

LEI, part of Wageningen UR

Final report

Economic risk analysis of agroparks

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This final report is for the general public.

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Project information

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Preface

This final report summarizes the work performed during the scientific project “Economic risk analysis of agroparks” commissioned by TransForum Agro & Groen (TransForum). The aim of the project was to develop a generic framework which can be used to quantify economic risks of agroparks.

Given the complexity of the agropark concept, this project represents an extremely challenging undertaking. As described in this report, economic risk analysis of agroparks touches upon almost every aspect of agropark development: technology, organization, financing, marketing, management, stakeholder relations, social embedding, legal approvals, etc. A generic framework must consider both the theories and practicalities of these aspects, which is a daunting task. We would like to thank Dr. Henk van Latesteijn and ir. Karin Andeweg from TransForum for their guidance and support from inception to completion of this project. Their experience and overview of various agroparks were of vital importance in shaping the results of this research.

The project team would like to thank all participants in this project for their contribution to the development of the theory and methods for risk analysis of agroparks. In particular, we would like to thank the entrepreneurs and project manager of the New Mixed Farm who have shared with us their vision and motivation in participating in agroparks and provided us the empirical information needed to develop the risk model.

It is sometimes said that risk analysis falls just short of rocket science. To illustrate the importance of economic risk analysis of agropark projects, we may refer to the following quote:

“You want a valve that doesn’t leak and you try everything possible to develop one. But the real world provides you with a leaky valve. You have to determine how much leaking you can tolerate.”

- Arthur Rudolph, Saturn 5 Rocket Scientist

If an ideal agropark is a valve that doesn’t leak, risk analysis is an essential step in determining how much ‘leaking’ an agropark project can tolerate. We trust that the results of this research would serve this purpose well.



General Director LEI Wageningen UR

January 2011, The Hague

Executive summary

Research problem and objectives

An agropark is envisaged as a spatial cluster of agricultural-related functions, which aims to apply the principles of industrial ecology in the agrosector. As a system innovation, the concept of agropark is accompanied by a multitude of uncertainties concerning technological, market and institutional developments in the future. These uncertainties present risks to the concept as an integral design as well as to potential stakeholders of an agropark as an individual actor. Lack of insights into the economic risks of agroparks made it difficult for stakeholders to decide whether or not to initiate or participate in agropark projects.

The objective of this research was to systematically identify and analyze risks of agroparks. The project aimed to develop a generic framework which can be used to quantify financial and economic risk of agroparks. Based on the framework, a risk model would be built and applied to an agropark being developed or to be developed.

Research approach and processes

The research combined desk studies (literature study, data collection, and stochastic modeling) and field studies in the form of survey, interviews and workshops to obtain subjective information. In particular, two Group Decision Room (GDR) sessions were organized to make an inventory of risk factors and possible risk management strategies.

The project proceeded in five phases, each with different focus and activities. Phase 1 was the preparation phase, followed by problem analysis in phase 2, design of qualitative risk analysis instruments in phase 3 and design of quantitative risk analysis instruments in phase 4. Phase 5 was the finalization phase. The practical agropark cases studied in this research were planned before December 2009.

The focus of the second phase was a problem analysis in which the primary task was to delineate the agropark concept. Bearing in mind that the agropark concept can be implemented in many different forms in different technical and social-economic settings, great attention was paid to the common issues and systemic risks in terms of their generality. In the third phase, relevant theories for agroparks were identified and analyzed to set up a generic framework for risk analysis of agroparks. The framework contains qualitative description of key issues and risks of agroparks. This has resulted in a scientific paper on the nature of agroparks.

Developing a risk model for quantifying risks of agroparks was the main task of the fourth phase. Consider the complexity of the agroparks and different phases of agropark developments, a step by step approach was developed. The primary method used to quantify risks was Monte-Carlo simulation in combination with fault tree analysis. In the final phase, technical documentation was made with the intention to make the modeling approach applicable to future agropark projects.

The data for the risk models were retrieved from statistical databases such as the CBS, Eurostat and Farm Accountancy Data Network (FADN) of LEI, part of Wageningen UR.

Data on key agricultural sectors were also collected from scientific and empirical publications. Elicitation of subjective parameters was combined with the GDR-sessions.

Key results and findings

The research has resulted in two scientific papers, a set of checklists, a risk model with documentation, and a PhD proposal which was submitted to grant institutions. The research project has also contributed to two MSc theses on agroparks, one analyzing the institutional challenges and the other performing a stakeholder analysis. The project has built a large set of literature resources and database concerning project planning, capital budgeting, technical performances, and risk management strategies of agroparks. The overall approach is summarized in a popular brochure entitled “Risk Management of Agroparks (RiMAP): A step by step approach”.

The first scientific paper, entitled “The Nature of Agroparks: Synergy versus Risk”, describes the analytical framework for evaluating the synergy and risks of agroparks. The theory of New Institutional Economics (NIE) was used as a vantage point to look at the institution cost of agroparks and its impact on the success or failure of agropark formation. The framework provides a useful checklist for agropark design and planning. Based on extensive literature study on theories and methods relevant to agroparks, a PhD proposal entitled “Risk management and institutional design of agroparks” was developed which focuses on the importance of institutional arrangements in managing the risks of agroparks.

The project has made a number of findings which may offer better insights into the challenges facing agropark projects. First of all, for many agropark projects it was difficult to make a well-defined project plan in conceptual planning phase with clearly specified budget, operational goal, and the time frame of the desired agropark. Second, implementation of agroparks can face a chicken and egg dilemma when it comes to institutional design: on the one hand, a well-defined institutional design is needed to make investors committed to the project; on the other hand, committed stakeholders are needed to specify the institutional arrangements. As a result, formation risk is likely to be the major risk of agropark projects.

Lack of institutional design impedes meaningful economic risk analysis of the synergy and risk of agroparks as the incentives offered by the agropark concept depend on the institutional arrangements among the stakeholders. Last but not the least, the process of planning and implementing an agropark can take many years before the concept is fully realized. Risk analysis should therefore be regularly updated to take into account new information.

Recommendations

Based on the results and findings, it is recommended that the analytical framework for risk analysis be integrated into the design and planning phase of future agroparks and the underlying principles of risk analysis be communicated to various stakeholders. When evaluating agropark plans, it is important to assess the formation risk, organizing costs and the impact of different institutional arrangements in the specific context.

Key learning points

From a scientific point of view, the key learning point was the use of New Institutional Economics (NIE) in analyzing the synergy and risks of agroparks. The NIE paradigm provides a useful vantage point to view how institutional factors determine the success or failure of agroparks. The theoretical challenge is to further characterize the institutional design which strikes the optimal balance between the gain from cooperation and the cost of institutionalizing such cooperation. Focusing only on the possible gains from cooperation would result in too optimistic views of its viability, but shed no light on the challenges of the agropark concept.

From an empirical perspective, it was learned that the ideal agropark depicted in various master plans of agroparks requires conditions that can differ from the practice. The design and planning approach should therefore start from identifying the divergence between the theoretical conditions and the practice. In particular, the institution cost of the agropark concept must be assessed in an early stage of the agropark planning.

Knowledge dissemination

The analytical framework developed in this project was presented at the annual IAMA conference (2010) to receive feedback from academic peers. The practical implications were presented to the entrepreneurs of the agropark New Mixed Farm. The brochure on the risk management of agroparks will be disseminated as a TransForum working paper.

The paper entitled “The nature of agropark: Synergy versus risk” has been submitted to the journal “Agribusiness: An International Journal” for publication and is currently under a second review after a major revision. Another scientific paper entitled “Stochastic fault tree analysis of agroparks” will be presented at the IAMA conference in June, 2011, and the manuscript will be submitted to the journal “Risk analysis”. It is expected that these papers will create more academic attention to the economics of agroparks or agribusiness clusters.

Social relevance of the research

From a societal point of view, reasoned risk-taking is the source of economic growth, improved quality of life, and technological progress. To make rational decisions involving risk-taking such as those related to agroparks, insights into the nature and magnitude of the risks are essential.

This research has developed a generic framework for assessing the synergy and risk of agroparks. Example application of the framework illustrated its practical use. In particular, the general tools developed can be applied to any specific agropark to quantify its formation risk and business risks. A systematic application of the developed instrument will bring stakeholders of agroparks to a deeper understanding of the risks and opportunities offered by the agropark concept and make better informed decisions in their venture into agropark projects. This will result in better allocation of public and private resources.

1. Introduction

1.1 Background

The concept of agroparks emerged as a sustainable solution to many environmental and socio-economic problems. An agropark is envisaged as a spatial cluster of agricultural-related functions, which aims to apply the principles of industrial ecology in the agrosector. The concept offers in theory a variety of economic advantages as well as environmental benefits such as the reduction of transportation cost and the recycling of production residuals and wastes. Moreover, through intelligent design and controlled production systems with closed material and energy loops, random effects of nature and waste of resources will be minimized. In theory, an agropark is a planned agribusiness system in which activities are geared towards sustainability.

The last years have seen increasing interests in the development of agroparks but also the laborious implementation of some agropark projects. One of the detected obstacles to the development of agroparks was the uncertainty about the feasibility and profitability of agroparks. Since these uncertainties could lead to severe financial or economic losses, many stakeholders hesitated to materialize their commitment to the development of agroparks. Difficulties in implementing agroparks arise out of the complexity of the concept and a multitude of technical, market and institutional uncertainties that are perceived as risks by various stakeholders. To many stakeholders, it was difficult to assess what the nature and magnitude of the risks would be. As a result, lack of insight into the risks was indicated as the reason for non-participation or withdrawal from agropark projects. This leads to a strong demand to further investigate the economic, institutional, and technical underpinnings of agroparks.

Agropark was one of the key perspectives supported by TransForum, whose main goal was to provide a more sustainable perspective for the Dutch agro-sector and green spaces by searching for and experimenting with new value propositions. In the past, TransForum agropark projects such as the New Mixed Farm and Greenport Shanghai had experienced considerable difficulties due to various uncertainties about agroparks. Addressing this problem, this scientific project “Economic risk analysis of agroparks” was commissioned by TransForum.

The project was led by LEI, part of Wageningen UR and executed in close cooperation with Alterra and Food & Biobased Research, all part of Wageningen UR, who are actively involved in the designing and planning of various agroparks.

1.2 Research problem and objectives

A key idea underlying the agropark concept is the synergy created by clustering different firms which should make the total benefits of the cluster higher than the sum of individual firms. It is often a challenge that this holds both for the expected benefits and for the uncertainties. The interactions and interdependencies among firms enlarge the uncertainties of the park as a whole and creates a system risk for the agropark. This risk should be investigated.

From a business perspective, agroparks create new value chains that require a new business model to capitalize on these values. Due to the novel nature of the value chains, it is difficult for banks or other investors to evaluate the business model and relevant investment projects in agroparks. Neither the government nor the bank has a protocol or a handbook available to evaluate the risks associated with a new business model like agroparks. Although financial calculations were shown in some reports on agropark design (see e.g., Agrocentrum Westerpoot, Greenport Shanghai), the results were typically deterministic, using average values of production or market data. As such, these calculations provided limited information on the potential risks.

For potential investors in agropark projects (for example, governments, public organizations, or venture capital), insights into the opportunities and risks are crucial for their decisions whether or not to participate in or approve agropark projects. It is therefore very important to carry out risk analysis already at the design phase of agroparks. By presenting the risks, the relevant stakeholders can gain better insights in the feasibility and profitability of agroparks. This will facilitate and accelerate their decision-making processes. Charting out risks can also help the firms in the agropark to take into account of risks while setting up collaboration agreements with each other.

The objective of this research was therefore to systematically identify, analyze and develop a tool to manage risks of agroparks. The project aimed to develop a generic framework which can be used to quantify financial and economic risk of agroparks. Based on the framework, a risk model would be built and applied to an agropark being developed or to be developed.

1.3 Reading guide

After this introduction, the research approach and processes are summarized in Section 2. Section 3 presents the key results and findings. Recommendations with regard to the research on and further development of agroparks are given in Section 4. Section 5 reflects on the research process with key learning points. Section 6 describes the knowledge dissemination and social relevance of this research and its results.

2. Research approach and processes

2.1 General approach

The general approach of the research combined desk studies (literature study, data collection, and stochastic modeling) and field studies in the form of survey, interviews and workshops to obtain subjective information. In particular, two Group Decision Room (GDR) sessions were organized with experts and stakeholders of agroparks. The first GDR was designed to take inventory of risk factors and possible risk management strategies. In the second GDR, subjective estimates were elicited for the agropark New Mixed Farm.

The whole project went through five phases, each with different focus and activities. Phase 1 was the preparation phase, followed by problem analysis in phase 2, qualitative risk analysis in phase 3 and quantitative risk analysis in phase 4. Phase 5 was the finalization phase.

In the first phase, a detailed work plan was made with an overview of the deliverables and the work flow. An overview of the workflow is shown in Figure 1.

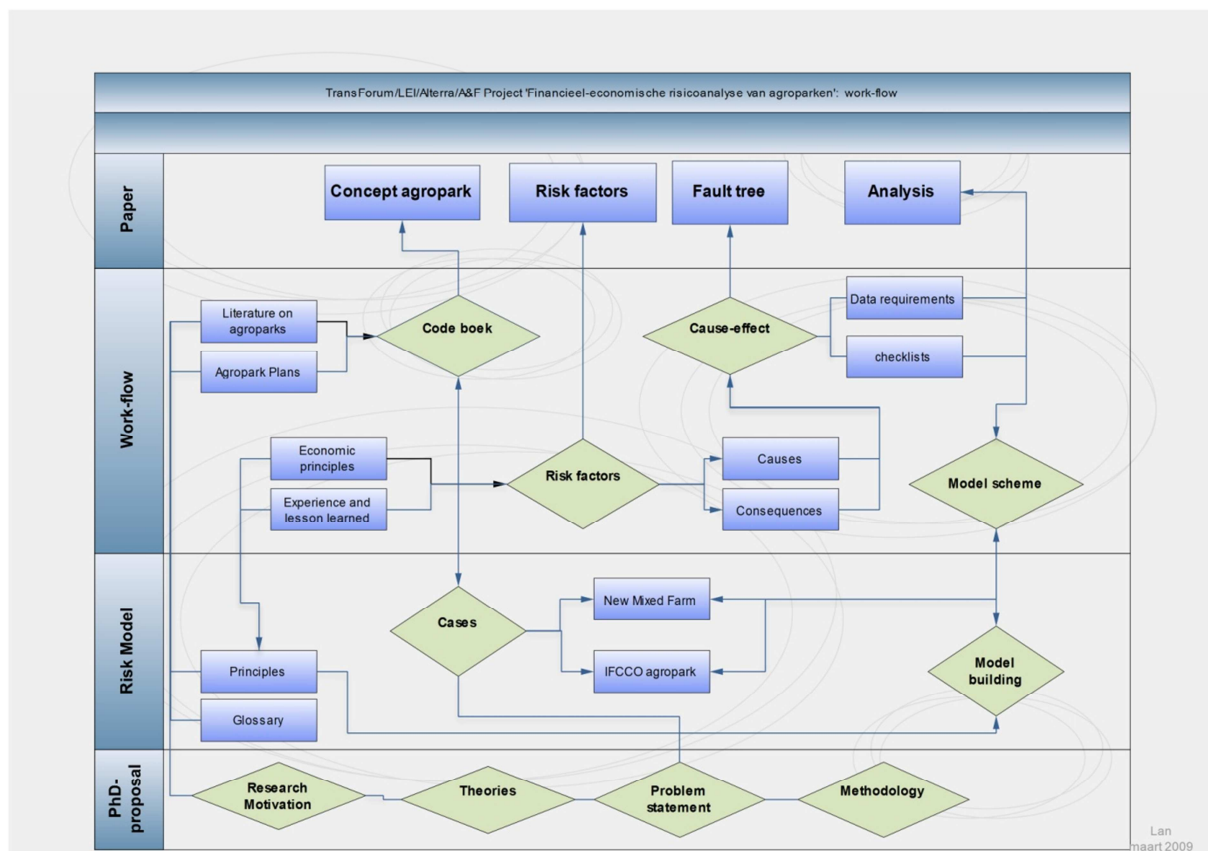


Figure 1. A detailed work flow of the project

The workflow laid out the logical relationships and coherence among the three main activities of the project: developing an analytical framework, developing the risk model, and writing a PhD proposal for more fundamental research on agroparks. To ensure the empirical relevance of the research, two cases were selected to gain insights into the practical challenges in developing agroparks. The remaining phases were then guided by the overview of the deliverables and the workflow.

2.2 Developing the analytical framework

2.2.1 Examining the nature of agroparks

The focus of the second phase was a problem analysis in which the primary task was to delineate the agropark concept. In particular, the guiding research question was: what distinguishes an agropark from other economic clusters? A quick scan was first performed to take inventory of agropark cases. Available project plans and documents for these cases were gathered and studied to gain more insight into the subject matter.

To provide a common frame of reference, key features of agroparks were compiled into a codebook which describes the possible configurations of agroparks. While studying the literature, the aim was also to identify potential risk factors and define requirements of a quantitative risk model. In identifying risk factors, a distinction is made between uncertainty and risk. Uncertainty refers to the lack of information or control in general (unknown outcomes), while risk refers to the quantifiable consequences and their associated probabilities (unknown outcomes with known probability). In practice, risk is often associated with potential losses (downside risk). As a first step, uncertainties and possible risks of the agropark concept are identified according to the structure shown in Table 1.

Table 1. Overview uncertainty and risk in different categories.

Category	Technical	Market	Institutional
Uncertainty	<ul style="list-style-type: none"> - Resource availability - Stability and flexibility of production and processing processes - Functioning of logistics 	<ul style="list-style-type: none"> - General economic setting - Input market (supply, pricing, information) - Output market (demand, price, competition, etc.) - Capital market - International trade 	<ul style="list-style-type: none"> - Policy and regulations - Contracts and agreements - Social values
Downside risk	<ul style="list-style-type: none"> - Shortage of resources - Low production level - Low production efficiency 	<ul style="list-style-type: none"> - Market malfunctioning - Negative profit - Negative welfare 	<ul style="list-style-type: none"> - Socially undesirable - Change of policy - Collapse of collaboration

Bearing in mind that the agropark concept could be implemented in many different forms in different technical and social-economic settings, great attention was paid to the common issues and system risks in terms of their generality.

2.2.2 Identifying key issues and methodological considerations

In the third phase, relevant theories for agroparks were identified and analyzed in order to build a common theoretical and methodological basis for the risk analysis of agroparks. The diversity of agropark designs necessitated a common frame of reference to structure and compare different agroparks. Such a frame of reference also facilitates communication among researchers with different disciplinary background.

An extensive desk study was carried out on both academic literature and practical reports. Literature was collected using keywords such as industrial ecology, clusters, network, agglomeration effects, system innovation, synergy, collective risk taking, and stakeholder analysis. To elicit expert knowledge and distil lessons from the practice, regular work sessions were organized with the project team and relevant experts consulted when necessary. In particular, a Group Decision Room (GDR) session was organized to take inventory of and rank risk factors for different stakeholders (project developer, entrepreneurs, and neighboring residents) and in different phases of agropark development (planning, implementation, and operational phase). The list of risk factors identified during the GDR session was attached in Appendix I. During the GDR session, participants were also asked to come up with possible risk reduction strategies.

2.2.3 Integrating theories and methods for agroparks

After conducting the literature study and taking inventory of the risk factors, the main task was to build a generic framework which, while integrating the theories and issues, offers principles and guideline for risk analysis of agroparks. This included defining the scope and limits of the factors to be analyzed and the mechanisms through which they influence the synergy and risk of the agropark concept.

The developed framework was used to generate qualitative description of key issues and risks of agroparks. For risk analysis of agroparks, the analytical framework serves a ground-laying function for further model building and analysis. With the aim to provide a theoretical reference for further theoretical and empirical studies on agroparks, the analytical framework was described in a scientific paper and submitted to an economic journal related to agribusiness.

The key issues and theories identified were used to develop a PhD research proposal which addresses more fundamental issues of the agropark. Prior to writing the PhD proposal, two MSc theses were carried out as a part of this project, with one focusing on the institutional challenges and the other on stakeholder analysis. During these MSc theses, practical information was gathered about a number of agropark cases and key

stakeholders were interviewed about the institutional issues experienced during the development of the agropark projects.

2.3 Developing the risk model

The analytical framework developed in phase three was used to develop guidelines for risk analysis of agroparks. The fourth phase of the project aimed to develop a risk model for quantifying risks of agroparks. In view of the complexity of the agropark concept and different phases of agropark developments, a step by step approach was developed to address the process of agropark development. Since most agropark projects experienced difficulties in the definition or planning phase, it was considered particularly necessary to develop checklists for these phases of agropark development. These checklists could be used to assess the quality of project plan and identify critical factors for the formation risk of agroparks. Formation risk was defined as the likelihood that the concept of an agropark would fail to obtain legal permits, financing, and the necessary cooperation among different firms.

The checklists were compiled based on the outcome of the GDR-sessions and structured according to the analytical framework. Based on these results, a fault tree analysis (FTA) was carried out for the formation of agroparks in which the success of agropark formation was jointly determined by the successes in obtaining legal permits and financing and establishing collaboration among different firms. Results of the checklists were used as inputs for further quantitative risk model of agroparks. FTA was originally developed in the early 1960's by the Bell Laboratories for the safety analysis of launch control systems. Application of FTA increases the understanding of the safety and reliability issues whilst highlighting the potential improvements that may be achieved through alternative designs.

FTA is a deductive and probabilistic risk assessment tool which elucidates the causal relations leading to a given undesired event (termed top-event). The terms "Failure" and "Fault" have specific meanings in the context of risk management with "Failure" referring to the non-functioning of a specific item of equipment and "Fault" referring to the non-function of a system or sub-system. A fault tree is typically developed top-down by decomposing the top-event (a fault) into its possible causes (failures). Each possible cause is then investigated and further refined until the primary events are identified. From a system design perspective, the FTA framework provides a logical framework for understanding the way in which an agropark project can fail during formation, which is essential for agropark project appraisal.

After estimating the formation risk, it should be assessed whether the business plans contain sufficient information for quantitative calculations of investment risks. For such purpose, templates of risk models are developed which can be tailored to the specific cases when the information is available. The primary method used to quantitative business risks was Monte-Carlo simulation. Monte-Carlo simulation is a suitable method for risk analysis when the system has complex interactions among its components, which made analytical methods impossible. The name Monte-Carlo is inspired by the

well-known casino in Monaco, since the simulation method uses multiple random drawings (replications) from probability distributions as if throwing an electronic dice.

The Monte-Carlo method was used to generate large number of possible scenarios, taking into account of the interactions among different factors by quantifying their correlations. The more random scenarios are created, the closer the statistics of these scenarios will represent the true randomness or variability of the project. With the help of the Monte-Carlo method, the opportunities and downside risks per category are quantified with probability distributions which indicate the magnitude and chances of various outcomes. The results can then be used for further decision analysis such as evaluating a particular investment project or a particular financial or organizational structure.

Relevant data for the risk model were retrieved from statistical sources such as CBS, Eurostat and Farm Accountancy Data Network (FADN). Data on key agricultural sectors were also gathered from scientific and empirical publications. Elicitation of subjective parameters was combined with a second GPR-session in which designers and entrepreneurs of agroparks participated.

2.4 Towards future application

In the final phase, technical documentation was made with the intention to make the modeling approach applicable to future agropark projects. Consider the contextual issues and specific interactions among the participating firms, the risk model must be tailor-made for each agropark. Since it is impossible to develop a turnkey risk model for all agropark projects, templates for possible components of the risk model were developed as building blocks. The general approach would serve as a basic guideline for building risk models for specific agroparks.

3. Key results and findings

3.1 Analytical framework

The analytical framework developed in this project was described in detail in the manuscript “The nature of agroparks: synergy versus risk”, which is currently under second review after a major revision by the journal *Agribusiness: an International Journal*. Reviewers were positive about the analytical framework and its importance in analyzing the synergy and risk of agroparks.

The paper showed that the theory of New Institutional Economics (NIE) offered a vantage point for formulating the economic nature of agroparks and explaining the obstacles in the implementation of the concept. A basic tenet of the NIE is that economic outcome is determined by four levels of interrelated institutions: social embeddedness (Level 1), institutional environment (Level 2), governance structure and coordination mechanism (Level 3), and incentive structure (Level 4). Analyzing the working of these institutions on agroparks not only provides insights into the institutional nature of agroparks but also generates a logical structure to organize economic analysis of agroparks. In particular, as summarized in Table 2, comparison between regular firms and agropark firms help reveal the defining features of agropark as an economic phenomenon.

Table 2. Agropark viewed from the four levels of institutions

Level of analysis	Regular Firms	Agropark Firms
Level 1: Social embeddedness	Social aspects of the firm and its industry.	Social aspects of the agropark as a whole; Social aspects of all firms and their industries;
Level 2: Institutional environment	Independent ownership; Own liability; Existing rules and regulations;	Shared or independent ownership; Own and collective liability; Often requiring tailor-made rules and regulations;
Level 3: Governance structure and coordination mechanism	Hierarchy	Hybrid (Hierarchy, Contracts, Club, etc.)
Level 4: Incentive structure	Based on formal institutional setting and market conditions.	Based on both formal institutional setting, market conditions and collaboration conditions within the park.

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The framework brought into prominence the impact of institutional arrangements on the success or failure of agropark formation. Combined with practical experiences in the project Greenport Shanghai and New Mixed Farm, it is shown how theoretical merits of the agropark concept may fail to materialize due to high institution cost of organizing, establishing, and maintaining the collaboration among different stakeholders as required by the agropark concept. The paper concluded that the key to successful formation of an agropark was the choice of proper institutional arrangements which create high incentives to cooperate and incur low institution cost.

Table 3. Risks of agroparks at different institutional levels

Level of analysis	Level of organization	
	Park level	Firm level
Level 1: Social embeddedness	Public opposition due to - Social issues of the park - Social issues of the participating firms and their industries	Public opposition due to: - Social issues of the firm - Social issues of the industry - Social issues of the park
Level 2: Institutional environment	Failure to obtain or delay in obtaining: - License for the park - Financing for the park	Failure to obtain: - License for the park - Financing for the park - License for own firm - License for key partners - Financing for own firm - Financing for key partners
Level 3: Governance structure	Failure to: - Attract participants - Establish and/or maintain collaboration	Failure to: - Observe agreements - Collaborate with partners - Comply to park rules
Level 4: Incentive structure	- Business risk of the park - Business risk of the firms	- Own business risk - Business risk from collaboration - Business risk of the park

Based on the analytical framework, a codebook was designed to describe the external context and internal structure of any agropark. Part of the codebook is shown in Table 4.

Table 4. Codebook to characterize agroparks

Category	Example
General condition	
Phase	Definition/Planning/ Implementation /Operational
Country	Netherlands/China/India/ ...
Location	Metropolitan area/Rural land/Special zone...
Available area	Small /Medium/Large
Accessibility/logistics	Poor/Good/Excellent
...	
Planning and implementation	
Investor	Government/Entrepreneurs/Institutional investor
Planning method	Top-down/Bottom-up/Co-design
Financing	Private/Public/PPS
Implementation phasing	Phased
...	
Social embeddedness and institutional environment	
Dominant culture with regard to Agriculture	Food security/Food quality/Multifunctional
Corruption index	High/Medium/Low
Investment climate	Stable/Unstable
...	
Governance structure and coordination mechanism	
Park management	Internal/Internal/Hybrid
Organizational form	Shared Ownership/Alliance/Mixed
Type of cooperation	Technical/marketing/Logistic
Access	Open/Closed
Responsible	Government/Project developer/Entrepreneurs
...	
Technological configuration	
Chains	Primary/Vertical integration/horizontal int.
Number of firms per link	
Interdependency	Input/Output/Utility/Marketing
Primary processes	Purchase, production, marketing
Secondary processes	Inventory
...	
External interactions	
Outputs	
Outputs	Animals, meat, vegetables, etc.
Output market	National
Externality	Positive/Negative
...	
Inputs	
Inputs	Animals, feed, energy, water...
Input market	National/International
Energy	
...	

The codebook offers a structured way to look at agroparks and the information gathered enables a quick scan of the possible risks in an early stage. A more detailed survey was also designed which contains questions regarding factors on all four institutional levels. Responses or answers to these questions were used as basic inputs for the quantitative risk analysis.

3.2 PhD research proposal

As argued in the scientific paper, the economic nature of agroparks raises fundamental research questions with regard to the optimal institutional arrangements. Institutions play an important role in economic activities and remain an important area of research in social sciences. System innovations such as agroparks entail institutional challenges at various institutional levels. Institutional design determine to a great extent the success or failure of such innovations. By linking institutional design to risk management of agroparks, the PhD research project would open up a new area of fundamental research on the institutional arrangements for system innovation projects.

The objective of the proposed research was to provide insights into the institutional design of agroparks for better coping with economic risks. Based on the research problems and objectives described above, the research questions are formulated as follows:

- What are the possible institutional designs for an agropark?
- What is the strategic vision of an agropark?
- Who are the key stakeholders of agroparks and what are their incentives and constraints in supporting or cooperating in an agropark?
- What are the possible governance structure and coordination mechanisms among these stakeholders?
- What are the factors relevant to the choice of governance structure and coordination mechanism?

Answering research question 1 requires a deep investigation into the institutional environment (level 1 and 2) and the characteristics of the stakeholders and the economic sector in which they are operating. In particular, strategic vision is a description of an organization in the future, moreover, it is a concept for a new and desirable future reality. The strategic vision of an agropark is one of the key issues in institutional design. The knowledge of strategic vision, management style, and main stakeholders' strategies in the selected agroparks will give a better overview of insight institutional design.

- How are risks in agroparks influenced by the institutional design and strategies of the stakeholders?
- What kind of decision-making behavior can we expect from the main stakeholders of an agropark given different institutional designs (based on game-theoretic concepts) ?
- How is this behavior influenced by risks and influencing the risks of agroparks?

- What are the possible consequences of different behavioral patterns, for instance when certain stakeholders deviate from the expected strategy?
- How are the consequences influenced by different institutional designs?

Answers to these questions can be used to provide strategic recommendations for future planning and development of agroparks.

Although agroparks are still in an early stage of development and the approach and ideas presented in this proposal may be subject to further evolution and improvement, it can be stated that this research will achieve highly relevant, unique and promising results. It will lead to a new way of thinking about formal and non-formal institutional change and the improvement of strategies to achieve successful implementation of large-scale innovative projects, such as agroparks.

Based on the current developments in sustainability, the growing tendency of cluster formation and profound effect of agricultural innovations, it can be expected that the development of this line of thinking will continue for a long time and the results will contribute to institutional change, sustainable development and success of agroparks. Methodology, analytical framework and results of this project can be generalized and implemented by a number of typical cases; however, the main focus is on agroparks.

3.3 Risk model

3.3.1 Model structure

With insights from previous phases, a generic risk model was developed to operationalize the theoretical considerations described in the analytical framework with practical tools. The risk model aims at assessing the formation risk and business risk for an agropark as a whole concept. The risk model follows the structure derived from the analytical framework and contains basic building blocks for risk analysis of an agropark.

The risk model consists of qualitative elements and quantitative elements and addresses issues in different phases of agropark development. It should be noted that using the model is not an one-time access and the situation in developing an agropark may evolve continuously. As such, risk analysis should accompany the design and plan process. Inputs for the risk model should be updated when new information is available. An overview of the general approach is presented in Figure 2, which laid out the necessary steps towards quantifying the economic risks of agroparks. The process starts from assessing whether the agropark project is well defined in terms of its budget, performance goal and time frame.

Final report

Economic risk analysis of agroparks

LEI, part of Wageningen UR

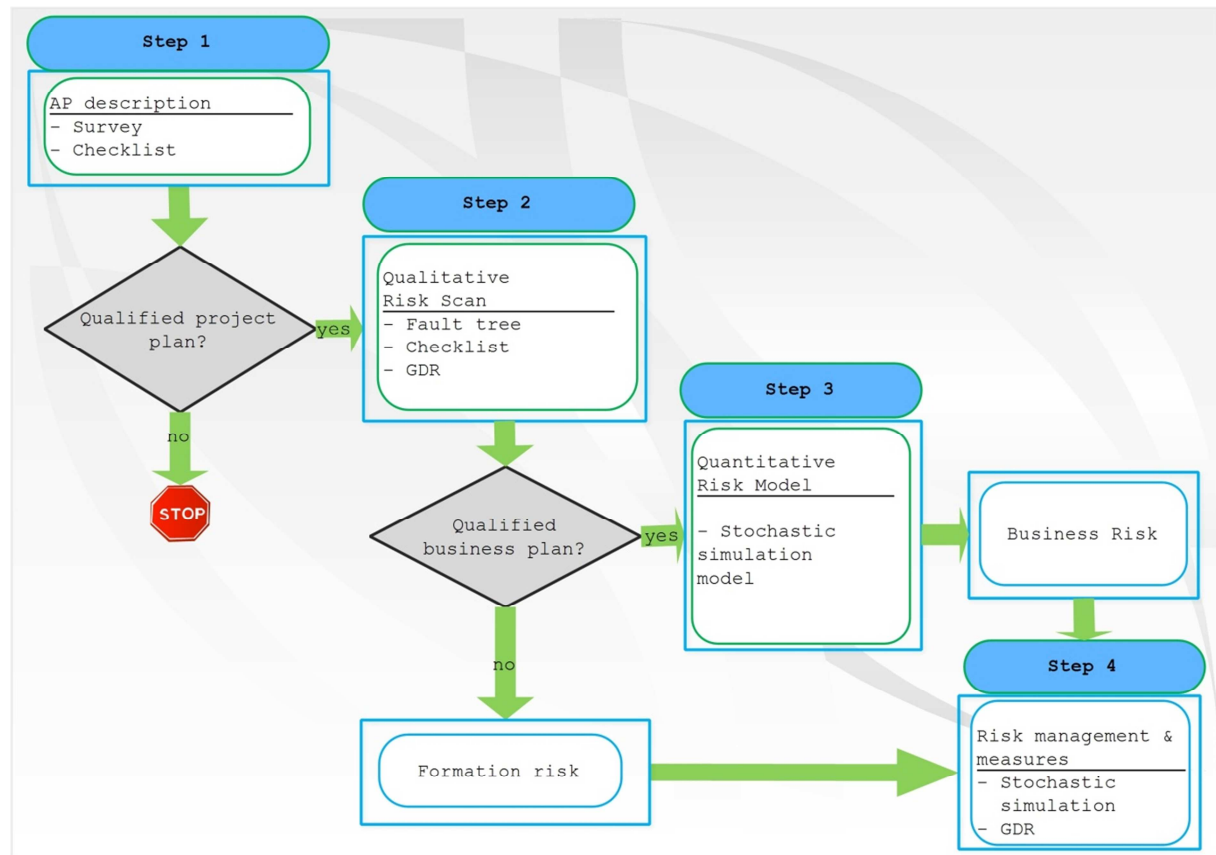


Figure 2. A step by step approach to risk analysis of agroparks.

If the project plan is well defined, a quick risk scan can be performed to specify the risk factors and their possible impacts. To gather information on the basic details of an agropark project, a structured survey was designed and attached in Appendix II. The answers to the survey questions are checked against a checklist to see whether the project plan contains sufficient details for further risk analysis. When this is the case, the generic risk models can be further specified according to the project plan. The workflow of the risk model is sketched in Figure 3.

A prerequisite to use the quantitative part of the risk model using Monte-Carlo simulation is that there must be a well-defined business plan which contains the necessary details for quantitative risk analysis. For projects in the business planning phase, the details should at least enable a capital budgeting analysis to quantify business risk. When the business plan is only broadly defined, quantitative assessment can only be made on the formation risk based on expected profiles of the firms involved. This means that for agropark projects that are in a conceptual planning phase, only qualitative risk analysis can be performed.

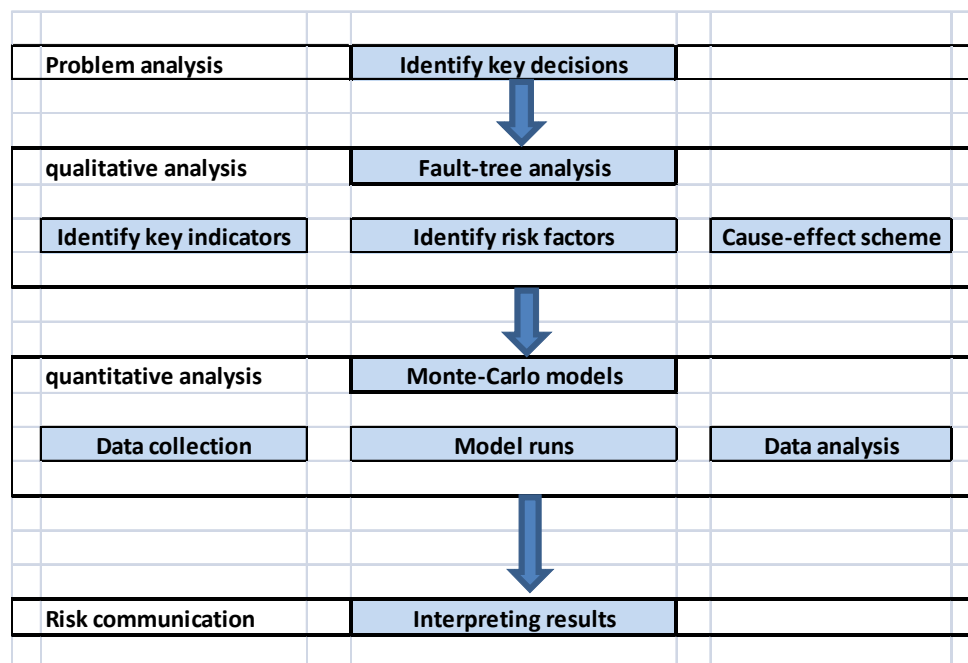


Figure 3. Model scheme of an agropark project

The methodological approach is described in a second paper entitled “Stochastic fault tree analysis for agropark project appraisal”. The paper represents not only a new application of the established technique, but also contains methodological innovation by including uncertainties about the failure rates. Conventional FTA usually assumes exact probabilities of the events. These deterministic probabilities are collected from historical observations or derived from experiments. Observational probabilities are appropriate for physical processes, but may be hard to assess for decision problems that are non-repetitive, one-time events, or are subjective by nature (for example trust). This may be a reason for the popularity of subjective probability in decision models. Moreover, randomness in the outcome of events is not accounted for.

To address these issues that are prevalent in agropark projects, the paper proposed a stochastic FTA in which Monte Carlo simulation (MC) is applied to obtain the joint distribution from the basic (subjective) probability distributions and to assess the uncertainty in the estimated probabilities. MC simulation is considered an appropriate and very flexible method of investigating aspects that are stochastic in nature. Risks are incorporated by random sampling from a priori specified probability distribution for variables affecting the events in the fault tree model. Many random numbers are drawn to reflect the likelihood of different outcomes of each probability distribution. As an illustration, the stochastic FTA was built in the program @Risk using a simplified example agropark.

3.3.2 Data and parameters

Quantitative risk analysis must rely on relevant data for the calculation of probabilities and consequences. This is particularly important for Monte-Carlo simulation as the variations in variables were modeled with probability distributions. The choice of probability distribution requires knowledge about the underlying stochastic process and good understanding of probability theory. Technical considerations are described in the documentation for the model.

Data used for the risk model consist of both objective and subjective data. Objective data concern historical observation or measurements on the variables of interest which were available from statistical sources such as CBS, Eurostat and other statistical databases. Information collected in the Farm Accountancy Data Network (FADN) by LEI, part of Wageningen UR was used to obtain statistical information for specific sectors. In the Netherlands, sector organizations and consulting services regularly publishes statistical information on key performance indicators among their members. Furthermore, reports of empirical research typically also contain large amount of data. The objective data are used in two ways. First, they are used to obtain the parameters for the probability distribution for the performance indicator. Second, they are used to generate benchmarks for possible firms in the agropark to evaluate their relative size and performance.

The main challenge in analyzing the risk of agroparks lies in the fact that a high level of subjectivity is inevitable. This is a logical consequence of the institutional nature of concept in which interaction among different stakeholders is inevitable. Essentially, agropark planning is not a game against nature but a game against rational economic agents. It is a human characteristic that rationality is bounded and behavior is adaptive. To model the interactive behavior among stakeholders of an agropark, the underlying factors such as perceptions, attitudes, expectations, and trust must be well understood. Subjective data are elicited from people, typically collected via survey questions, interview and workshops.

The project has built a large set of literature resources and database concerning project planning, capital budgeting, technical performance of key sectors, risk management instruments, and market information on possible products of the agropark. These data are regularly updated to reflect the actual development of the underlying risk factors and their consequences.

3.3.3 Model outcome

A model is a tool to support decision making. In this respect, the risk model developed can be used to calculate various outcomes of interest. Two important outcomes are for example the likelihood of agropark formation and business risks. The likelihood of agropark formation is based on the fault tree analysis taking into account the likelihood of obtaining legal permits, financing, and establishing collaboration as conceived by the

agropark. This information is important to assess the institution cost which might offset the theoretical benefits offered by the agropark concept.

For potential investors in agropark, business risk could be calculated as the variability in the return on investment (ROI) based on the chosen business plan, taking into account possible technological, market, and institutional uncertainties. For example, Monte-Carlo simulation of a business plan can generate a histogram of the future ROI such as shown in Figure 4, which indicates the possible range of the ROI and the likelihood of the ROI falling below, between, or above any chosen level.

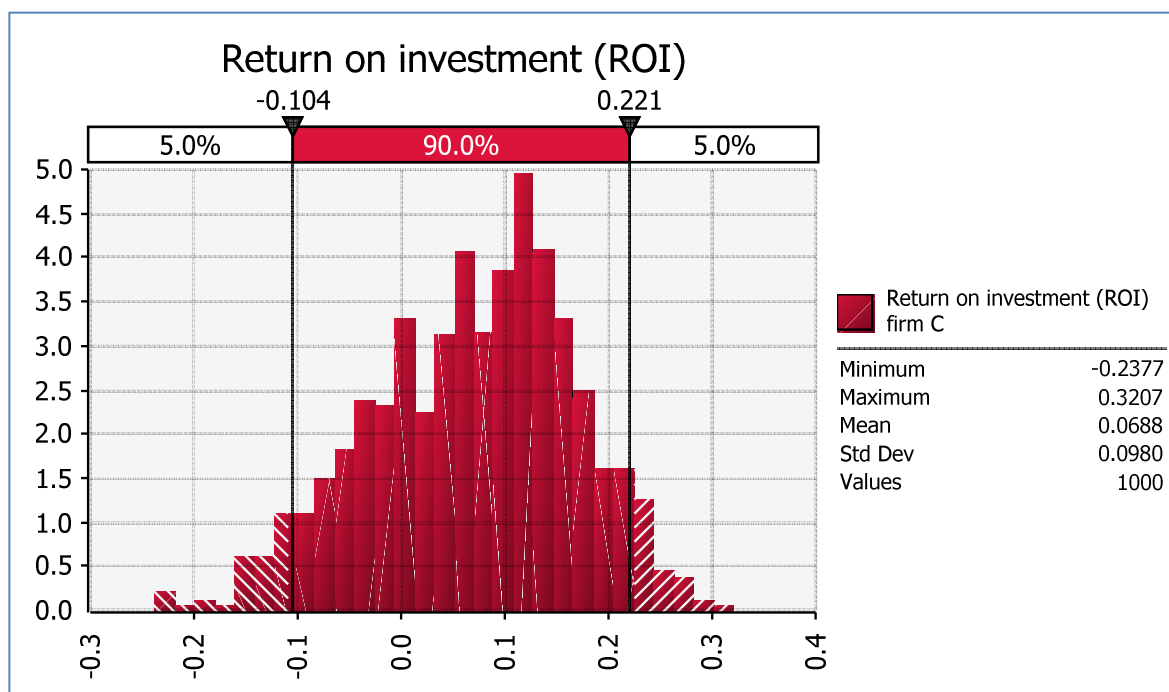


Figure 4. Model output of return on investment

Calculating business risk requires detailed information on the investment decisions and the involved business operations, which means the results cannot be generalized to all agroparks and must be interpreted within the context of the business plan. To test the empirical applicability of the risk model, information of the New Mixed Farm was used to calculate the business risks. The results are not published due to confidentiality reasons. However, the model structure is made general so that it is applicable to specific agroparks after the required information is collected. To illustrate the working of the model, a simplified agropark is used to show fault tree analysis and Monte-Carlo simulation are combined to quantify the formation risk and business risks.

3.4 Key findings

A critical examination of agropark plans such as Agrocentrum Westpoort, Deltapark, New Mixed Farm, Greenport Shanghai and IFFCO-Greenport Nellore showed that the theoretical benefits implied by the agropark concept can be jeopardized by factors such

as: 1) social or legal resistance to the development of the agropark; 2) the economic or environmental impact elsewhere; 3) technological problems in implementing the concept; 4) the level in which stakeholders share the value propositions of the agropark and agree to cooperate under these propositions; 5) the level in which participating enterprises are prepared to abide by cooperation agreements even when they become unfavorable due to changes in market conditions.

Reflecting on these conditions, the following findings may offer better insights into the complex challenges facing agropark projects. First of all, for many agropark projects it was difficult to draw up a well-defined project plan in conceptual planning phase with clearly specified budget, operational goal, and the time frame of the desired agropark. In particular, the role and responsibility of stakeholders with regard to these elements were usually kept abstract or undefined. For practical implementation of agroparks, these need to be made concrete.

In the second place, implementation of agroparks can face a chicken and egg dilemma in terms of the institutional design: On the one hand, a well-defined institutional design for the agropark which specifies the conditions and arrangements of cooperation is needed to make investors committed to the project; On the other hand, committed stakeholders are needed to specify the institutional arrangements that offer sufficient incentives for cooperation under the agropark concept. If this is not well thought through, the practical implementation of agroparks can take a long trial and error process in finding the right mix of stakeholders and the right set of institutional arrangements, resulting in a long and uncertain period of negotiation between stakeholders before implementation can start.

Lack of institutional design impedes meaningful economic risk analysis of the synergy and risk of agropark as a business concept. Economic analysis of projects and operations requires correct identification of costs and benefits, which depend on the institutional arrangements. More importantly, institutional arrangements also determine the risk interdependencies among different stakeholders which necessitates joint business planning to manage possible risks.

Last but not the least, the process of planning and implementing an agropark can take many years before the concept is fully realized. This can pose a problem to investors with short time horizon. It should be noted that development an agropark is a dynamic process in which the situation may change. Existing uncertainties may be resolved and new uncertainties may arise. Risk analysis should therefore be regularly updated to take into account new information.

4. Recommendations

Based on the results and findings, it is recommended that the analytical framework be integrated into the design and planning phase of future agroparks. A systematic application of risk analysis can help avoid unnecessary efforts in developing agroparks by focusing on the critical issues and selecting the most promising projects.

The underlying principles of risk analysis and its outcome should be communicated to various stakeholders to enable informed decisions. Due to the involvement of multiple stakeholders, risk is a choice rather than a fate for agroparks. Insights into the possible opportunities and risks can serve as a basis for designing sustainable institutional arrangements among the stakeholders.

When evaluating agropark plans, it is important to assess the formation risk, the organizing costs and the impact of different institutional arrangements in the specific context. A careful stakeholder analysis and joint business planning are essential in the designing and planning phase.

5. Key learning points

5.1 Scientific research on agroparks

As a scientific project, an implicit goal of this research was to contribute to the scientific theory and methods for sustainable development of which the concept of agropark represents one possibility. Whether this concept can indeed contribute to sustainable development and whether it is desirable had been subject to much debate in the Netherlands. The debate took place not only in the general public, but also within the project team consisting of multidisciplinary researchers. Arguments used to defend or criticize the concept demonstrated clearly the difference in scientific backgrounds and ways of reasoning.

The multiformity of agroparks in theory and in practice posed a serious challenge to the research. During various project meetings in the first phases, a returning question was: what constitutes an agropark precisely? This question triggered the effort to isolate and define the essential characteristics of agropark as a business system. It was learned that, as a necessary condition of success in this endeavor, the description ought to avoid attitudes of defense or criticism of the system under examination. The intention was to understand what an agropark is and as such to reach the understanding as to what it can and what it cannot accomplish.

Following this path, it was observed that discussions about the area, location, product, technology etc. about various agroparks touched only the surface of the concept, the essence of the concept is an institutionalized cooperation it aims to establish. From a scientific point of view, the key learning point was the use of New Institutional Economics (NIE) in analyzing the synergy and risks of agroparks.

The NIE paradigm provides a useful vantage point to view how institutional factors have determined the success or failure of agroparks. The theoretical challenge is to further characterize the institutional design which strikes the optimal balance between the gain from cooperation and the cost of institutionalizing such cooperation. Focusing too much on the possible gains from cooperation would result in too optimistic views of its viability, but shed no light on the challenges facing the agropark concept. Focusing too much on the costs and risks of co-operation would result in no agropark design at all.

It is believed that this theoretical development would lead to a clear conception of the fundamentals of agroparks and what is reasonable to expect from the ideal results and where it can differ.

5.2 Practical perspective

The concept of agropark and its underlying principles have inspired many initiatives in practice. Unfortunately, many of them had experienced challenges in different development phases. An important motivation of this research was to distill lessons from these initiatives and make them applicable to new initiatives. As such, results of this project have greatly benefited from action research and practical experience in

developing these initiatives from project partner Alterra, part of Wageningen UR. Difficulties and challenges experienced in their efforts in co-designing and organizing various agroparks offered great learning opportunities to understand where the pitfalls were and what challenges can be expected.

From an empirical perspective, a key learning point was the observation that the ideal agroparks depicted in various master plans requires conditions that can differ from the practice. The design and planning approach should therefore also identify the divergence between the theoretical conditions and the practice and formulate action plans for different stakeholders to change that practice. Simultaneously the institution cost of the agropark concept and the time needed to reach changes in institutions (if possible at all) must be assessed in an early stage of the agropark planning.

Reflection on past experience also indicated that the challenges for agropark projects to obtain legal permits and attract committed investors might have been partly symptomatic. Other causes could arise from the inherent challenges of realizing a system innovation in a changing institutional environment, where it is very difficult to have full understanding of how the system can work. Even if the concept had weathered all practical frictions to become a reality, it could still be doubted whether the outcome would have been as originally planned. Viewed in this light, obtaining legal permits and financing on the basis of these original plans is only the first step. More challenges are to be expected in the implementation and operational phase. To tackle these challenges, theories and methods developed in this project will provide a philosophical and methodological basis.

6. Knowledge dissemination

The research has resulted in two scientific papers, a set of checklists and tools, a risk model with documentation, and a PhD proposal which had been submitted to grant institutions. The research project has also contributed to two MSc theses on agroparks, one analyzing the institutional challenges and the other containing a stakeholder analysis.

The analytical framework developed in this project was presented at the annual IAMA conference (2010) to receive feedback from academic peers. The practical implications were presented to the entrepreneurs of the agropark New Mixed Farm.

The paper entitled “The nature of agropark: Synergy versus risk” has been submitted to the journal “Agribusiness: An International Journal” for publication and is currently under a second review after a major revision. Another scientific paper entitled “Stochastic fault tree analysis of agroparks” will be presented at the IAMA conference in June, 2011, and the manuscript will be submitted to the journal “Risk analysis”. It is expected that these papers will create more academic attention to the economics of agroparks.

The project has generated a rich set of literature resources and database concerning project planning, capital budgeting, technical performance of key sectors, risk management instruments, and market information on possible products of agroparks. These databases will be maintained and regularly updated by LEI, part of Wageningen UR. The overall approach is summarized in a brochure entitled “Risk Management of Agroparks (RiMAP): A step by step approach”.

In summary, the project has led to following publications and presentations:

1. Paper “The nature of agroparks: synergy versus risk”
2. Paper “Stochastic fault tree analysis for agropark project appraisal”
3. PhD Proposal “Risk management and institutional design of agroparks”
4. MSc thesis “Stakeholder analysis of agroparks”
5. MSc thesis “Institutional challenges in the implementation and realization of agroparks”
6. GDR reports “The risks of agroparks”
7. Documentation “Quantitative risk model for agroparks”
8. Brochure “RiMAP”
9. Presentation “The nature of agroparks” at IAMA conference (2010)

7. Social relevance of the research

From a societal point of view, reasoned risk-taking is the source of economic growth, improved quality of life, and technological progress. To make rational decisions involving risk-taking such as those related to agroparks, insights into the nature and magnitude of the risks are essential.

This research has developed a generic framework for assessing the synergy and risk of agroparks. In particular, the general tools developed can be applied to any specific agropark to quantify its formation risk and business risks. A systematic application of the developed instrument will bring stakeholders of agroparks to a deeper understanding of the risks and opportunities offered by the agropark concept and make better informed decisions in their venture into agropark projects. This will result in better allocation of public and private resources.

Although the framework and tools were developed for the risk analysis of agroparks, a broader perspective is to use the general approach to analyze risks in similar initiatives such as clustering, strategic alliance, co-siting, and the conglomeration of Greenports. As such, the results of this research can be of great interest to policy makers and institutional investors.