lack of money. The fact that this possibility is there for them will protect some of them. But from a farmer to an agrodealer is kind of a trading system and for trade, there is the issue of quality. So if a farmer does not meet the quality standards the agrodealer may not accept it. This issue is also organized in the certified system ut we want to give the rights to farmers to set the standards of the seeds to make sure that the quality is accepted at the national level. And based on those standards they can trade.

Q: The quality level is good to look at, now it feels that the agrodealers can say if a seed is good enough or not, but if the farmers could do this it would become less unfair.

A: Yes, but I do think this is a little bit tricky because we are trying to put two subsystems together, namely the certified seeds where the standards are known and certification is done by a research institute, and besides that the peasant seed system that has its own standards for seed quality. Which will be determined by farmers themselves. So we have two systems, and we are given the choice for those interested in seeds. The standards of the two systems will not be the same and we should not be comparing those we are producing in the peasant system with those who are producing in the certified seed system. Then the agrodealers have a choice between the different systems and know what they are looking for. This levels the playing fields but also gives the choice to everyone. This encourages the coexistence of the two systems. There were also the issues from when we were beginning the advocacy for the recognition of the peasant seeds system that some wanted to combat the certified seed system and others said no, let’s just leave them alone and do our own system. So
if the coexistence is there, there is a choice. Then in an agrodealer want certified seeds, he can go for that, and if a farmer does not produce that he may be less favorable in this situation.

Q: If two systems coexist and the laws and rules are different, how do you make sure that one of the systems is favored more? How are you going to make sure that not everybody chooses one?

A: The standards and vision of the systems are not the same so one is not better than the other. So we can’t compare them and we can’t say one system is above or better than the other. Farmers should choose the system that they see fit. The standardized certified system is there but has its own limits. We know also the advantages of each system so anybody can make an informed decision.

Q: So there is a difference in governance between the systems where the farmers in the peasant seed system are more autonomous?

A: Exactly, and this can be seen as two governance systems. It’s one governance, but with adapted rules for each system. Seeing the peasant seed system as a different system that needs different rules and different types of governance. That’s why we said we need a different law that will specify what are the rules for the peasant seed system. This will not mean it will be underqualified or less good than the certified seeds. We just want to capture it in the law to make it official and also be looking at what interaction can be regulated between the two systems. If a seed comes from the peasant seed systems there are no rules for example if someone puts intellectual property rights on it. There should be some rules to kind of govern the interaction between the two systems.

Q: Can there also be farmers who are in both systems? In the certified seed system and in the peasant seed system?

A: Yes that can happen, because for example PP, which is a peasant organization in Mali, used to do both. At some point, they were doing the production of certified seeds, while the organization consists of farmers. So these farmers produced their own uncertified seeds, but for the organization, they created certified seeds. And they can do both if they can follow both rulesets of the systems. That’s why I said the choice is given to people and you can try to do both. The certified system is all about trading and commerce, but in the peasant system, there are the issues of agroecology, healthcare, climate change adaptation, and food sovereignty. So there are many objective why you would choose one system or another, or you could choose to be in both systems. But you have to know that the two are not compatible. You can not use the same fields for the two systems. You have to have a seed production field for the certified seeds, whereas in the peasant system
your own production field is also your seed production field, you are creating food but also selecting seeds from this field. That’s why these systems are not the same and why they need different standards and that is what we are trying to do.

Q: In the certified seed system a lot more people and organizations are involved, because of the rules, is that correct?

A: Yes, that’s correct. This is because it is kind of segmented. There is production, there is distribution, commercialization, and certification, and there are a lot of different steps like a value chain. But with the farmers’ system, you have only farmers and maybe researchers that help them. But farmers are at the beginning and the end of the system, whereas in the certified system you have producers, who can be anybody with validation, and researchers that set new varieties, certificates, and distributors.

Q: Do you also think that there are more conflicting goals because there are more actors in a system?

A: No, in the certified system it is organized in such a way to avoid conflicts, that why I said it is segmented. That’s why you have to act in one of these segments. Either you are a producer, or you are a distributor or in certification. But there are cases where you can be both producer and distributor, but there is no conflict. These conflicts arise only when farmers do not see their interest in it or when their rights are violated. If they are not allowed to do certain things.

Q: And instead of seeing conflicts are arguments, but more as conflicting goals, in a way that actors want something different from a situation, does that make you think of something?

A: The goal for farmers by claiming their autonomy and own rules for their system is to not depend on the system, which conflicts with the interest who favor the certified seed system. This is because they want to earn more money and privatize the certified seed system. Sometimes the government does not per se have an interest in one system or another and does not know how to situate itself, because sometimes it is influenced by big organizations in the certified system who think that only the certified system will work. Some are saying we want to transform African agriculture by commercializing it. So they are making it an industry model of agriculture where the seeds are made by highly standardized methods. But at the same time there are farmers who say no, we don’t want that. We want our own rules and our own food sovereignty and the government and researchers to support us. Myself I situate myself in the latter so we try to say, the green revolution model is not what we need in Africa. So overall the two systems are in conflict in terms of goals and vision, sometimes farmers see the certified seed system as a threat
8.2 Interview Mohamed Coulibaly, 16-6-2022

...to their own system. Because of this system, when it’s there it can kind of push to be generalized. This pushed farmers to disappear from the seed production and this illustrates the conflicts that you stated. Now the solution could be that there are laws and rules that officially recognize the peasant seed system. This means that now the peasant seed system is a component of the seed system. Second, by putting content into it by asking questions like what is the peasant seed system, it becomes known. The law will protect the system indirectly, because it puts power in the hands of farmers, stating they exist officially and stating the laws that they have, which is a good thing. That’s why you see in some laws it is prohibited to produce peasant seeds because then they are putting themselves in danger somehow. So this is what we are trying to do, trying to find out what are the loopholes.

The word that we use is “defining”. We are trying to define the certified seed system and the laws that accompany them and we try to remove all the teeth from this system. So it may be a solution to reduce the conflicting goals between the two systems to protect farmers because they are the ones that need to be protected.

Q: That’s interesting to look at the conflicting goals between the systems too. Now with the peasant seed system being allowed, but still without a government, this may be a good time to look at what is working and what is not working in the certified system and how can we use that to create a good peasant system.

A: Exactly, and if you go beyond that to see the bigger picture the agricultural model can be used. At some point, you can look if you can use this in your reflection. For example, what is the agricultural model for a developing country like Mali? Why are we pushing for certified and commercial seed systems? Are they adapted to the context? Who is pushing for this, and what are their interest and goals? But at the same time, what is the reality in the field? Why are farmers resisting this system? And what are they proposing? Can these systems even coexist? Maybe is the peasant seed system the only needed system?

8.2 Interview Mohamed Coulibaly, 16-6-2022

Q: Are you okay with me recording the interview? A: Yes

Q: Last time we spoke about the fact that you and others were creating a draft that is designed to recognize the peasant seed system in Mali. Is there any progress in that process since the last time we spoke? And also in what time span do you think that such a draft could be implemented?

A: Yeah I think it will be only months because now the draft is being validated in the workshop. This is not specifically for the peasant seed system, it is a revision of the full
seed policy in Mali. There were no sections on the peasant seed system in there so this is what we inserted in the draft policy for the official recognition and the key elements of how we can promote it, and how the state can support it. This is now done and for us the content is now good enough, and we also organized the national validation workshop and the policy was validated with the stakeholders and now it is sent to the government for adoption which is the last step. This will take maybe 2 or 3 months but it will hopefully be adopted. After this adoption there will be some room to revise the law itself.

Q: We also spoke about the autonomy of the farmers and how that is important in the peasant seed system, is that also included in the draft policy?

A: Indirectly it is, by making the peasant seed system a component of the seed system you recognize the autonomy of the farmers. Now peasants can organize themselves for seed production, distribution and conservation. These are the key elements of the system and this is what we inserted in the policy to say yes farmers have this liberty and the law can give the full details on how the state can protect their rights and make others respect those rights.

Q: If you recognize it like that, this system is still centralized in a way that the government makes and regulates the laws right?

A: Exactly, the state will make the laws, so we can’t go any other way. But by having an official framework in place farmers could then maneuver within that framework the way they want.

Q: The DECENT Ontology makes a difference between legislation and regulation. This could be used to create some point of certification without the need of a central governance of the system, where farmers for example can do the regulation of the rules. Is that something that you think could work?

A: There is even more than that, because the standards are not developed by the state, but by the farmers themselves. We are advocating for a legislation in place for farmers to organize themselves the way they want in their seed activities. This is like an enabling environment for farmers and then farmers themselves will come together, because they are already organized in national and regional associations up to the local level. Within those networks they can now work on the standards. The seed quality standards are already known, the key steps in production are known. But now for seed distribution and seed acces some rules need to be implemented. It is also important to know what the key mechanisms are. Because farmers have different rules for this. The only thing that the state will be doing is make some obligation for some public research institutes to support farmers seed activities, for example, to put in place some collaborative research programs,
to use farmers criteria and demands in research objectives. If a farmer has problems with certain pests problems for example, then the institute can support them with funding from the state. This is a full system we want to put in place in parallel with the certified seed system, which will continue to exist. So yes, there will be framework legislation in place but the state will not interfere with farmers creating their own standards, their own rules and things like that.

Q: If farmers have their own standards there could be a lot of differences between the seeds of these farmers. Do you think that integrating a standardized quality measurement system would be something farmers are interested in if they could do this with the same autonomy?

A: Exactly, seed rights is a collective right and not an individual right. So farmers have to come together if they want to survive and they have to work together. And this is they are proposing some type of participatory guarantee system to have their own rules and to guarantee the quality of their seeds. If this is put in place by farmers themselves, and if they accept to be part of it, and they accept the rules there will be no obstacle for them to access quality seeds produced by themselves. It doesn’t have to be an individual deciding on what types of seeds they want to have, but a network will decide and farmers have to align themselves with that network. And I think this is the way they are going to, because I have not seen any farmers that would like to be individually deciding on their own seed quality standards.

Q: Another topic from the last interview was the agricultural model, could you explain a bit more about that?

A: The idea behind this is that this agricultural model is the vision of agriculture. So now we know that at least two types, we have the greener pollution type industrial agriculture, but there is also the family farming system that is not using chemicals in everything. So in Mali, and in many other African countries, we need to have a clear vision of what type of agriculture we want to develop in that country. And that type of agriculture should also be in line with the context, the culture, and with the habits of people in that country. My understanding, and also the general understanding in the literature, is that the industrial and commercial type of agriculture is not what is needed in Africa. We need to develop these family farming systems that are already available in many countries. Because when you do commercial agriculture, it will just be in the hands of multinational companies and the family farms will disappear. So people who are not used to being farmers anymore will migrate to the cities which causes new problems. So agriculture is also a way of giving people jobs. So these agricultural models are also a political view and we want to say that
Mali needs to have their vision on what type of agriculture they need, but unfortunately what we see is immigration towards commercial and industrial agriculture. But there are a lot of failures with this because it is not adapted to the context of the country. We should build on what we have and a peasant seed system is in line with the family farm agriculture. Some states have already put this in their laws, where they state that food sovereignty is the agricultural guideline in Mali. Which means we are not for industrial agriculture in Mali. That is by law, but in the field we are doing the complete opposite of this and the systems are commercialized.