Chapter 6

Conclusion

The Dutch government promotes agricultural system innovations, that is, innovations which bring along sector-wide changes that potentially contribute to sustainable development. To this end, it subsidises system innovation programmes that initiate innovation projects. In innovation projects entrepreneurs, applied researchers, intermediaries and civil servants cooperate to develop and implement novelties (i.e. new products, processes and technologies) which have the potential to contribute to sustainable development.

In this concluding chapter, I take a broad view in which I relate my findings to my main research objectives of contributing to (i) the theoretical understanding of agricultural system innovations, and (ii) understanding of the guidance of agricultural innovation projects. I do this by addressing the nine questions (see table 6.1 on next page) that I raised in chapter 1 and examine what answers are provided by specific studies reported in this thesis (chapters 2 to 5).

I structure my findings along the chronological dimension of the system innovation trajectories. First, I present my findings regarding the phase of developing a prototype (i.e. attempt to construct the first real life manifestation of a specific novelty in a market context). In section 6.1 I focus on interactions of actants in innovation project (who operate at niche-level). Second, in section 6.2, I present my findings regarding the phase of implementing a prototype. I focus on interactions between the participants in innovation projects and stakeholder groups (who operate at regime level). Third, section 6.3 provides insights regarding the initial diffusion phase (i.e. implementation of the first dozen real-life manifestations of novelties directly after the prototyping phase). In section 6.4 I propose some recommendations for further research.
Table 6.1. Overview of research questions (shaded columns relate to the first research objective; the right-hand column refers to the second research objective).

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6.1 Developing a Prototype

System innovation takes place when several coinciding developments lead to sustained changes in the configuration of the socio-technical network. An increasing number of scholars and practitioners experiment with interventions that may shift the agricultural sector along a more sustainable path. For instance, through developing novelties, supporting their implementation in practice, and encouraging the wider adoption of these local experiments. This section describes the lessons we can learn from the cases I studied in the prototype development phase. From my research we can learn about how novelties are actually shaped (see 6.1.a), and about the role of the different contributing actors (see 6.1.b). Furthermore, my research provides lessons for practitioners on how to guide the development phase, particularly on how to stimulate inter-institutional collaboration and learning (see 6.1.c).

6.1.a. Dynamics of Shaping NOVELTIES

What do the interactions of actants in innovation projects during prototyping disclose about the dynamics of shaping novelties? We have seen that a novelty is dynamic during the prototype development phase. Chapter 2 reveals that the vision of a future novelty (e.g. the Agropark vision of the future) does not necessarily correspond fully with its prototype (e.g. Biopark Terneuzen). Actors in innovation projects further shaped and thereby modified the novelty to produce a prototype that suits the local context. I refer to this tailoring process as contextualisation.

Contextualisation contributes to developing a prototype which suits the frame and circumstances of the prototypers. A contextualised novelty positively influences the strength of commitment of participants to implementing the novelty.

At the same time, the process of contextualisation implies that sustainable scripts, which are inherent in the initial vision of the novelty, are not necessarily strongly embedded. Chapter 2 confirms this implication and shows that contextualisation can have an adverse effect on the potential value of the novelty: during the contextualisation of Agroparks, actors un-linked several environmentally, economically and socially beneficial functions. I therefore argue for modest expectations with regard to what visionary designs (e.g. reflexive designs) may bring. Even though these designs may include all the elements necessary to induce
sustainable behaviour or effects and may be based on the preferences and needs of the different stakeholders, in practice they may still turn out differently as project participants modify them.

On the positive side, contextualisation provides the opportunity to add valuable new features (i.e. scripts) to the novelty. In section 6.2.a I further investigate the dynamics of novelties during the prototype implementation phase as I explore the relation between prototypes and the socio-technical network in which the prototype is to be implemented. Moreover, in sections 6.1.b and 6.2.b, I elaborate on the roles that innovation project participants and stakeholder groups in the broader socio-technical network play in adding and removing scripts of the novelties.

6.1.b. Role of ACTORS in Niches

What do the interactions between the participants in innovation projects reveal about the role of actors in niches? I first consider who these actors are and how they can be distinguished. Next, I elaborate on the interactions between several types of actors.

Geels and Schot (2007) distinguish between ‘niche actors’ and ‘regime actors’. Although they do not explicitly mention who the niche and regime actors are, one concludes from the argument that niche actors are dedicated to a specific novelty and operate within niches to advance the novelty. Regime actors, on the other hand, are part of the socio-technical network and perceive the novelty either as a threat to the prevailing regime or as an opportunity. What can we learn from my research about this distinction?

In the five innovation projects I studied, I was unable to strictly distinguish between niche actors and regime actors. For example, entrepreneurs who participated in all five innovation projects (chapters 2, 3, 4, and 5) were either farmers on working farms, or employees of industrial enterprises, contracting firms or trading companies. This observation strengthens the findings of Elzen et al. (2008) that within the agricultural sector most novelties are introduced by established actors (e.g. farmers) instead of new entrants (outsiders). As these participants are established actors, it can be argued that they are part of the current regime, yet are dedicated to developing a specific novelty further. I therefore argue that within the agricultural system innovations no distinction can
be made between niche actors and regime actors. Rather, I observe that actors move about in both niche and regime spaces. Depending on an actor’s perception of, and relation to, the novelty, he or she finds or locates himself or herself in the niche or regime space.

If, in the case of the five agricultural innovation projects, we cannot distinguish between niche actors and regime actors, nor between new entrants and established actors, then what different categories of actors were involved? A distinction can be made between the type of participants in innovation projects. The players generally consist of (i) entrepreneurs, who are motivated to develop, adopt, and use the envisaged novelty; and (ii) researchers, civil servants, other intermediaries, monitors, and other experts involved in the projects who assist the entrepreneurs during the development, adoption, and application of novelties with their knowledge and expertise. The expertise of this latter group (i.e. ii) is needed to develop a novelty that could contribute to agricultural system innovations as these novelties essentially cross diverse disciplines. So interactions between entrepreneurs (i.e. group i) who want to adopt a novelty and experts with diverse institutional backgrounds (i.e. group ii) are needed to develop novelties. I introduce the term *inter-institutional collaboration and learning* to refer to the interactions between actors within and between these two groups to develop a novelty. What can we say about the nature and value of these interactions on the basis of our five cases?

In chapter 3 I investigate the dynamics of inter-institutional collaboration and learning by analysing the interactions between entrepreneurs and researchers in three innovation projects. Inter-institutional collaboration and learning is difficult because scientists, entrepreneurs, and policymakers have distinct working cultures that are poorly matched. Even so, close study of the interactions shows that actors from different institutional settings do manage to interact meaningfully. This raises the question as to what value the interactions bring.

Researchers *re-frame* the proposal of the entrepreneurs to suit the discourse of the science domain. For example, researchers modulated and calculated the entrepreneurs’ initial plans and so drew up technical specifications that provided insight into the magnitude of the input and output streams to be expected. These re-framed proposals provide feedback to the entrepreneurs regarding technical feasibility and opportunities and as such assist in the course of the innovation trajectory. In addition, the example described in chapter 4 indicates that
innovation project participants from other domains, such as civil servants and architects, also re-frame the initial prototype proposals. As chapter 4 focuses on the implementation phase of a prototype, our findings imply that shaping continues throughout the implementation phase. I will return to this issue in section 6.2.

I indicated in section 6.1.a that participants in innovation projects play a role in removing and adding scripting to the design of the entrepreneurial prototype. Chapter 2 reveals that innovation projects participants who support entrepreneurs during contextualisation, struggle with the following dilemma when assisting in shaping a novelty: should they focus on developing a more feasible design even when it is less ambitious, or remain ambitious even if feasibility becomes questionable? I observed that these participants play an important role in guiding and motivating entrepreneurs to inscript numerous valuable features without losing sight of the frames of the entrepreneurs and their commitment to financially invest.

6.1.c. Suggestions for Facilitating Inter-institutional Collaboration and Learning

What do the experiences of the innovation projects tell us about how to facilitate inter-institutional collaboration and learning? From the above, we can distil several challenges to facilitate the process of prototyping. To develop a novelty successfully, actors from very different institutional settings are obviously needed, each of them invited to join the project on the grounds of specific expertise or expected contribution. When these actors introduce their expertise to the group in the way they are accustomed to, however, their differences in language, values and routines will probably prevent any synergy from developing. Behind the Scenes 2 illustrates that when participants in an innovation project follow their usual routines (for example, academic researchers by writing scientific papers and entrepreneurs by waiting for clear-cut recommendations on complex issues), collaboration and collective learning are impeded. Moreover, inter-institutional collaboration and learning may be especially difficult in the agricultural sector because farmers value their independence and are relatively inexperienced in articulating their expectations and visions. What actions can facilitators take in overcoming these inherent tensions of inter-institutional collaboration and learning?
First, facilitators should start by building trust with a small group of participating entrepreneurs (i.e. group i). The analyses of chapters 2 and 3 show that it is often not fruitful when innovation project coordinators start with direct confrontation between the points of view and expectations of the entrepreneurs (i.e. group i) and those of researchers (i.e. group ii). A better approach seems to be to facilitate sub-groups of participants, who share a background and/or vocabulary, to develop and articulate their point of view before sharing this with each other. This is a reflexive process, whereby the various sub-groups alternate between discussing among themselves and interacting with the other groups. This usually lead to the re-framing of ideas.

These observations may fine-tune the message of strategic niche management to facilitators, that visions and expectations should be articulated during the start-up of innovation projects. In the setting of agricultural innovation projects, at least, it seems preferable that facilitators first establish mutual trust in homogeneous sub-groups before initiating the articulation of visions and expectations in a common meeting.

Second, facilitators can assist in increasing the synergy between homogeneous groups by regularly monitoring the development within the groups and assessing the level of consistency between different groups. This way, facilitators can help align the activities within diverse groups without direct group interaction.

Third, I suggest that facilitators develop congruency rather than consensus. Following the work of Grin and van de Graaf (1996), in chapter 3 I explain that congruency refers to the formulation of visions and questions to which each of the involved parties can assign a distinct meaning. In an inter-institutional setting, seeking congruency is recommended over consensus as formulating consensus about what is the most valuable aspect of the goals of the innovation project in an inter-institutional setting is likely to be a never-ending exercise.

Fourth, I recommend that facilitators motivate participants in innovation projects by delegating responsibilities. Chapter 3 demonstrates that making participants who assist entrepreneurs (i.e. group ii) responsible for specific domains assists in advancing a sense of ‘ownership’ and thereby commitment to the innovation project.
Fifth, facilitators can play an important role in safeguarding and adding valuable features to the novelty during the development phase. Chapter 4 shows that facilitators can actively explore the needs of various stakeholders (e.g. community members) and motivate entrepreneurs (i.e. group i) to integrate these needs into the novelty. Chapter 4 focuses on interactions between the participants in innovation projects and stakeholder groups during the phase of implementing a prototype, to which I will return in section 6.2.c.

6.2 Implementing a Prototype

Developing the idea of a novelty (e.g. the concept of an Agropark or a Closed Greenhouse) does not automatically lead to its implementation. What follows instead is a process of deciding where and how to construct the novelty, gaining public acceptance and political approval for its establishment and the act of actually realising the novelty. In the research period of this thesis (2006–2010), several of the innovation projects I studied were attempting to implement a prototype (in particular the Agroparks), and one of them was actually realised (notably Biopark Terneuzen). A relatively large variety of actors is involved during attempts at implementation – not because they are committed to the idea, but because the construction (and its approval) of the novelty falls under their formal responsibility (for instance, those of civil servants and politicians). Or, the novelty will be established in their backyards (neighbours and the local community members). All these actors are part of the socio-technical network of which the novelty will be a part after implementation. In the following sections, I draw lessons from the cases studied with respect to the relationship between the novelties and the socio-technical network (6.2.a), as well as the role of various stakeholders in the implementation process and their influence on the process (6.2.b). Section 6.2.c provides recommendations for facilitating the process of implementing a prototype.

6.2.a. Relation Between NOVELTIES and the Socio-technical Network

What do the interactions between project participants and stakeholders within the broader network reveal about the relationship between novelties and regimes? Geels and Schot (2007) argue that the way in which a novelty is adopted by the socio-technical network depends on whether the novelty has a competitive or symbiotic relation with the socio-technical system. The interactions between the various actors during the development and implementation of the prototype of a
novelty, which are described in this thesis, show a more nuanced picture. For example, the novelty Agropark had competitive as well as symbiotic relations with the socio-technical networks throughout the prototyping phase. Chapter 2 reports that Biopark Terneuzen (i.e. an Agropark), which included the construction of greenhouses, had to compete for users (i.e. growers) with regular greenhouses. Dutch growers were hesitant to use the Biopark Terneuzen greenhouses because conventional greenhouses provided them with the opportunity to use co-generation (i.e. combined sources of heat and power; in Dutch: ‘warmtekrachtkoppeling’). Co-generation installations convert natural gas into heat which is used to warm the greenhouse and electricity which is then fed into the national grid. Furthermore, as the government subsidises co-generation installations, many growers favour these facilities. Apart from competitive relationships, symbiotic relationships can also be found between the novelty Agroparks and socio-technical networks. With respect to the case of the New Mixed Farm (chapter 4), another example of an Agropark, I observed that the novelty Agroparks provided farmers with the opportunity to expand and improve their working farms (see chapter 4).

These examples show that competitive and symbiotic relationships between novelties and the socio-technical network can exist at the same time during the prototyping phase. This ambivalent relationship is understandable because there is a high degree of uncertainty about the potential value of the novelty as well as about any threats to the socio-technical network the novelty may present.

Chapters 2 and 4 show that the uncertainty regarding the value of the novelty impedes the implementation of prototypes. This adverse effect can best be understood when considering that the agricultural system innovation pathway fits the characteristics of the reconfiguration pathways best (see chapter 1, figure 1.2). In the reconfiguration pathway the socio-technical network adopts novelties that are perceived as beneficial. Chapter 4 confirms that some degree of social acceptance is needed to gain permission to reconfigure the socio-technical network when introducing a prototype of a novelty.

The gatekeeping role of the socio-technical network on approving the implementation of prototypes pressures actors in niches to add new and valuable scripts to the prototype. For example, chapters 2 and 4 illustrate how in one version of the Agropark the participants added the ‘extra value’ of not castrating pigs; this action can be considered as ambitious because meat from non-castrated pigs is more difficult to export.
The finding that new values are assigned to novelties during the prototype implementation phase indicates that novelties are also being modified during this stage. Thus, a novelty is not static after the development of a prototype. Prototypes change during the implementation phase as a result of interactions with the socio-technical network.

The Agroparks studied were customised according to the needs and conditions of the local socio-technical network. This sometimes happened by direct involvement, reflecting the needs and preferences of the local community, and sometimes through organised interaction with adjacent parties. As a result several Agropark configurations emerged, because each innovation project developed a novelty in a distinct context. Below I specify how actors within the socio-technical network influence the further shaping of the prototype during the implementation phase.

6.2.b. Role and Influence of STAKEHOLDERS in implementing a prototype

What can be concluded from the interactions between innovation project participants and stakeholders, within the broader network, about the role and influence of the different actors on the implementation of a prototype? This thesis strengthens the notion that diverse actors within the socio-technical network, such as community members, civil servants, financiers, NGOs and politicians, influence the shaping and implementation of prototypes. Although these actors will not use agricultural novelties directly, they will be affected by their implementation and use and will therefore exert their influence to promote their interests (e.g. those of the local community in the case of the New Mixed Farm). There are also participants who have a formal say in the decision-making process regarding adoption (e.g. local politicians). For example, in the case of the Agropark, the support of local politicians is needed to gain the required government approval for implementation, and some measure of acceptance by the future neighbours of the Agropark is needed to avoid hostility. Thus, to varying degrees, diverse stakeholder groups have a say in the decision-making process concerning the implementation of prototypes. In this section I present my finding regarding the role and influence of stakeholders during the adoption of a novelty that I uncovered by exploring the interactions between innovation project participants and its stakeholders.
Chapters 2 and 4 show that stakeholders within the broad network of innovation projects have diverse normative perspectives towards the prototypes proposed. An actor’s normative perspective is greatly influenced by his or her network (i.e. institutional background), expectations, and underlying structures of belief, experiences and appreciation (i.e. frame of reference). As indicated above, all of these stakeholder groups have ways to support or hinder the implementation of proposed prototypes. How does this affect the process of prototyping?

Chapter 4 shows that stakeholders motivate the participants in innovation projects to change the prototype to suit the needs and frames of the various stakeholder groups. For example, innovation project participants ascribe additional meanings to the proposed prototype that are relevant to the stakeholders, who play a role in approving the implementation of the prototype. In the case of the New Mixed Farm, for example, the proposal was also coupled to national policy to reduce manure emissions, as well as to the local policy of municipalities to develop so-called agricultural development sites (in Dutch: ‘Landbouw Ontwikkeling Gebied’). As such, innovation project participants re-aligned the prototype proposal several times to accommodate different perspectives.

In addition, participants in innovation projects modify prototype design to incorporate the values of stakeholders group into the novelty. For example, interactions between innovation project participants and local community members resulted in adding air-filtering vegetation to the architectural landscape design of the prototype. Another example is provided in section 6.2.a; the farmers decided not to castrate pigs at their Agropark.

Furthermore, innovation project participants invest in the development of a supportive social network. Diverse actors such as politicians, neighbours, civil servants, representatives of interest groups, local communities and formers of public opinion are invited to join committees, task forces and work groups to streamline the prototyping phase. Innovation project participants thereby form partnerships with diverse stakeholder groups instead of creating opponents.

So, to cope with the issues that there are different stakeholder groups with diverse normative perspectives and interests, innovation project participants: (i) couple the proposed prototype many times to different frames; (ii) inscript features of value to the prototype design; and (iii) invest in developing a supportive social network.
Why, therefore, do innovation project participants invest in these re-alignment strategies? The underlying assumption is that successful alignment increases the overlap between the frames of reference and the interests of concerned actors and the proposed prototype, thereby increasing the level of acceptance of the proposal and lowering potential resistance to its implementation. Chapter 4 suggests that re-alignment assists in overcoming adoption barriers as the normative stance of stakeholders towards the novelty can change throughout the prototyping phase. Moreover, the perceptions of actors change as new functions and images are added to the novelty and as new political trends emerge.

However, re-alignment does not result in the overall acceptance of prototypes. In chapters 2 and 4 I point out that several actors within the broader network of Agropark innovation projects strongly opposed implementation of the prototypes proposed. This opposition was not only fuelled by conflicting normative perspectives, but also by the fear that the prototype may be harmful to community members, existing businesses and the local environment. The adoption of any prototype usually entails a series of changes throughout the socio-technical network, which inevitably means that some actors will suffer (Collingridge, 1981). However, precisely because the prototype is novel it is difficult to determine in advance who will profit and who will get hurt. This may explain why efforts to change the status quo tend to run into resistance, inertia, lock-ins (with everybody waiting for everybody else) or even result in a backlash. For these reasons, it is unrealistic to expect to achieve full social acceptance of novelties. In the next section some guiding principles are provided to assist entrepreneurs and the coordinators of innovation projects on how to influence levels of acceptance towards proposed prototypes.

6.2.c. Suggestions for Guiding Implementation of Prototypes

What do the experiences of the innovation project tell us about how to facilitate the process of implementing a prototype of a novelty?

So far, I have argued that numerous actors with diverse normative perspectives, attitudes and interests influence the adoption of novelties. Chapter 4 illustrates that during the phase of implementing a prototype, public protest may bring an innovation project to a halt, especially when the local community and NGOs oppose it. In chapter 4 I investigated the interactions between innovation project participants and stakeholders to uncover which strategies innovation project
In chapter 4 I distinguished seven alignment strategies and two de-alignment strategies that facilitators can implement to assist adoption. I divided these strategies into three categories: relational, conceptual, and functional alignment and de-alignment. Below, I explain which types of actions correspond to the three alignment categories and explain the de-alignment strategies separately. In addition, I provide examples of alignment actions that facilitators can take.

First, facilitators can assist the introduction of novelties by developing networks of actors who support the implementation of proposed prototype (i.e. relational alignment by means of recruiting hybrid actors and organising hybrid forums). Hybrid actors can attend to the issues that I raised in section 6.2.a such as: a mismatch between the novelty and the socio-technical network (e.g. task force). The key to securing the commitment of hybrid actors is that they perceive they can contribute to the implementation of a specific prototype. Facilitators therefore need to ensure that hybrid forums have a specific role, which contributes to the continuation of the innovation project. This feeling of relevance by hybrid actors is important for their support as they usually participate on a voluntary basis. When they perceive they cannot make a real difference, they tend to terminate their investments. In addition, in the case of the task force, the assurance of political support was needed to encourage the involvement of civil servants.

Second, facilitators may influence how actors perceive the proposed novelty by adding diverse images and stories of the novelty. Chapter 4 indicates how the project coordinator of the New Mixed Farm pressured the participating entrepreneurs to invest in the development of an attractive architectural design of their envisaged prototype. The project coordinator thereby tried to accommodate to the desire of community to resident in an attractive area. I refer to actions that aim to change the way in which stakeholders perceive the proposed novelty of the innovation project as conceptual alignment. Above, I have introduced the concept of alignment strategies of coupling the concept to problems, policies and/or politics. In addition, project participants reduced uncertainty by testing the validity of the concept by, for example, conducting an environmental and sustainability
impact assessment. This fourth alignment strategy also assists in making potential threats and opportunities explicit and thereby helps to overcome the resistance of actors who were being ambivalent towards the proposed novelties (as indicated in section 6.2.a).

Third, facilitators can recommend to the prototypers (i.e. entrepreneurs) and designers that they make adjustments to the proposed novelty to align to the needs and interests of stakeholders. In section 6.2.b I illustrated the strategy of de-scripting undesirable functions (in this case, castrating pigs). Chapter 4 also shows an example in which the project coordinator proposed to incorporate air-cleaning vegetation to the New Mixed Farm, thereby addressing the interests of the local community. I refer to this strategy as inscripting new functions into the proposed novelty. Also, new design criteria were added throughout the course of adoption to attend to the concerns and desires of stakeholders. I refer to these types of alignment strategies as functional alignment as they entail making adjustments to the intended functions of the novelty.

Fourth, facilitators can try to anticipate opposition from NGOs by interacting with these groups before publicly introducing the proposed prototype. This way, facilitators can try to un-coupling the proposed prototype from the action agenda of the NGOs. During interactions with NGOs, facilitators can negotiate the issues raised by them.

Fifth, facilitators can regularly assess the perceptions of stakeholders regarding the proposed prototype, to ensure that the latters’ perception has not become antagonistic towards the prototype.

6.3 Initial Diffusion

Once a prototype of a novelty has been successfully implemented it may be adopted at many sites, which in turn may lead, in the long term, to its wider application. This wide diffusion may induce a cascade of technical, practical and cultural changes and eventually to a more sustainable agricultural sector. A wider diffusion starts out with pioneering farmers who apply the techniques, processes and products developed in the previous phases. In my thesis I refer to the actors who were the first dozen adopters of a novelty, after the implementation of the prototype, as initial innovators. And I refer to the phase of implementation and usage of novelties, by the initial innovators after prototyping, as initial diffusion. I
noted in this thesis that current system innovations studies pay scant attention to the initial diffusion phase. Studies in the field of system innovation that do address the initial diffusion of novelties often analyse the entire system innovation process from pre-development until stabilisation (e.g. Geels, 2005; Geels and Schot, 2007), but are generally less specific on the experiences of the initial innovators. In this section I focus on the experiences of initial innovators during the initial diffusion phase. First, my research gives insight into how novelties continue to be shaped during the initial diffusion phase by initial innovators (see 6.3.a), and second, into the role of the different actors involved (see 6.3.b). Furthermore, my research provides lessons for policymakers on how to support the initial diffusion of novelties (see 6.3.c).

6.3.a. NOVELTIES and Initial Diffusion

What do the interactions of actants in the network of initial innovators who implement and use a novelty after the realisation of a prototype uncover about the nature of novelties?

Based on interactions of actants in the network of initial innovators, lessons can be learned regarding the theoretical understanding of agricultural system innovations. It appears that the common depiction of novelties as rather static artefacts has to be adjusted. As illustrated in chapter 5, the novelty (semi) Closed Greenhouse was repeatedly opened-up after the prototyping phase.

Linkages between bits and pieces were broken down; new parts were incorporated, and new linkages were created. I introduced the term re-contextualisation to refer to the process in which prototypes and early versions of a specific novelty are re-constructed by actors who want to adopt and use the novelty (i.e. initial innovators). This observation that novelties are subject to change during the initial diffusion phase receives little attention in system innovation and transition studies. Rather, from Geels and Schot’s (2007) study, we may infer that novelties are rather static entities. In the representations of pathways that best typify agricultural system innovations, novelties are depicted as constructs that do not change over time (see the square, triangle and pentagon portrayed in figure 1.2 p. 13). Geels and Schot (2007) refer to these static objects as add-ons or component replacements. In contrast to the more dynamic picture that emerged from chapter 5, I call those novelties as described by Geels and Schot closed, following the idea of ‘closure’ as described by Pinch and Bijker (1984). They
define closure as the stage in which the artefact reaches its final form (i.e. it stabilises). Before this closure, artefacts are open to more than one interpretation as social groups give different meanings to new technologies. Pinch and Bijker (1984) label this phenomenon interpretative flexibility.

Chapters 2, 4 and 5 show high interpretative flexibility for the novelties Agropark and (semi) Closed Greenhouse, which resulted in multiple configurations (i.e. regional adaptations) of these novelties (see also section 6.1.a). This suggests that closure of novelties does not occur after the implementation and usage of the prototype. I therefore argue that in the initial diffusion, the novelty is not something ‘static’. On the contrary, there is ample room for different interpretations, configurations, and ‘framing’ of the novelty.

6.3.b. Role of INITIAL INNOVATORS

What do the interactions of actants during the implementation and usage of novelties reveal about the role of initial innovators during the phase of initial diffusion of novelties?

One group that plays a gatekeeping role in the initial diffusion of novelties are initial innovators. Initial innovators introduce novelties in the socio-technical network in which they are embedded. The question then is what the interactions of initial innovators during adoption of novelties reveal about the role of initial innovators during the initial diffusion phase. In chapter 4 I argued that different social groups give different meanings to novelties during this phase. Chapter 5 shows that high interpretative flexibility with regard to a novelty exists between different social groups, and also within a social group, as a result of which initial innovators may have diverse reasons for adopting a novelty. In the (semi) Closed Greenhouse, the interpretative flexibility of initial innovators and specific local contexts resulted in multiple configurations of the (semi) Closed Greenhouse. Those initial innovators who adopted the (semi) Closed Greenhouse re-contextualised (i.e. reconstructed) it accordingly.

There is uncertainty in the process of re-contextualisation, as there is no prior working experience of these new configurations. Chapter 5, for instance, illustrates that several initial innovators observed undesirable crop behaviour (e.g. among tomato plants) when grown in their particular (semi) Closed Greenhouse. The
initial innovators who encounter unforeseen and impaired functioning of reconstructed novelties seek solutions by consulting and experimenting. For example, as shown in chapter 5, several initial innovators introduced test plots in a working (semi) Closed Greenhouse to investigate diverse climate conditions. This experiment resulted in the acquisition of fundamental and practical knowledge regarding the functioning of the (semi) Closed Greenhouse. Furthermore, the innovation project Synergy played a crucial role in assisting experimentation, knowledge development and knowledge sharing. Based on this, in section 6.3.c I assess the interactions that took place in the network of Synergy to provide lessons to guide initial innovators during the initial diffusion phase.

It can thus be said that initial innovators fine-tune novelties by means of reconstruction and experimentation. This fine-tuning is crucial for maturing the novelty into a final model. As indicated above, when a novelty reaches its final form, it stabilises (i.e. achieves closure). This stabilisation is necessary to achieve the rapid wider application novelties. However, chapter 5 also shows that entrepreneurs have a tendency to wait for the next generation of a novelty, whereas this next generation needs to be modified and adapted by these very entrepreneurs. To overcome this inertia, I suggest how to assist initial innovators who are considering implementing a novelty during the initial diffusion phase.

6.3.c. Suggestions for Policy to Stimulate INITIAL DIFFUSION

What do the experiences of initial innovators tell us about how policy could stimulate the wider implementation and usage of novelties?

Based on the above analysis, several types of innovation policy can be formulated. Chapter 5 indicates that the initial diffusion of novelties does not mean simple straightforward implementation by initial innovators; rather it means entering into a learning trajectory. Also, it illustrates that initial innovators play an important role in the practical development of novelties by testing diverse models in various settings and providing valuable feedback to the designers. This joint construction of new technology, that may help on the path to sustainability, could be supported by government policies.

The policy assessment in chapter 5, however, reveals a discrepancy between the needs of initial innovators and current policies aimed at stimulating initial diffusion. While the initial innovators need expert assistance in problem solving
related to the learning about the novelty in practice, current policies concentrate on providing subsidies aimed at overcoming financial obstacles. If government policy is to support the initial diffusion of novelties, I suggest that to further shelter the novelty during initial diffusion phase. In particular, I recommend developing the kind of assistance that facilitators can provide in innovation projects. Facilitators can transcend the business, policy and science domains and facilitate the alignment of actors within them. Below I summarise other strategies that facilitators can adopt to assist initial innovators during the implementation of novelties.

First, facilitators can establish and organise learning groups for initial innovators. The latter can share experiences with the aim of improving each other’s practice (such as by cultivating a community of practice (Wenger et al., 2005)). Chapter 5 also shows that such learning groups can provide moral support to initial innovators when unexpected, adverse consequences of their actions occur (e.g. the folding of the tomato leaves in a pioneering greenhouse).

Second, facilitators can motivate and assist initial innovators in professionalising and sharing their knowledge. Chapter 5 reports how coordinators of the innovation project Synergy motivated innovators to expand their experimentation. In addition, Synergy supported knowledge sharing by developing a standard approach for screening the performance of (semi) Closed Greenhouses performance. Furthermore, Synergy instructed researchers involved in this project to develop a database to record systematically the results they obtained and to assess them.

Third, facilitators could use their network to seek potential investors to share financial risks of initial innovators. Additionally, facilitators could also play the role of intermediating between the innovators and investors.

Last, I note that facilitators can play an important role in ensuring that initially added values keep being incorporated into the novelty. Moreover, the facilitators can take advantage of the flexibility of the novelty during initial diffusion and suggest how the initial innovators might enhance the novelty by adding new valuable features during reconstruction.
6.4 Concluding remarks

In this section I formulate recommendations for further research on the subject of novelties and actors, in the context of agricultural system innovation and in other contexts. I end this section with an epistemological suggestion to scholars in the field of system innovation.

This thesis shows that agricultural system innovations are complex as they involve contextualisation, re-alignment and re-contextualisation of novelties. In the cases that I studied, novelties were still being developed during the initial diffusion phase (e.g. of (semi) Closed Greenhouse). We can anticipate that novelties eventually reach their final form and so stabilise. Such closure (i.e. the stage of stabilisation) is seen as an important condition for the rapid diffusion of innovation (Geels, 2005; Rogers, 2003). Insights into the dynamics of closure of novelties could assist in guiding wider application in practice – a crucial phase for achieving agricultural system innovation. Hence, I recommend that scholars in the field of system innovation investigate further the phenomenon of closure of novelties in depth. It can be anticipated that closure of a large architectural structure, such as a farm, differs from that of a manufacturer of goods such as pens, bicycles and cups. Relevant questions are therefore; to what extent do agricultural novelties close fully? and to what extent is the closure of novelties required for their diffusion? and how can one facilitate the closure of novelties?

The findings that are presented in this thesis also provide insight into the role and influence of actors in agricultural system innovations. The interactions of actors in the network of innovation projects show that a distinction between niche-actors and regime-actors is inappropriate as all participants are part of the agricultural socio-technical network. Rather, actors move about in niche and regime spaces. It would be interesting to explore what motivates certain actors to operate in niches rather then following the mainstream? Is it possible to distinguish between actors who prefer operating in a niche space and those who prefer the support of the established regime? Further research on these topics is recommended.

Furthermore, it is important to note that the research presented in this thesis is based on two novelties in the agricultural sector. It would be interesting to investigate to what extent the findings would be of use in other domains of system innovation such as the health and the energy sectors.
To conclude, this thesis demonstrates that agricultural system innovations require inter-institutional collaboration and learning among farmers, researchers and civil servants in niches. It also entails negotiation between project participants and other stakeholder groups that will be affected by the adoption of a novelty. And it demands experimentation and knowledge sharing between initial innovators, during the initial diffusion stage, to refine the novelty. This thesis has examined in detail the interactions of actants during the prototyping phase and the initial diffusion of novelties. These interactions revealed that tensions (i.e. dilemmas) are an inherent part of system innovations and that actors struggle with recognising these tensions in their different guises. I invite scholars to expand their engagement with actors in niches, and to actively assist actors in niches by making the tensions a continuous part of the learning process.