2 Project overview

2.1 Problem analysis and societal impact

2.1.1 Problem analysis

The consortium came together on two sessions for a brainstorm on the problem analysis and societal impact of our case following the impact analysis pathway. The text below is a reflection from these consultations.

Farming provides the basis for an economy and farmers are seen as stewards for the natural environment in which they live. Yet, the drive since the fifties to produce more for less has had many detrimental consequences for the environment. Biodiversity is showing a rapid decline for many decades both in agricultural and more natural environments [1, 2]. Habitat fragmentation and the ongoing intensification of agriculture are among the main drivers of biodiversity loss [3-6]. Various programs designed to halt biodiversity loss both by governments (NL and EU) and private initiatives (Deltaplan Biodiversiteitsherstel) have not (yet) resulted in 'bending the curve'. The widespread use of insecticides is considered particularly harmful for biodiversity, but also affects water quality and human health.

The loss of biodiversity in agricultural systems has also resulted in a loss of ecosystem services provided by biodiversity, including those that are important for agriculture itself, such as soil fertility, pollination and natural pest control [7, 8]. The loss of these ecosystem services make agriculture more dependent on external inputs, which has created a vicious circle: e.g. the use of insecticides reduced the number of natural enemies, further increasing the need to use insecticides [9].

Farmers, policymakers, the value chain, scientists and consumers all agree that we need to make changes to the way we produce our food. The pathway towards this change is an ongoing debate. What is clear is that to comply with European standards for sustainable farming, the use of pesticides and fertilizers and their spread towards the environment need to be reduced. Some pesticides are so harmful for the environment or pose a risk for human health that they will be banned in the near future. This brings farmers in a difficult position when no alternative solution is available while the market demands they continue producing the same yield and quality as before.

Arable farmers in the Netherlands and society at large are thus in urgent need of alternatives to chemical-based pest control. Functional agrobiodiversity (FAB) measures aim at restoring the ecosystem services that contribute to agriculture itself, thereby increasing sustainability and biodiversity in general. Natural pest control is such an ecosystem service, which is greatly supported by well-designed landscape structures such as FAB field margins and hedgerows, while also methods of crop field management can support the species that contribute to pest regulation. FAB not only offers a potential alternative for chemical pest control but also has direct positive effects on overall biodiversity in and around production systems. Despite its benefits, FAB as an alternative approach to chemical pest control is not yet widely practiced in arable farming in the Netherlands.

We identified three **causes why FAB is not mainstream or considered a viable option for pest control** in arable farming in the Netherlands:

1. Current farming practices and agricultural landscapes do not sufficiently facilitate natural pest control. Intensive agricultural practices are associated with habitat loss and poor quality of remaining habitat for natural enemies of crop pests. In particular, the limited availability of floral resources, loss of hedges and other semi-natural habitats lead to low abundance and diversity of natural enemies. Agroecosystems are thus deficient in terms of natural pest suppression. Several studies demonstrate that simply adding floral resources, hedgerows or other semi-natural habitat does not always adequately improve natural pest control. What is required is a good understanding of the species involved in pest control and providing the means to support them, i.e. by specific flowers that the natural enemy uses for feeding but which are not employed by pest insects [10, 11]. We do know a lot about the natural enemies of aphids, but for some other pests more knowledge on their natural enemies and how to enhance them is required. We also need more knowledge on the responses of pest insects to FAB-measures, to design FAB-measures that support the control of all pest species in a cropping cycle.
2. There is little incentive for farmers to switch from chemical- to FAB-based pest control. Current agricultural business models and pricing in the value chain are based on relative cheap chemical pest control. Costs and benefits of chemical versus FAB-based pest control cannot easily be compared, because of (a) differences in spatial scale of application and the reach of benefits that often goes beyond the individual farm, (b) differences in private costs and public benefits (biodiversity, human health, quality and attractiveness of landscapes), and (c) differences in temporal scale, with FAB investments that yield (financial) benefits only in the long term. Chemical pest control has a low crop failure probability, is relatively cheap, easy to apply and works quickly. In contrast, FAB requires longer term investments of with uncertain benefits, requires more labour and expertise for (manual) monitoring, and faces unknown risks and securities. We lack knowledge on the economic, political, social, and psychological conditions

needed to motivate farmers to switch from chemical to FAB-based pest control in arable farming. We also lack knowledge on what society and consumers are willing to pay for products produced using FAB.

3. FAB aspects are not yet included in pest management decisions. Farmers lack specific knowledge on how to apply FAB on their farm. FAB-based pest control requires better monitoring of pests ánd their natural enemies to make well-informed past management decisions, however monitoring is still labour-intensive. Damage-thresholds would need to be context-specific, where expectations on trends take the presence of natural enemies and FAB-measures into account. FAB is not an integral part of (agricultural) education, hence farmers and advisors are not sufficiently knowledgeable about natural enemies and 'working with nature' and monitoring biodiversity. As a result, there is a lack of knowledge and thereby uncertainty on FAB effectiveness, and a lack of insights into risks of crop failure under various FAB measures. We lack validated decision rules based on damage-thresholds for a pest management system where FAB-measures are fully integrated for arable farming in The Netherlands.

FABforward employs an interdisciplinary research approach to acquire the knowledge gaps identified above, that requires agronomical and ecological knowledge, insights in socio-economic drivers and barriers of farmers to adopt FAB-measures, and knowledge on the necessary changes in policies and regulations. To find solutions for enhancing natural enemies of pests of all crop types is not possible within the time window of this project. We therefore focus on the four main arable crop types in the Netherlands that together comprise more than 75% of the cultivated area. These crop types included cereals, ware and starch potatoes, sugar beets and onions. For each crop type we choose one or two key pest species for which we aim to enhance natural pest control. These pests include species from aphids, leaf beetles, root flies and thrips. By enhancing generalist predators for the key species, we assume that also secondary pest species will be reduced in number. Moreover, the FAB measure to enhance natural enemies designed for our focus crops and key pest species may also be benefit natural pest control of similar pest species in other crop types.

2.1.2 Societal impact

From a policy point of view, **FABforward** is closely aligned with strategic goals of connecting agriculture and nature of the Uitvoeringsprogramma Toekomstvisie Gewasbescherming and National Programma Landelijk Gebied, and with various other strategic policy goals, such as development of nature-inclusive agriculture as set out in the Agenda Natuurinclusief, water quality goals as defined in the Kaderrichtlijn Water, and improving the conditions of natural habitats for Basiskwaliteit Natuur. **FABforward envisions a future in which agriculture and biodiversity are balanced, meaning that agroecosystems are robust and stable, soils and landscapes are healthy and more biodiverse, and farmers are rewarded by society for their work as healthy food providers and biodiversity care takers.**

This implies a substantial reduction in the use of pesticides in arable farming systems, and that FAB-measures are an integral part of Dutch arable farming in a climate-proof agricultural system. This also requires that society and authorities favour FAB-based arable farming through a positive societal view on FAB-farmers and their produce, with political and legislation conditions favour FAB, and with agricultural payments that reward the use of FAB measures for pest control, using monitoring data that show the positive effects of FAB on biodiversity. To bridge financial gaps that exist between the costs of FAB adoption for farmers, and the risks involved when adopting FAB measures, FAB needs to be supported by the entire value chain, making FAB economically viable. This may entail that farmers using FAB-based pest control instead of pesticides receive a price premium for their products through food value chains, but may also means that banks and insurance companies facilitate FAB implementation through external finance and economically viable insurance contracts. Ultimately this should lead to farmers successfully implementing FAB in climate-proof arable farming in the Netherlands, such that pesticide-use is minimal (only as a safety net) because pests and diseases are mostly controlled naturally, and pest management decisions are supported by monitoring data and reliable model predictions on both pests and biological control agents.

2.1.3 Assumptions

1. Current practices in arable farming have a major negative impact on biodiversity in the Netherlands, and we assume that these practices can no longer be maintained under current societal and policy demands and needs. Alternatively, the use of pesticides has no viable alternative on a large scale, and will remain an integral part of pest control. We assess this assumption by keeping track of policy developments in the Netherlands and the EU.
2. We assume that a key reason for not adopting FAB measures on a large scale is that current measures for natural pest control are not sufficiently specific, and that knowledge on their effectiveness and consequences is lacking amongst farmers. This is reinforced by limited practical experiences and missing knowledge on simply how to apply FAB measures in the field, what the practical consequences are and how to deal with these. Alternatively, current FAB measures are proven effective and knowledge among farmers is high, implying that there are more important factors that prevent adoption, which we investigate during the project.