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The Sectoral Innovation System of the Dutch Vegetable Breeding Industry

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ABSTRACT

In a number of studies, the Dutch vegetable breeding industry has been described as a highly innovative sector, but the root causes for its innovativeness have not yet been analysed systematically. In order to understand the factors that affect innovation and business performance, the Sectoral Innovation System (SIS) framework was used to analyse the linkages and interactions among the different actors in the Dutch vegetable breeding industry. Within SIS, five interacting domains are recognized and analysed: the business domain, the research & education domain, the intermediate organizations, the market demand, and the infrastructure & framework conditions, resulting in an integrated picture of the innovation system. It was found that the business domain, the research & education domain and the intermediate organisations do not only show an outstanding individual performance, but more importantly, they closely collaborate via public-private partnerships (PPP), research consortia, etc. It is shown that especially the cluster characteristics of the Dutch vegetable breeding industry, i.e. the geographical proximity and the high level of intra- and interconnectivity within and between domains, induces an intensive knowledge flow, a key indicator for the innovation level of a sector.

1. Introduction

After one century of development of the plant breeding business, the Netherlands has become the major exporter in the world of starting materials of plants, representing an increasing export value of 2.5 billion euro [1]. Dutch companies enjoy positions as global market leaders in plant reproduction material (seeds, cuttings, plantlets for ornamentals, potatoes, flower bulbs, grasses, and vegetable seeds). This position is based on craftsmanship, entrepreneurialism and innovation, and as a result the Dutch breeding industry is cited as one of the most innovative in the world [2]. Particularly in the vegetable breeding sector, companies with their basis and main premises in the Netherlands account for about one third of the worlds' vegetable seed exports and one eighth of the world vegetable seed imports [3]. This makes the Netherlands both the largest vegetable seed exporting as well as importing country. Over the past three decades, the vegetable breeding industry has become more and more consolidated due to many mergers and acquisitions. As a result the top ten vegetable breeding companies now account for over 85% of the vegetable seed market in the world [2], and most of these top ten companies originated in the Netherlands or have important R&D facilities in the Netherlands. This successful industry is playing important roles in the Dutch public domains related to food, agriculture, trade and the environment [4], as its innovations in this first phase of food production and food processing finally affect the whole supply chain [5]. It is, therefore, of particular interest to uncover the underlying factors that made the Netherlands outstanding and the most innovative in this field, so that other industrial sectors may benefit from this. Although the major task of breeding companies is developing new cultivars, innovation here is more than just developing cultivars. It also includes, new ways of organization, marketing, production and sales.

In a number of studies, the Dutch vegetable breeding industry has been described as a highly innovative sector, but the reasons for its innovativeness have not yet been analysed systematically

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[5–8]. Generally speaking, the development of new products and processes is not only based on the creativity of the individual researcher, entrepreneur, company or research institute, but rather the result of interaction and co-operation within a much larger system [9]. In other words, innovations are dependent on the interaction between the proprietary and external knowledge stocks of stakeholders in the system [10]. Connections across firms and industries have been shown to be fundamental to competitiveness, productivity, and (especially) to the direction and pace of new business formation and innovation [11]. Successful innovations require a collective effort to join together people, ideas and targets that were previously separate, and an effective networking among heterogeneous entries spanning various markets and technologies [12]. In this study, we used the framework of the Sectoral Innovation System (SIS) that was derived from the National Innovation System (NIS) model of Arnold and Bell [13], and we further developed SIS by putting more emphasis on the knowledge flow within the system [14].

The paper is organized as follows. In Section 2, we introduce the theoretical framework of SIS. In Section 3, on research context and methodology, the methods of data collection and analysis are described. Then in Section 4, the results from different domains of the Dutch vegetable breeding industry are presented, and in the final Section 5, we present the integrated picture of the SIS of this industry, in the discussion and conclusions.

2. Theoretical framework

Innovation is widely recognized as one of the major drivers of business success. Theories on innovation have gradually expanded their focus and complexity, beginning with the individual company or entrepreneur, and moving to a broader view on the environment and industrial sector in which the company operates, and finally encompassing the national system of regulations, institutions, human capital and governmental policy [15]. The NIS approach is based on the premise that understanding linkages among the actors involved in innovation is key to understanding their innovative performance. From this perspective, the innovative performance of an economy depends not only on how the individual institutions perform in isolation, but also on how they interact with each other as elements of a collective system of knowledge creation and use, and on their interplay with social institutions (such as values, norms, legal frameworks) [16].

Arnold and Bell [13] have developed a framework for NIS that is simple and integrative, including all NIS actors, such as companies, universities, research institutes, technology transfer agencies and technology policies [17]. Moreover, the model also takes institutional aspects into account, which are defined by new institutional economics, such as trust levels, standards, norms, rules or laws, etc., and also the typology of actors within an innovation system [18,19]. In recent years, the NIS framework has been used to analyse certain countries, such as all OECD countries [20], Norway[16], China [21]. In other cases, the focus was on the innovation system around a new technology, such as biotechnology [22–24], but also industrial sectors, such as the cocoa industry [25], copper mining industry [26] and IT industry [27]. In this study, we applied the SIS approach for the analysis of the vegetable breeding industry in the Netherlands. Cohen and Levinthal [10] showed that the interaction between proprietary and external knowledge stocks is important to the performance of a SIS. We therefore further developed the model of Arnold and Bell [13] by putting more emphasis on the knowledge flow within the system.

For the analysis of the Dutch vegetable breeding industry, we evaluated the five principal domains that constitute SIS of the Dutch vegetable breeding business. We analysed how the flow of knowledge is organized between: 1) The business domain, with a focus on breeding companies that apply and use codified knowledge and produce mainly tacit knowledge; 2) The research & education domain, with a focus on the professional and higher education and research institutes that produce and transfer codified knowledge; 3) the intermediate organisations that stimulate knowledge transfer and application; 4) The market demand referring to the final demand from consumers and intermediate demand from other actors in the production chain; 5) The infrastructure and framework conditions that include the more general aspects that can influence innovation, such as finance, taxation, and mobility. It is hypothesized that the available stock of knowledge and the knowledge flow generated in and among the first three domains play an important role in the innovation performance of the breeding sector. It is expected that the other two domains, market demand and infrastructure & framework conditions influence this process. The arrows in the theoretical framework (Figure 1) represent the main flows of knowledge. In section 4, the five domains of the Dutch vegetable breeding sector will be analysed in more detail.

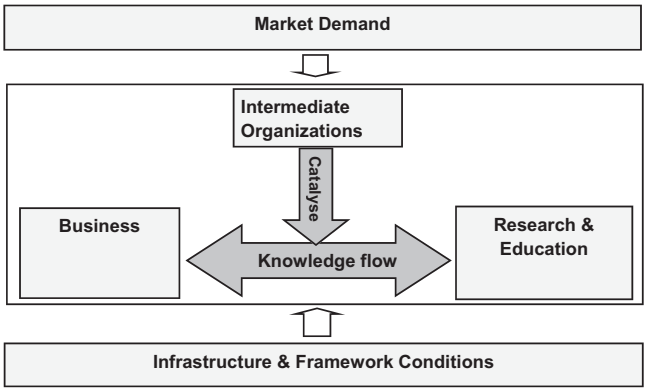

Figure 1. Theoretical framework for a sectoral innovation system
Source: adapted from Arnold and Bell [13].

3. Research methods

To ensure the validity of data collection and analysis, we have used a triangulation approach, by looking from different angles at the same phenomenon, and by using different data collection strategies and data sources [28–31]. We applied different data collection strategies for the business domain, research & education domain, and intermediate organisations domain. Archival data, such as time series of fiscal statistical year books from both domestic and international sources and regulations and governmental documents of the breeding industry, were checked, summarized, and compared.

In analysing the business domain, the Dutch vegetable seed sector appeared to be highly consolidated with only 28 companies active in the vegetable seed market. Many of them are only active in producing and selling seeds. Only ten companies could be identified as integrated seed companies that were active in breeding, seed production, and sales, and had a reasonable size (> 10 employees). All other companies in this seed sector were either smaller or only active in trading seeds. The integrated seed companies were either private family-owned companies or part of large multinational companies (Table 1). We visited and interviewed the senior managers of all 10 companies, using a semi-structured interview and questionnaire. In each of the visited companies, one or two senior managers were interviewed for 1-2 hours and asked to fill in the questionnaire. The following six aspects were discussed: 1) history and current organization of the company, 2) business