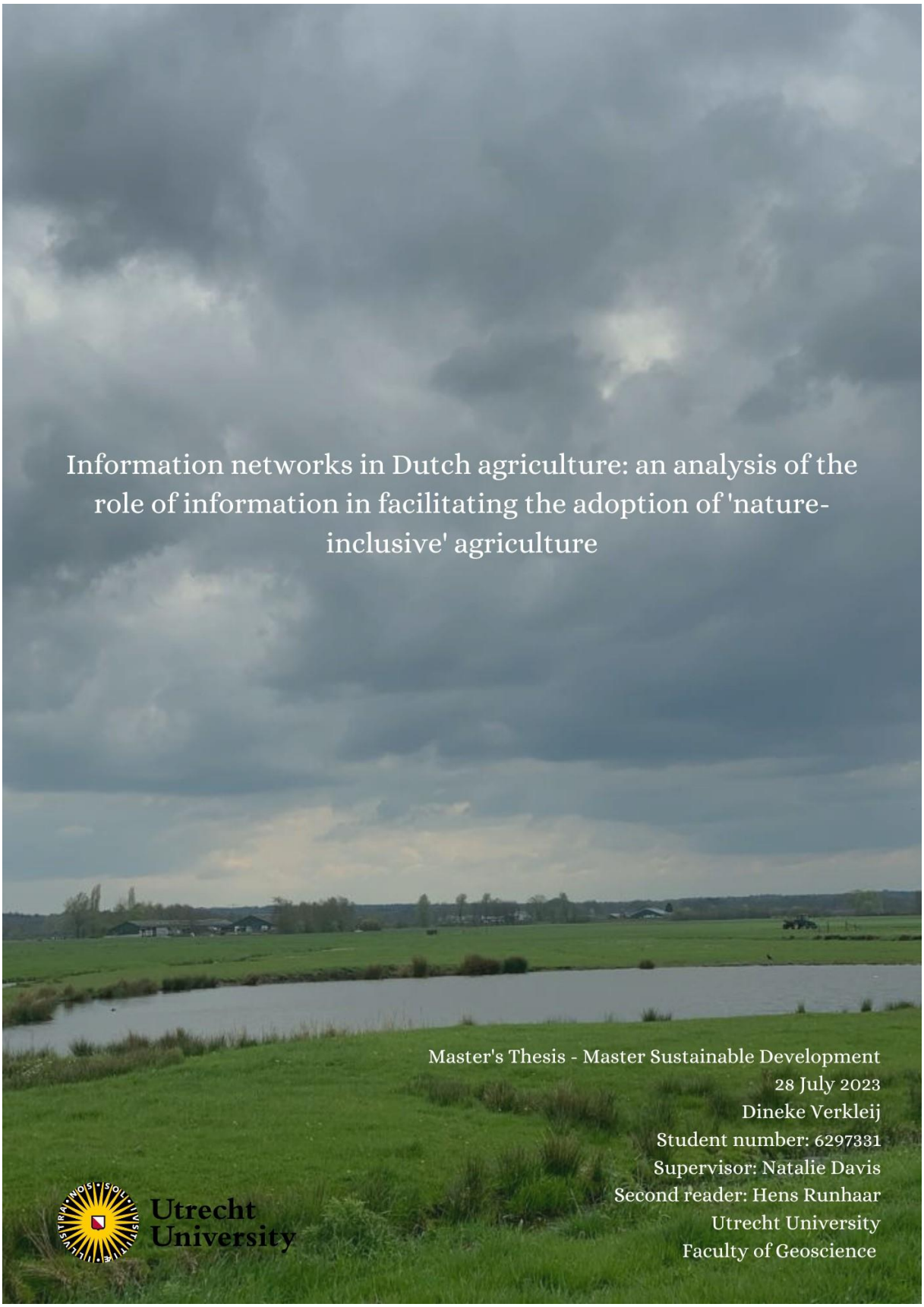

Information networks in Dutch agriculture: an analysis of the role of information in facilitating the adoption of 'nature-inclusive' agriculture

Master's Thesis - Master Sustainable Development

28 July 2023

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Summary of research

In this study insight is gained into the exchange of information among Dutch farmers and other sources affecting their transition to sustainable agricultural practices. The focus is on how farmers interact with information while considering or adopting nature-inclusive agriculture (NIA). The Netherlands has widespread intensive agriculture, negatively impacting species abundance and nitrogen levels. To address this problem, the Dutch government introduced NIA as an alternative practice aiming for a positive, reciprocal relationship between farm management and natural capital (Van Doorn et al., 2019). NIA's transformative potential has gained attention, but its adoption remains low (Vermunt et al. 2022). While a few empirical studies have explored the process of transitioning to sustainable farming there is less understanding of the role of information and its transformative potential concerning NIA.

This study explores how the lack of NIA adoption is affected by how Dutch farmers gather, interact with, and apply information, as it is influenced by their subjective evaluation. Therefore, the research objective is to gain insight into the various types of information sources within a farmers' network that either enable of hinder transition to NIA. This is achieved by developing a social network analysis that captures the interaction with available sources by farmers. Transition theory of Gosnell et al. (2019) is utilized to analyze how these information sources can either facilitate or hinder the shift to NIA, combined with social identity theory.

A case study is conducted with seventeen farmer interviews in the south-west of the Netherlands. The findings highlight the significance of farmers' identification with information sources, particularly when those sources align with their farm and business characteristics, as well as their value orientations, and differ from strong, one-dimensional nature-oriented approaches. Results particularly highlight the importance of bidirectional information exchange in evaluating information as trustworthy or relevant. Acknowledging the multifaceted 'farmer's identity and considering relevant business attributes can enhance the effectiveness and acceptance of information dissemination within the agricultural context. Such insights contribute to a deeper understanding of how information exchange influences decision-making processes among farmers, and they can be used to guide efforts to disseminate information within the mode of public-private partnerships.

Key concepts: *Nature-inclusive agriculture; Transformational adaption; Zones of friction and traction; Social identity approach; Famers' identity*

Wordcount: 15.521

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1. *Introduction*

In the Netherlands, highly intensive agriculture is found throughout the country. The dairy production is a sub-sector that occupies more than a quarter of the total land surface of the Netherlands (Centraal Bureau van de Statistiek, 2021). Conventional agricultural production in the Netherlands affects the local ecosystems resulting in alarming environmental costs. Nowadays, the conservation status of many species and habitats in the agricultural landscape such as grassland and croplands are endangered resulting in a decrease in biodiversity (EEA, 2015). Moreover, the dairy sector is responsible for 25% of the total nitrogen deposition in the Netherlands, which causes high levels of acidity in the ground that disrupts native ecosystems (Sikkema, 2019). A transition towards alternative farming practices and land use is therefore encouraged by the government, research institutes and non-governmental organizations as well as farmers themselves who organize in nature agricultural organisations (NAVs).

In response to the abovementioned ecological costs, the Ministry of Economic Affairs introduced a public policy vision for Dutch nature to transform the current agricultural management towards Nature-inclusive agriculture (NIA) (Ministerie van Economische Zaken, 2014). NIA is an attempt to pursue a positive, reciprocal relationship between agricultural management and natural capital (Van Doorn et al., 2019). In the conceptualisation of NIA, three dimensions are identified; (1) the care for nature, meaning that landscape and nature management is focused on the conservation of specific species and the creation of landscape diversity; (2) the use of functional biodiversity, meaning the care and use of ecosystem services such as pollination, pest control and nutrient cycling instead of chemical inputs; and (3) reducing environmental impact, by efficient use of resources and decreasing emissions (Van Doorn et al., 2019) (Figure 1). In practice, examples of implemented measures are diversification of the sward and more permanent grassland to improve the above- and below-ground biodiversity, as well as soil carbon storage, and extensification of the farm, i.e. reducing the number of livestock units per hectare of grassland (Vermunt et al. 2022).

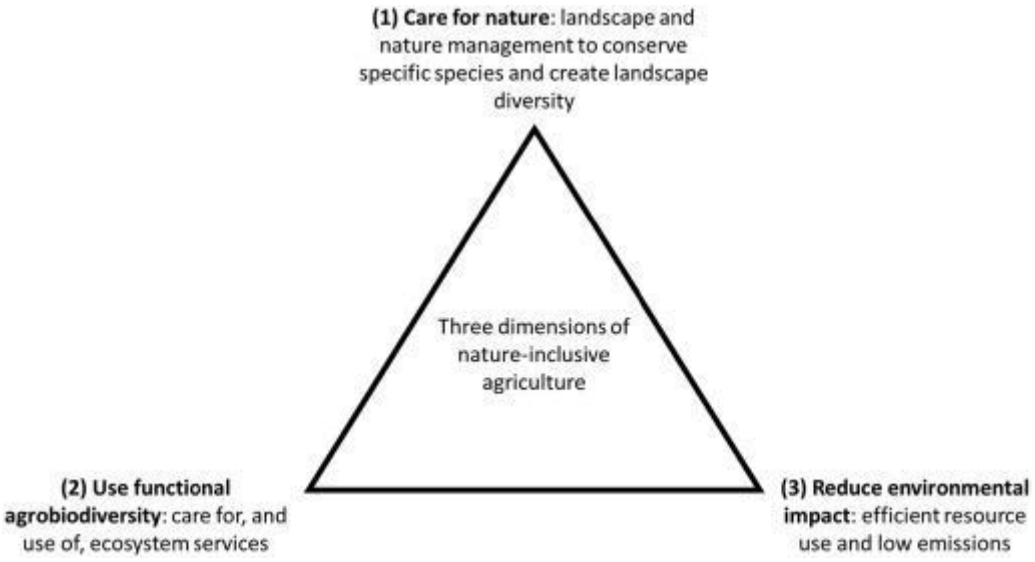

Figure 1. Definition of Nature-inclusive Agriculture taken from Vermunt et al. (2022)

NIA differs from other practices in the Dutch context, such as regenerative agriculture, organic agriculture and circular agriculture in solving environmental issues. NIA, similar to agroecology, directly targets biodiversity and integrates the use of nature (so-called functional agrobiodiversity) in agricultural management. Regenerative, organic and circular agriculture differ from NIA due to their indirect approach to target biodiversity, such as the aim to stop using chemical fertilizers (Vermunt et al., 2022). Individual practices in all these ways of agriculture can to some extent overlap. For instance, NIA also encourages reducing or stopping the use of chemical fertilizers as a part of their discourse. To understand NIA in practice therefore, it is useful to understand the management of the farm on a continuum of relatively high degree of implemented NIA, or a relatively low degree of implemented NIA.

Several studies have been conducted focusing on NIA (Runhaar et al., 2018; Polman et al. 2018; Smits et al. 2019). These studies focused on bottom-up initiatives in realizing NIA and the economic sustainability of such practices. Often, these studies have a hard time presenting how farmers perceive NIA. Moreover, despite the efforts to enhance biodiversity via public policy, the implementation of NIA is found to be limited in the Dutch dairy sector (Vermunt et al., 2022). Vermunt et al (2022) discovered the following problems; (1) insufficient economic incentives for farmers, (2) limited action perspective of many dairy farmers in the Netherlands, (3) lack of concrete and shared vision, (4) lack of specialized and integral knowledge, and (5) resistance to overall system change related to the abovementioned blocking mechanisms (Vermunt et al., 2022).

The abovementioned problems indicate barriers in the implementation of NIA in the Netherlands. However, there is not yet a detailed understanding of processes prior to the decision to implement NIA. In the case of farmers that consider implementing or did implement NIA, insights into the process that underly this consideration could help encourage a broader transition to NIA. For example, since research and policy makers have indicated an interest (Cupercus et al. 2019; Bouma et al. 2020; Westerink et al. 2019) in understanding farmers networks present in the Netherlands, identifying characteristics of the social networks of farmers that transition to more sustainable practices, together with understanding the processes prior to their decision to transition, could provide insights to accelerate the transition in the Netherlands.

Specifically, looking at how information travels through networks of farmers could provide a starting point to understanding what drove or enabled their transitions. Information is broad, and plays a pivotal role in influencing decision-making. Through association and interpretation of facts and data, meaningful information is developed (Bawden, 2007). As information is subject to interpretation, it remains intrinsically tied to individuals cognitive processes (Bawden, 2007; Ford, 2004). Humans consciously attribute meaning to information and engage in its interpretation. Knowledge, consequently, embodies the assimilated and accessible information residing within an individual (Stone, 2012). This knowledge subsequently informs their actions, thus becoming intertwined with experience and practical application (Stone, 2012). An individual then regards certain information as 'known' by contextualizing it within their personal circumstances.

We can understand sources of information as a part of the system of a farm (Meadows, 2007). What is meant by farm system, is that information acquired by a farmer can determine the way in which a farm is managed. For example, information about new technologies or materials for a farmer can be acquired in a social context via neighbours. This information can influence practices in agriculture. How the farm then operates can thus be understood to depend on the interpretation of this information, and can be affected by delayed, biased, scattered or missing information (Meadows, 2008). Hence, such malfunctions could be interesting to explore in understanding what hinders or facilitates the adoption of NIA for farmers.

For example, Cupersus et al. (2019) explain that the information on NIA is dispersed, difficult to find and incomplete, and that farmers are obliged to search for information they personally find necessary. This in turn in also influenced by the individual motivation of a farmer to actively search for information. Cupersus et al. (2019) therefore argue that there is a risk of non-optimal use of the information available and that this slows down the transition. It is premature to assume that information is a force that hinders the adoption of NIA, especially since literature has shown that the

absence of incentives and economic viability is a strong indicators for the lack of adoption (Vermunt et al. 2022). This research therefore explores how information about NIA is diffused, and whether there is a difference in the sources and types of information used when comparing farmers with relatively high and low implementations of NIA.

1.1 Problem definition and knowledge gap

As indicated in the introduction, the Dutch government is stimulating the implementation of NIA since it can prevent a further decrease in species abundance and the increase of nitrogen in the atmosphere. The adoption of NIA is however limited (Vermunt et al. 2022). Although economic factors are considered the primary barriers for implementing NIA, this does not explain why certain farmers do have a relatively high implementation of NIA, despite the economic pressures. There are also farmers interested in NIA who would like to transition to it, therefore the aforementioned problems need to be addressed in conjunction of one another. This study therefore explores whether a possible explanation for the lack of adoption of NIA lies in the process of gathering, exchanging and interacting with information by farmers. There is however limited literature on how farmers find/use information (e.g. Šūmane et al. 2018; Skaalsveen et al. 2020), especially in the context of NIA. Šūmane et al. (2018), for instance contribute to the understanding of information exchange between farmers and other organizations. They however do not provide inside into how farmers evaluate the information they receive, which may determine information use.

For this reason, the research aims to gain insight into the different types of information sources in a network of farmers. To achieve this, a comparison is made between networks with relatively high implementation of NIA and those with relatively low NIA implementation, examining their interaction with information sources. This study seeks to discover mechanisms that enable or hinder the transition to NIA practices through the analysis of information gathering, exchange, and interaction. This analysis is conducted by adapting the framework of Gosnell et al. (2019) on transformational adoption, complemented by the theory of social identity (Brown and Pehrson, 2019; Kemper, 2016). The results of this research could potentially add to two relevant scientific debates; (1) What factors contribute to the adoption of different agricultural practices and land use that are considered sustainable; (2) understanding the process of transformational adoption in agriculture.

In addition, this study could provide recommendations concerning the improvement of information sources available to farmers, by understanding what farmers need concerning information to enable them to adopt more sustainable agricultural practices. Knowledge can help facilitate change, and

insight into the manner with which the current available knowledge is used to change towards NIA, could reduce possible stagnation in the knowledge transfer. Therefore, findings can have implications for policy strategies aimed at improving the adoption of NIA in the Netherlands, both by government or non-governmental organizations that help farmers to adopt NIA. When more farmers decide to adopt NIA practices, it may have a positive effect on the abundance of species and the nitrogen disposition.

1.2 Central research question(s) and sub-questions

Main research question:

How do farmers engage with information when considering or transitioning to NIA practices, and how can an understanding of the process of information use help accelerate the transition to sustainable agriculture?

Sub-questions:

- What information sources and types of information are identified by farmers that affect their decision-making to consider or adopt NIA practices?
- How do farmers intentionally search for information or come across new ideas?
- How do farmers decide to use the information received in social networks?
- How can information sources on NIA be improved to accelerate the transition to sustainable agriculture in the Netherlands?

2. *Theoretical chapter*

This study is linked to two theoretical debates. The first is focused on understanding what factors contribute to the adoption of different agricultural practices and land use that are considered sustainable (e.g. regenerative agriculture, organic agriculture, circular farming). The second concerns the actual process of change that is enacted when a farmer decides to search for, use, and exchange information to adopt an alternative agricultural practice. Knowledge can help facilitate change, and insight into the manner with which the current available knowledge is used to change towards NIA, could distill possible barriers to knowledge transfer. In the following, both theoretical debates are described, and the role of information sources as facilitators of change is explained, resulting in a conceptual model.

2.1 factors that influence the decision-making of farmers and the role of information

There is a multidisciplinary debate amongst researchers concerning the drivers of adopting alternative sustainable agricultural practices. Economics argues that prices and funding of the market are dominant factors (Kaufman et al. 2009; Kerselaers et al. 2017; Bouma et al. 2020; Schrijver et al. 2022). Agroeconomists argue that the characteristics of the farm are the dominant factors (Lamine & Bellon 2009; Padel 2001; Burton & Wilson 2006; Mzoughi 2011; Stock 2007; Fuetsch, 2022), and social psychologists argue that the dominant factor is subjective norms and professional identities (Neumeister et al. 2011; De Buck et al. 2001; Khamzina et al. 2021).

Information transcends these separate factors, as it can encompass both relatively objective aspects, such as the practical elements of agricultural management and economic considerations, and more subjective aspects, like paradigms and norms related to ‘good farming’. Consequently, this research does not assume any initial dominance of specific factors diving transformational adoption. Instead, it recognizes that a combination of information encompassing practical aspects and economic considerations, as well as it exchange, constitutes an information system.

One recent framework known as Agricultural Knowledge and Innovation Systems (AKIS), represents the complex networks of interactions and relationships among various actors involved in generating, disseminating and utilizing agricultural knowledge and innovation (Knierim et al. 2015; Šūmane et al. 2018). Although this framework exceeds the scope of this master thesis, this study similarly understands information system as a network of interactions and relationships through which farmers receive and diffuse information. Within this system, the decision-making of a farmer is facilitated.

Differently, in this study the focus is on the characteristics of a network and the actors within it that determine how it operates in facilitating useful information exchange. Which in turn, may contribute to enabling transition.

Drawing from Roger's (2003) understanding of information systems, the exchange of information and diffusion occur within a social system. Actors such as individuals and formal and informal groups, form part of a social system and shape the structure of the information system when they disseminate information (e.g. commercial agricultural suppliers, consultants, and governments). The roles that these actors have in the social system influence the diffusion of information, by deciding on the content of the information that is diffused, and by being influenced by what is delayed, considered biased, dispersed or missing information.

This research focuses on the information sources that influence farmers' decision-making regarding the adoption of NIA. To explore this, the conceptual framework of Gosnell et al. (2019) is adapted. In this framework, influential factors in the decision-making process are divided into the personal, practical, and political spheres of a farmer (Figure 2). The personal sphere includes the farmers' values, beliefs, worldview, identity, and emotions; the practical sphere includes the environmental conditions, social dynamics, and economic factors; and the political sphere involves the political, legal, economic, and cultural institutions and systems. This understanding of farmers' decision-making behaviour is relatively similar to other authors who have attempted to capture this process. Ambrosius et al. (2015) for example divide the process into personal (e.g. farmers identity, farmer style, age attitude), contextual (e.g. investment rhythms and farm size) and social factors (farmer status, and social dynamics).

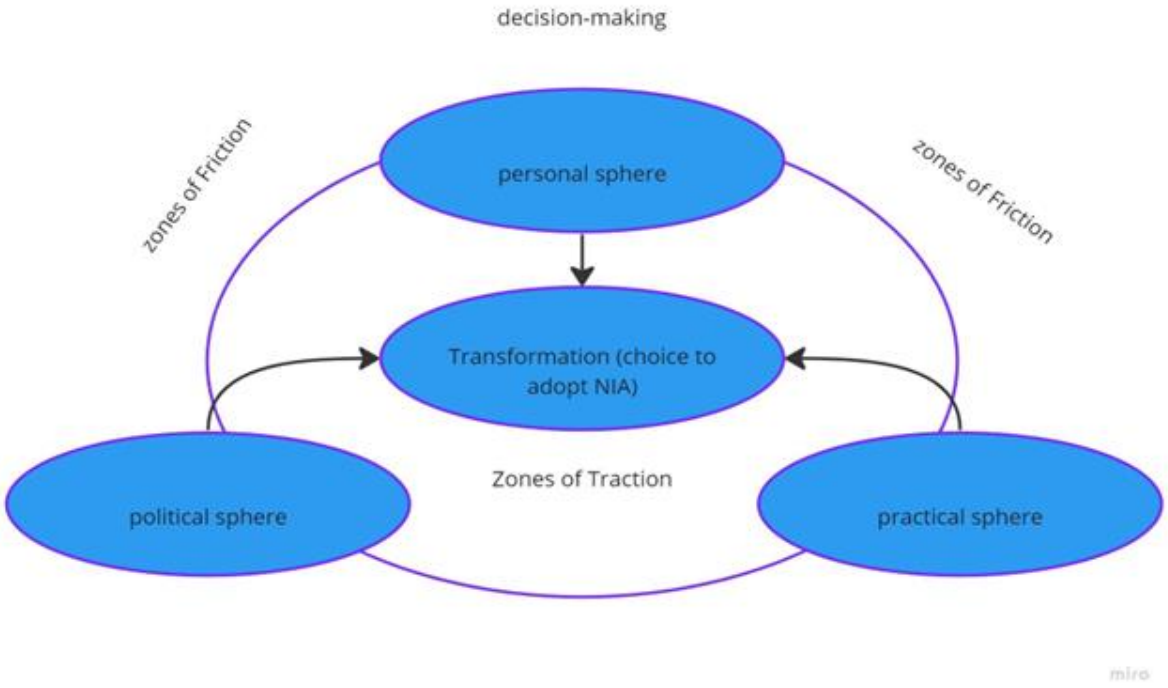

Figure 2. Conceptual framework of transformational adaption by Gosnell et al. (2019).

Information can be understood as a factor that shapes and is shaped by the personal, practical and political sphere of a farmer's life. Understanding how information interacts with and impacts these distinct spheres requires examination. To illustrate this dynamic, a particular example from this case study is presented. The Staatsbosbeheer, an organization dealing with public nature management (TBO), offers mandatory information courses for farmers who have contracts and are responsible for managing protected natural areas. This information is embedded in an institutional system that aims to enhance biodiversity through collaboration with nature organizations and scientific institutions. In this specific instance, the provided information focused on implementing the narrow plantain as a means to establish herb-rich grasslands (Pijlman et al. 2020). However, the farmer perceived this information as incongruent with his everyday practices, leading him to view it as invalid and disregarded it as a possible solution in decision-making. The reluctance to consider this solution in practice stemmed from a recognized disparity between existing knowledge and the longstanding practices of the farmer.

The example shows how information is not solely a one-way flow but rather a dynamic interplay between various spheres of a farmers life. Misalignment between provided information and knowledge of practical realities can influence the decision-making process. This underlines the

importance of understanding the contextual factors influencing farmers interpretations and adoption of information, particularly in the pursuit of sustainable agricultural practices. Gosnell et al. (2019) argue that the personal sphere is especially critical to understand since transformation in the personal sphere has consequences for the other spheres. Specifically, personal transformation "shapes the way that the systems and structures (i.e. the political sphere) are viewed, and influences what types of solutions (e.g. the practical sphere) are considered "acceptable" (O'Brien and Synga, 2013).

2.2 Information sources in a social network as facilitators of change

Here we arrive at the process of change that is enacted when a farmer interacts with information sources and decides to search, use, and exchange information to adopt different agricultural practices. Gosnell et al. (2019) use the theory of "zones of traction" and "zones of friction" to explain the decision-making and actions of farmers (Figure 2). Zones of friction are pathways of resistance to more sustainable outcomes, or contradictory practices which entrench less sustainable outcomes, while zones of traction are pathways towards more sustainable outcomes. Friction therefore constrains or hinders transformational change and occurs where norms, dispositions, and everyday routines do not align with more sustainable practices, such as in NIA. In contrast, traction can be seen as occurring with moments of deroutinezation – moments of change or crisis, during which relationships and flow can be reappraised, interrupted, and reconfigured to be consistent with changed circumstances, changed or existing values, or insights from self-reflection (Gibson et al. 2013). The zones of friction and traction are applied across personal, practical and political spheres of transformation to serve as a tool to delineate key areas or points at which transformation and the persistence of new thinking and practice are facilitated or impeded (Westley et al. 2011).

Information sources both shape and are being shaped by the separate spheres and influence the decision-making of farmers. Information gathering, using and exchanging by people is a dynamic procedure that takes place on the multi-levels of the separate spheres as proposed by Gosnell et al. (2019). Information in this study is assumed to be is a driver that is identified as contributing to the adoption of NIA and understood as realizing a zone of traction, or the opposite, as a zone of friction of transformation. The internalization of information as conceptualized here is the process by which farmers search for, use and exchange information and apply it in their practices. This research posits that information can act as a source of traction or friction, based on how the information both shapes and is shaped by interaction of the political, practical, and personal spheres (Figure 3). How farmers engage with the information depends on the source, how it is approached, exchanged, and applied.

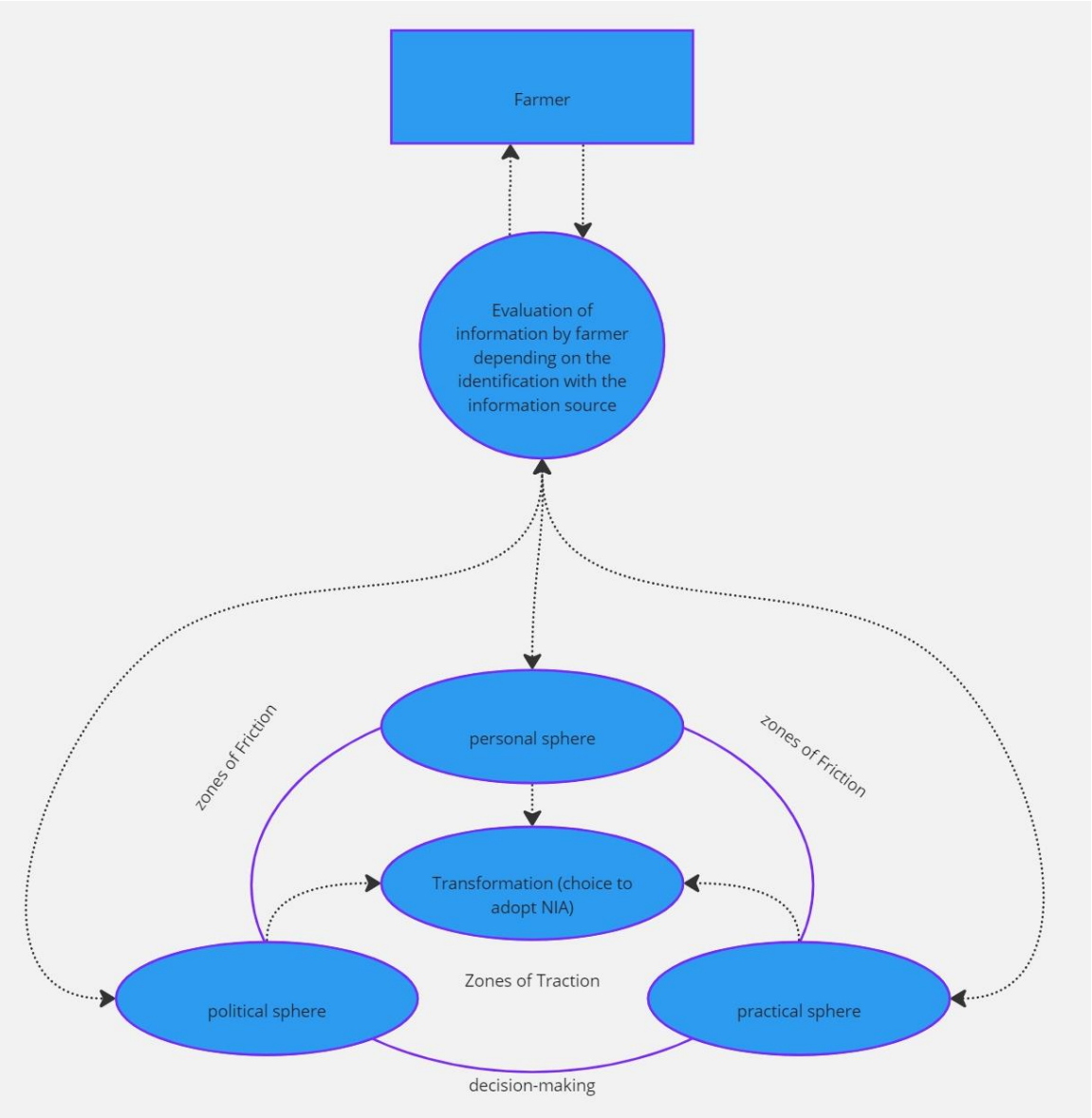

Figure 3. **Adapted conceptual model of Gosnell et al. (2019).** The arrows represent information flows coming from sources in the personal, political and practical spheres of a farmer. The information sources are searched for by farmers, or they come across them. The internalization of this information depends on whether these sources are valued and accepted, depending on social identification. This valuation of information sources may act as a source of friction or traction as it shapes and is shaped by the interacting spheres, resulting in acceleration or hindering of adopting NIA practices.

2.3 Information as a source of traction and friction

What effect do the social dynamics and interactions in a system of information sources have on the internalization of information by farmers affecting the decision-making process? In this framework, the extent to which information acts as a source of traction for a farmer in transitioning to NIA practices can be separated into whether it provides traction (1) objectively (e.g. is factual), and (2) subjectively (e.g. perceived as trustworthy and relevant, therefore fitting within the worldview of a farmer). The social identity approach is useful in understanding how information is perceived (Brown, 2019; Terry and Hogg, 1995; Turner and Oakes, 1986). This theory comprises two components: the relation to social interaction and the relationship to behaviour change, occurring through social dimensions of a person's self-conceptualization. Humans have a universal drive to evaluate their opinions and attitudes to increase their self-esteem, confidence, and status as members of a 'reference group' (Brown and Pehrson, 2019; Hogg et al. 1995; Tuner and Oakes, 1986). A reference group may be an actual or perceived group whose opinion and behaviour is important to one's choices (Brown and Pehrson, 2019; Kemper, 2016). Information coming from a source perceived as part of a certain reference group can therefore influence one's decision-making, since the opinion or behaviour of that group carry varying degrees of importance.

This reference group, therefore, represents a group to which a farmer identifies or not. This depends on various perceiving aspects: (1) similarity between self and other(s), i.e. whether they are in-group or out-group members; (2) the similarity in situational context between self and other(s); (3) the status of oneself and the other(s) within the group, i.e. the direction of influence; (4) the level of identification with the ingroup (Brown, 2000; Terry and Hogg, 1995; Turner and Oakes, 1986). In the Dutch context, for instance, this could include farmers with similar attitudes or 'farming styles'. Ambrosius et al. (2022) identified styles such as profit-oriented and innovative farmers, as well as idealists producing for the biological market.

In the Dutch context, this can also include non-farmers, which refers to individuals or organizations that exert influence on the dairy sector. Similarly, farmers can perceive these individuals and organizations as either an ingroup or outgroup member based on factors like similarity in context, the perceived extent of influence they have on each other, and the level of identification with the ingroup. Identification with the other famers, or individuals or organization within the social network of a farmer, who serve as information sources, can lead to an evaluation of the credibility of the information provided. This evaluation, in turn, can impact whether the information acts as traction or friction within the dynamic spheres of political, practical, and personal realms that affect the farmers' decision-making process. This statement will be explored in this study.

3. Methodology

3.1 Methods and data collection

In this study, information sources in a social network are analyzed to explore how they act as traction or friction in decision-making. Social network analysis is the method used to examine the structural properties of the network of information sources utilized by a given farmers. Additionally, Gosnell et al. (2019) propose investigating relational networks to understand zones of traction and friction. In this study, a quantitative and qualitative analysis is conducted using the social identity approach to explore how the relation of the farmer with the information sources helps or hinders the adoption of NIA. The reason for employing social network analysis is the emperical analysis is fixed in time. Before exploring potential changes over time (dynamics), first an understanding of the nature of information sources and their flows in fixed time should be explored by emperically capturing the structural properties of a network. Thus, in this study the role of information sources in a social network with regards to the diffusion of information is examined and what role it might play in addressing barriers to the implementation of NIA.

To gain insight into the quantitative network structure and qualitative aspects of information sources, types of information, and the process of information gathering, exchanging, and application, and how this relates to the objective and subjective valuation of the information by the farmer, the method of semi-structured interviews is applied. This method helps to gain insight into the 'why' question and captures the perception of individual farmers. The combination of social network analysis and semi-structured interviews is inspired by a relative niche in research that attempts to capture the complexity of social relations in the transition to more sustainable practices (Nelson et al. 2014; Manson et al. 2016; Ambrosius et al. 2019; Ataei, 2019). In study however, no complete network of farmers including multi-actor perspectives is analyzed. This study focusses on the ego-network of a farmer.

The structure of the interview questions will be to first determine key sources comprising the farmer's information network; then second, ask follow-up questions to add to the qualitative richness of the network model and understanding of how the farmer interacts with the different sources, and why. Example questions will revolve around: the types of information sources (e.g. reference materials, person), type of relationship (e.g. family member, bank employee, neighbour), nature of the relationship and the type of information (websites informing on NIA, study groups sharing knowledge on NIA), the perceived similarity (reference group), and the directionality of the exchange (unidirectional or bidirectional).

The data generated by the semi-structured interviews will provide insight into how farmers interact with information and its sources. This data will then be used as input for the network analysis in R. The objective and subjective evaluation of the information by the farmer will require a seperate qualitative analysis. The network for analysis consists of nodes representing sources of information, such as other farmers, NAVs, or agricultural suppliers and consultants. These nodes are connected by ties that represent flows of information.

3.2 Site and data-collection

This study will focus on the networks of dairy farmers in the south-west of the Netherlands. The south-west of the Netherlands is known as the 'Green Heart' of the country. The area is primarely characterized by the NNN (Nature Network Netherlands), with little presence of Natura 2000 sites. Seventeen semi-structured interviews are conducted with farmers. Initially, expert opinions were seeked including representatives of non-governmental organizations and consultancy bureaus that assist farmers in transitioning to NIA. These representatives identified the first farmers for the snowball sampling as key informants (Miles and Huberman, 1994). The interviewees have given consent to record the conversation and publish the data anonymously (appendix 1). Table 1 presents the farm characteristics of participants in this study. Table 2 presents the NIA practices that can be identified within the farm management of farmers.

Verschuren and Doorewaard (2010) discuss a case study as a research strategy used to gain insight in processes, such as decision-making, which is the case in this study. This study is characterised by a small number of research units, intensive data generation, and in-depth research rather than broad research and quantitative data and research methods (Verschuren and Doorewaard, 2010). The focus of single case studies should lay on triangulation of sources. Multiple sources are used to validate the findings, including expert opinions, semi-structured interviews, literature review and policy analysis. A case study allows for a holistic approach, and provides flexibility and the results are more easily accepted by people in the field. The largest disadvantage of a single case study is the external validity of the results. The limited external validity is made transparent by including the farm characteristics of the farmers that participated (Table 1).

Table 1. Farm characteristics of participants in this study.

F	Farm size in ha	Farm size in livestock (dairy cows/ young stock)	Amount of ha in grassland	Amount of ha in maisland	Amount of ha in nature management	Type of market	Type of soil
1	40	105/50	40	0	0	Conventional	Peatland
2	40	60/10	40	0	0	Conventional	Peatland
3	55	125/63	45	0	0.5	Conventional	River clay
4	80	150/70	27	0	53	Conventional	Peatland
5	33	65/25	21	0	12	Conventional	Peatland
6	44	60/0	36	0	8	Coventional	Peatland
7	85	85/40	40	0	45	Biological	Peatland
8	60	150/44	40	10	10	Conventional	Peatland
9	80	70/30	38	0	42	Biological	Peatland
10	186	150/80	76	0	80	Biological	Peatland
11	108	190/120	108	0	0	Conventional	River clay, peatland
12	80	150/NA	63	0	17	Conventional	Sand, clay on peatland
13	60	80/40	48	0	12	Biological	Peatland
14	70	170/80	70	0	0	Conventional	Clay on peatland
15	70	125/80	55	15	7	Conventional	Clay on sand
16	96	215/145	77.5	18.5	9.5	Conventional	Clay on peatland
17	80	210/0	66	14	0	Conventional	Clay on peatland

3.2.1 farmer interviews

Semi-structures interviews were conducted either online or at the farm with the primary decision-maker. In many cases, this individual was one farmer, but some interviews involved husband-wife partnerships. The choice for a semi-structured interview method was made to enhence reliability by ensuring consistent data collection. It ensured that all participants were asked the same set of questions.

The interviews lasted for approximately one hour and convered various aspects, including the farmer's history, personal motivation, knowledge on NIA, type of management, innovation in agricultural management and questions related to social networks (appendix 2). To examine the network structure and the significance of the sources, the farmers were asked to name the sources of information that provided them with relevant knowledge on NIA. Furthermore, they were asked about the importance of the information and the organizations that provided it.

3.2.2 Categorization by high and low NIA

After conducting the interviews, the interviewees were classified into two groups based on their NIA implementation: relatively high NIA implementation and relatively low implementation. The list of NIA practices in the dairy sector (Table 2) was used to assign points to each practice that was present on the farm. For example, if a farm had at least one landscape element, it received a point in the "creating landscape elements" category. This resulted in a diverse group of interviewees with different levels of NIA implementation, and the categorization is explained below.

Table 2. List of NIA practices in dairy farming (Erisman et al., 2017; Vermunt et al., 2022).

Manure management to improve soil structure and soil health, such as the reduction of fertilization and practices as realising erosion of grassland.
Local feed production to eliminate the overseas impact of feed production

Primarily grass-based feeding due to higher soil organic content of grassland relative to arable (feed crop) land
Diversification of the sward and more permanent grassland for improved above- and below-ground biodiversity as well as soil carbon-storage
Grazing to improve botanical composition and biodiversity of meadows, close nitrogen cycles and reduce ammonia emissions.
Phased mowing to reduce direct impacts on ground-breeding birds and to improve the survival change of chicks
Creating landscape elements such as marshland systems, dykes, ditch banks, living fences and tree alleys to provide habitat for species
Extensification of the farm, i.e. reducing the number of livestock unit per hectare of grassland [>1,5 GVE/ha]

To define NIA, Bouma et al. (2020), established three levels: 0) the dairy farm only meets the legal oblications; 1) partial land is used to implement measures that increase biodiversity; 2) efforts are made to optimize the input and output cycles; 3) the farm is fully integrated into the surrounding landscape and ecosystems, with optimized in- and outputs, and the cattle fitting within the ecosystems.

Inspired by the definition of Bouma et al. (2020), in this study a clear distinction is made based on the impact of NIA practices. In cases of low implementation, the farmers makes minimal changes to their business operations or makes minor adjustments to comply with agricultural nature management. On the other hand, high implementation of NIA leads to more significant consequences for the business operations, affecting various aspects. In this study, a farm is considered to have high NIA implementation if it has at least two practices from the right side of Table 3, and at least four practices

from the left side. Table 4 shows an overview of the implemented Nature-inclusive agriculture per farmer.

Table 3. Definition Nature-inclusive agriculture.

Category low implementation of NIA	Category high implementation of NIA
In cases of farms that apply only to the legal obligated practices that are consider NIA, and in cases of farms that apply implement measures that increase biodiversity and cover partially the total amount of ha.	In cases of farm that apply practices that optimize the in- and output cycles, and total optimization of in- and output cycle in which the company is integrated with the surrounding landscape and ecosystem.
- Manure management to improve soil structure and soil health, such as the reduction of fertilization and practices as realising erosion of grassland. - Diversification of the sward and more permanent grassland for improved above- and below-ground biodiversity as well as soil carbon-storage - Phased mowing to reduce direct impacts on ground-breeding birds and to improve the survival change of chicks - Creating landscape elements such as marshland systems, dykes, ditch banks, living fences and tree alleys to provide habitats for species	- Local feed production to eliminate the overseas impact of feed production - Grazing to improve botanical composition and biodiversity of meadows, close nitrogen cycles and reduce ammonia emissions - Primarily grass-based feeding due to higher soil organic content of grassland relative to arable (feed crop) land - Extensification of the farm, i.e. reducing the number of livestock unit per hectare of grassland [>1,5 GVE/ha] - Creating landscape elements such as marshland systems, dykes, ditch banks, living fences and tree alleys to provide habitat for species

Table 4. Overview of implemented Nature-inclusive agriculture per farmer.

NIA	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17
Manure management	0	0	1	0	0	1	1	0	1	1	0	0	1	0	0	0	0
Local feed production	1	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0
Primarily grass-based feeding	0	1	1	0	0	1	1	0	0	0	0	1	1	0	0	0	0
Diversification of grassland	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
grazing	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1
Phased mowing	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0
Creating landscape elements	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Agricultural nature management	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0

Extensification of the farm	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0
Level of NIA	L	H	H	L	L	H	H	L	L	H	L	L	H	L	L	L	L

3.3 Transcription and coding

The semi-structured interviews will be transcribed and coded in Nvivo12. The coding of farmer interviews will focus on understanding the network structure (information sources) and the nature of these sources, to then build the network for analysis in R. Validity of this method is strengthend by reaching data saturation (Verschuren and Doorewaard, 2010). Data is collected untill no new themes or insights emerge. This is the moment in the proces of data gathering in which findings only confirm what has already been observed, and therefore captures the complexity of the phenomenon under study (Verschuren and Doorewaard, 2010)

3.4 Operationalization of variables

Here the operationalization of the identification of farmers with the sources are based on social identity theory. Intially, an attempt was made to apply the theory of reference groups by Ambrosious et al. (2019). However, two problems arose. Firstly, it cannot be used for groups other than farmers. When identifying with other organizations, farmers tended to focus more on values and the understanding of farm workings rather than situational contexts. Secondly, in applying the theory to information exchange, categorization based on relevance to farmers involved similarities such as producing for similar markets and having similar soil types. Therefore, a different approach is used to understand how farmers identify with a source.

3.4.1 Reference groups

To explore how information sources and types of information are valued by a farmer, the level of social identification with that group and the relationship is measured (Table 5). The indicators that will help measure these variables are found in Table 5, the cells describe the type of answer that is looked for to determine the identification.

Table 5. Operationalisation of reference groups (Ambriosius et al. 2015).

Reference groups	Variable	Indicator
Personal similarity	- Perceived similarity between self and other(s),	- Similarity in values, beliefs and worldviews
Contextual similarity	- Perceived similarity of situational context between self and other(s),	- is the information source another farmer? -> ingroup - is the information source not a farmer? -> outgroup
Status similarity	Perceived status of oneself and the other(s) within the group (i.e. the direction of influence), and	- reciprocity of information exchange -> Unidirected>bidirectional
Identification of in-group	Perceived level of identification with the in-group	- Frequency of contact ->one month - < one month

3.4.2 *Subjective evaluation of information*

To explore the role of subjective dimensions in the evaluation of information leading to the implementation or non-implementation of NIA, the framework of 'spheres' is adopted: practical, political, and personal (O'Brien and Sygna, 2013).

Farmers are asked to list up to 10 or more information sources and whether they consider these sources as relevant or trustworthy. These questions are qualitative and open-ended, allowing farmers to explain why they perceive a source as relevant and trustworthy.

To deterine whether an information source acts as ‘traction’ or ‘friction’, its impact on resistance or pathways to NIA implementation is considered. To operationalize these terms, codes are used. An information source receives a ‘traction code’ when it leads the farmer to accept NIA or related practices as benificial. Conversely, a ‘friction code’ is assigned when the information makes the farmer view NIA negatively. For instance, if a sources provides information suggesting that NIA practices do not directly benefit farmers, and the farmer considers this information as trustworthy, resulting in a negative view on NIA, the sources is seen as a friction source.

3.5 Network structure in R

R is used to construct and analyze two seperate networks for comparing their characteristics. Two approaches are employed to compare the high and low networks. Firstly, the two networks were compared with regards to the amount of information sources a farmer mentioned. For every ego (farmer) in the high NIA network the total amount of sources was counted, and the average of the overall high NIA network was calculated. Secondly, the densities of the seperate networks are calculated. Density quantifies the number of edges in a network divided by the total possible numbers of edges.

3.6 Limitations

One methodological limitation in this research is that due to the topic and selection method, farmers in this sample may be more inclined towards environmental issues and research compared tot he broader population of dairy farmers. The small sample size was chosen with the intention of gathering detailed, qualitative data for each farm and to observe any patterns that might emerge across different management types.

4. Results chapter

This study investigates how information and knowledge contribute to the adoption of NIA practices, using semi-structured interviews (N = 17) and social network analysis. The results show that farmers gather information from a variety of sources, especially trade journals, NAVs and TBOs, study groups, other farmers, and 1:1 advisors. Surprisingly, family, consultancy bureaus, and research institutes are mentioned the least. Dividing the information sources into private, civil, governmental and research sectors shows that the most information is received from the private sector, followed by civil organizations. The type of information that is mostly shared amongst farmers is typically about implementing nature agricultural management and the effects of NIA on nature and climate. Notably, information on nature agricultural management is mostly received by high NIA farmers from civil organizations, while information on the effects of NIA on nature and climate is received by both high and low NIA farmers from private organizations. In addition, low NIA farmers are receiving almost all of their information from private organizations and little from civil organizations, whereas high NIA farmers are getting info from a range of organizations, comparatively less from private ones. Lastly, the absence of mutual information exchange leads to a situation where farmers are unable to influence information sources that steer the practices on their land. Information sources act as friction by disregarding farmers' input, contradicting their value of finding optimal solutions that work in harmony with nature and practice to promote biodiversity enhancement and emission reduction, and instead imposing a nature-oriented approach on farmers.

4.1 Information and knowledge in NIA

In this section, the results of the first research question are discussed: *What information sources and types of information are identified by farmers that affect their decision-making to consider adopting NIA practices?* To answer this, the structure of the information sources forming the network will be presented, followed by identifying the types of information from these sources.

4.1.1 NIA practices implemented by farmers

In this case study, the NIA practices present in farm management are assigned to a general list of practices as presented in Table 2. Figure 4 shows the frequency with which these separate practices were implemented on all farms in this study. Diversification of sward and more permanent grassland and creating landscape elements were the most implemented practices in this study. In practice, the

implementation of sward involves seeding grassland with herb-rich seeds such as clover. Permanent grassland is often combined with the practice of restauration management of grassland to reduce acidity levels in the ground. The landscape elements are created by small marshland systems, and farmers planted trees for creating flora and fauna habitats and migration areas. Notably, the extensification of the farm with less than 1.5 GVE per hectare was only applied in three cases, two of which are producing for the biological market.

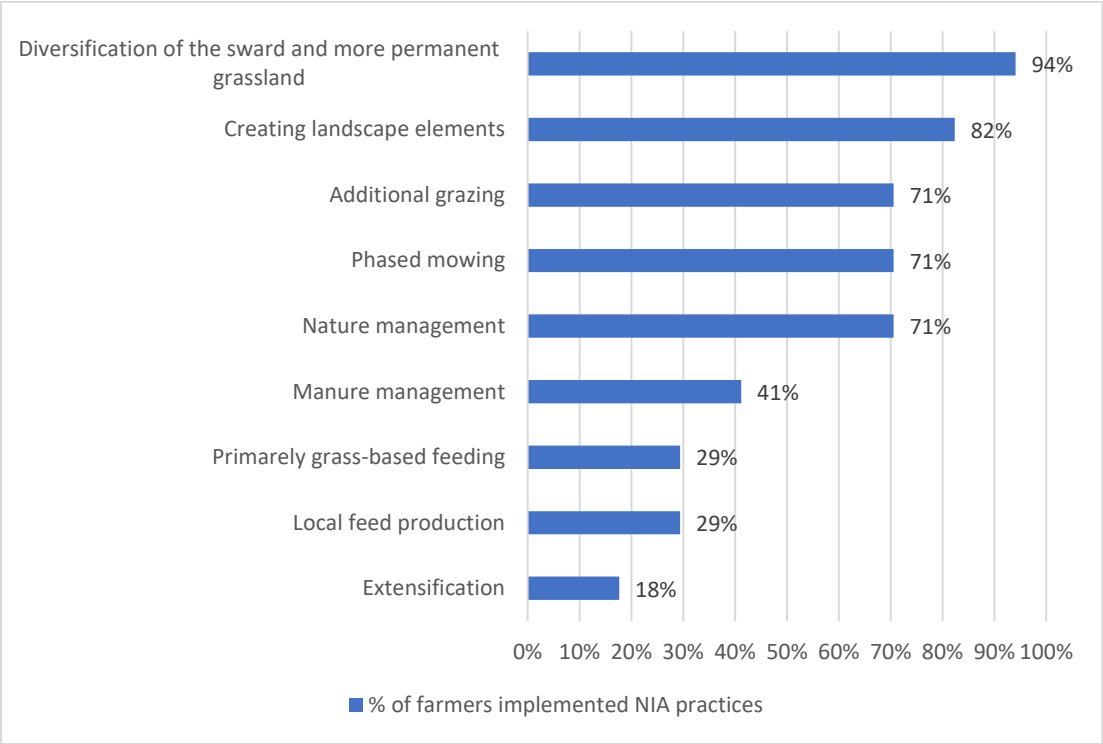

Figure 1. Implemented NIA practices on farms in this study (*N17*)

4. 1.2 The network structure of information sources

In considering whether to implement or actually implementing NIA practices, farmers obtain information and knowledge from a variety of sources. On average, the interviewed farmers (17) named 8.64 (SD 2.68) sources. Figure 3 illustrates the types of information sources that an information source can be ascribed to and the frequency in which the sources that were mentioned and their frequency with respect to the total number of sources, expressed as a percentage. The most frequently mentioned sources are trade journals, agricultural nature organizations (NAVs and TBOs), study groups, other farmers and 1:1 advisors. This was followed by nature associations, government

departments, and dairy cooperations. Surprisingly, family members, consultancy bureaus, and individuals associated with research or research institutes were the sources identified least by farmers.

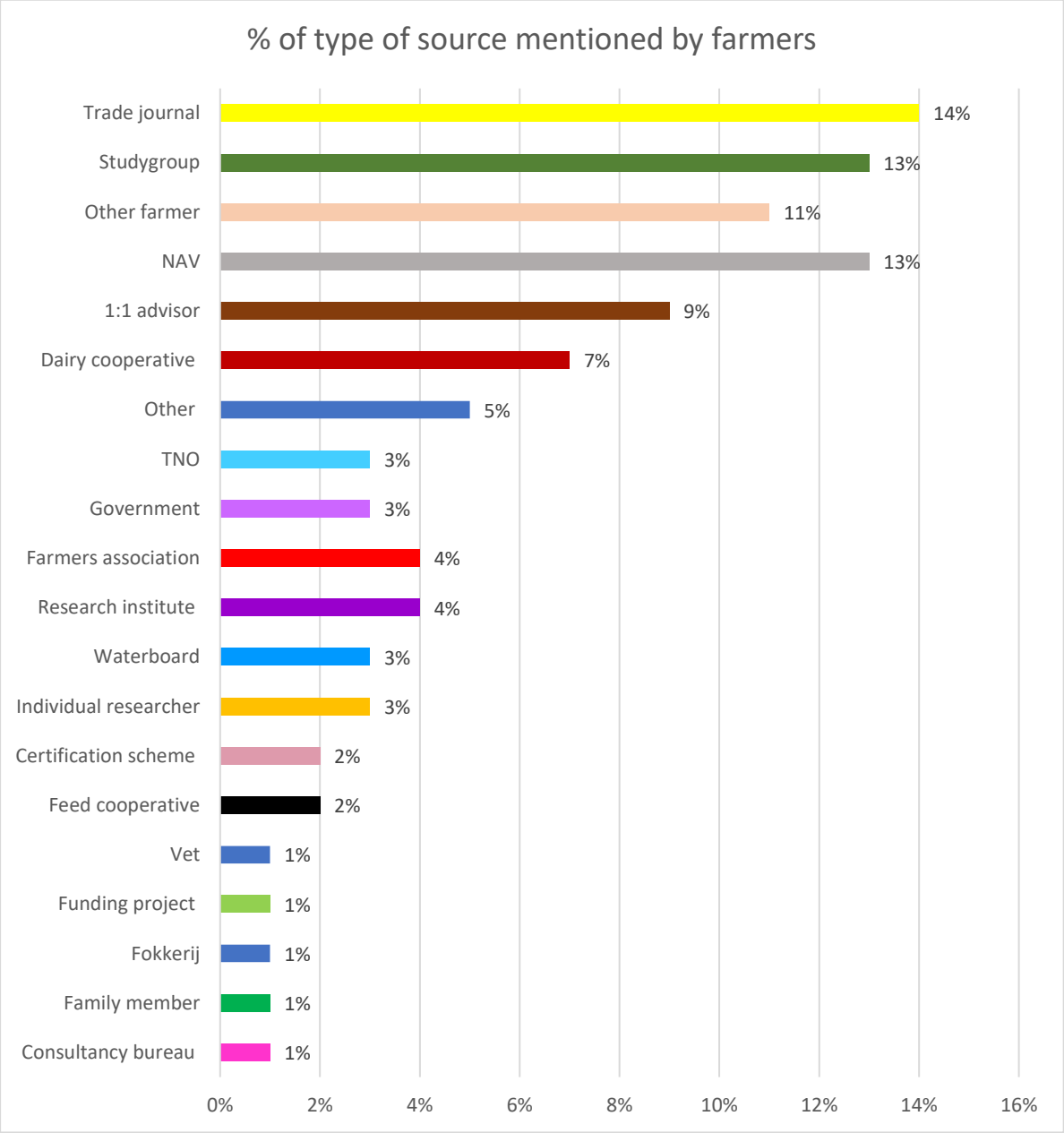

Figure 3. Percentage of type of sources mentioned by farmers

The bars show the frequency of identified information sources, expressed in a percentage of the total list of information sources mentioned by farmers (a total of 148 information sources). One particular information source may be mentioned more than once; for example, when two farmers are members of the same NAV. Therefore, the percentage of NAV shows how many times the NAV is mentioned by the 17 farmers, of who two farmers may mention the same NAV twice since they both have a signed contract in the same region.

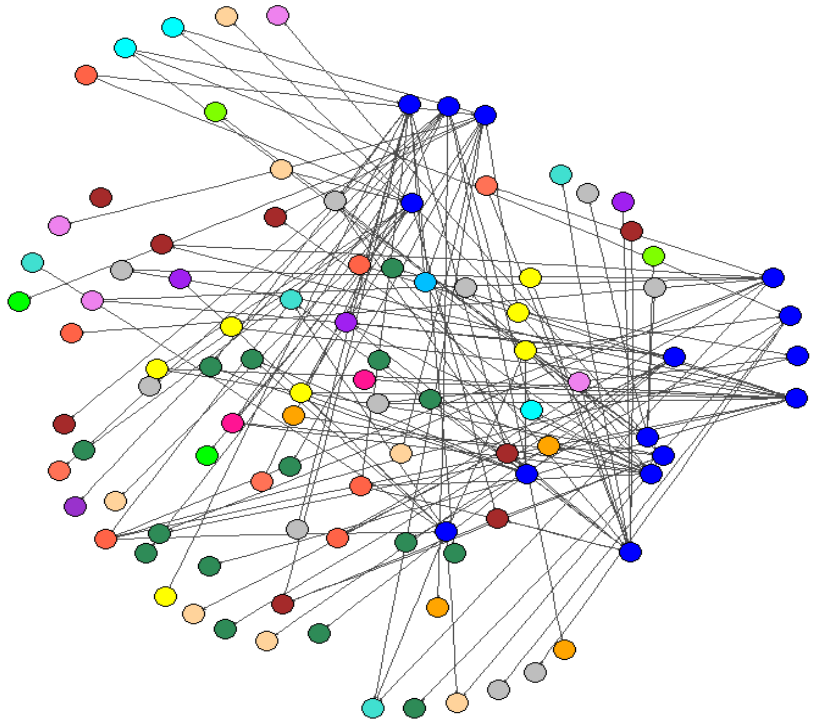

Figure 4. Network structure of types of sources mentioned by farmers.

The sources are coloured by type of information sources as presented in figure 3. The dark blue dots represent the farmers. Different from figure 3 is the colouring for 'other', which include in this figure also 'vet' and 'fokkerij', those are represented with the colour light brown.

4. 1.3 Type of information shared with farmers in the information system

The information shared among farmers is diverse and can be categorized into following types: 1) information on how to implement agricultural nature management on the farm, 2) information on technical agricultural innovation, 3) examples of NIA practices, 4) information on the economic sustainability of NIA, and 5) the effect on nature and climate of the NIA practices, including agricultural nature management and technical agricultural innovations. An alluvial diagram is used to visualize the connection between different topics, the sources that diffused the information and knowledge, and

how it relates to two different groups; high NIA and low NIA depending on the degree of implemented NIA (see Table 3 for the division). These results are discussed in more detail in the following sections.

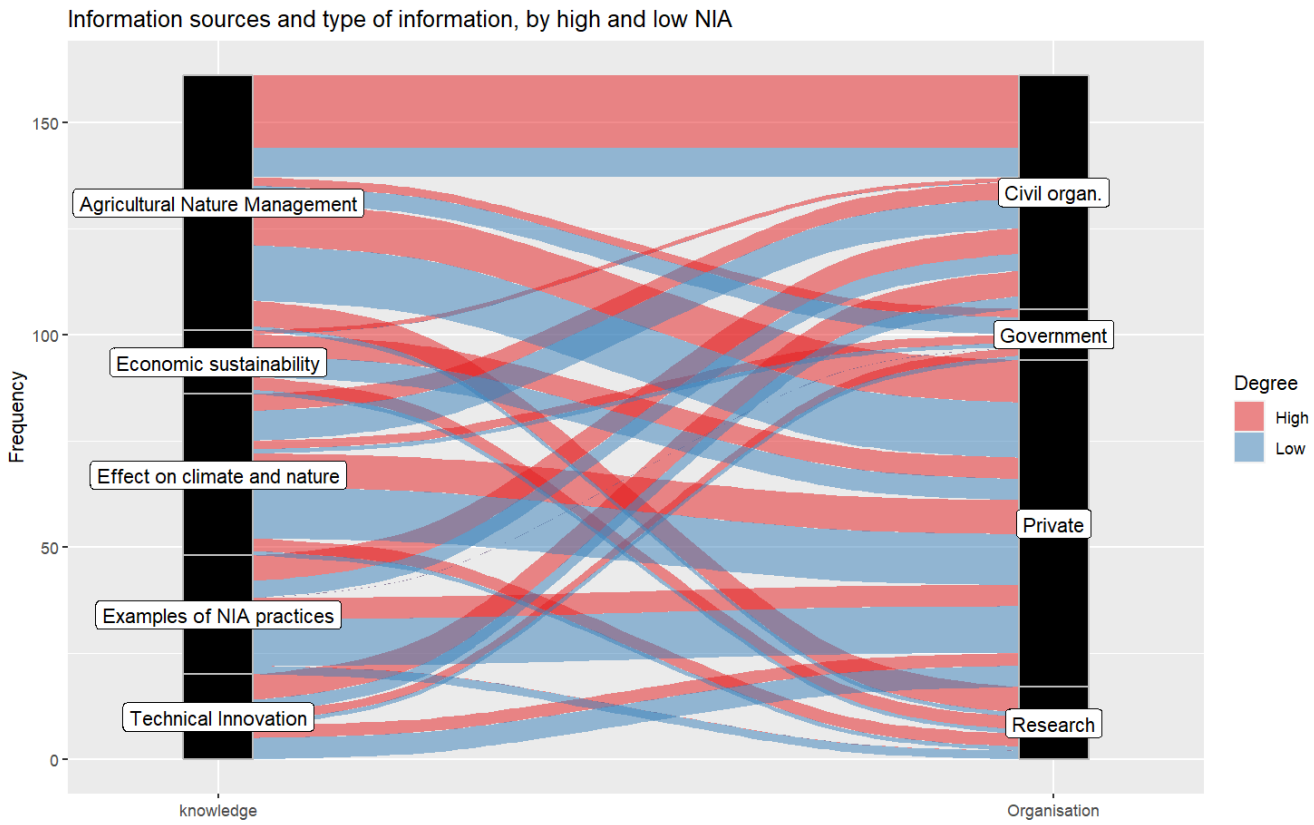

Figure 5. Alluvial diagram with types of sources of information, by high and low NIA diffused by civil organizations, governments, private sector or research institutes.

The following types of sources of information are ascribed to civil organizations: NAV, study groups belonging to NAVs or other nature associations, other farmers, neighbour farmers, family members, 1:1 advisors belonging to NAV, TBOs or other nature associations. The following type of sources of information is ascribed to government: Waterboard, municipalities and provinces. The following type of information sources are ascribed to private organizations: trade journals, study groups organized by dairy companies, feed companies, or consultancy bureau's, dairy cooperatives, feed cooperatives, and the veterinarian. Lastly, information sources belonging to research are individual researchers, research institutes such as universities and independent institutes.

4.1.3.1 Information on how to implement agricultural nature management on the farm

Information on nature management in NIA revolves around topics such as herb-rich grassland, bird protective management of meadows, protection of partridge edges, the practice of restauration management of grassland to reduce acidity levels in the ground, small marshland systems and other landscape elements. These practices are focused on stimulating biodiversity for both flora and fauna while limiting the intensive use of grassland. High NIA farmers tend to get information on agricultural nature management from civil organizations the most (Figure 5), specifically NAVs, TBOs, and study groups (Figure 3).

Interviewee 12 "Together with the NAV we implemented a partridge edge. They have volunteers that help you, and you receive information via newsletters. With regards to NIA, they are an excellent source of information".

Farmers with relatively low NIA receive most of their information on agricultural nature management from private organizations (Figure 5), with trade journals, and study groups being the most significant contributors (Figure 3).

Interviewee 3 "I participate in a project together with a dairy cooperative to reduce emissions. One of the ideas is to experiment with clover grassland to reduce the use of fertilized manure. The nice thing about this project is that there is a budget to implement seeds for clover grass, since it is costly and it will only be beneficial over time. Now it is paid for, and we can start the transition. I was already working on it before, but now we have the financial capacity to speed up the project".

4.1.3.2 Information on technical agricultural innovation

Information on technical innovation in NIA regards pressure drainage, technology for fermentation of manure, and stable innovations; these topics are often focused on reducing emissions. Figure 5 demonstrates that farmers with relatively high NIA are mostly informed about technical innovations from civil organizations, followed by private organizations.

Interviewee 6 "I participate in a project with 12 farmers to implement pressure drainage. I speak with the NAV on weekly basis, and we share a WhatsApp-group in which we all share interesting articles. Also, the Waterboard is involved and they also started sharing information so you really are in conversation with each other. The system is helpful to bridge a gap between theory and practice, and they help also with the rules"

Farmers with relatively low NIA receive most of their information on technical innovation from private organizations, followed by civil organizations.

Interviewee 12 "An example is the study group about the manure biogas plant facilitated by Friesland Campina and executed by a consultancy bureau. You have to invest 500 000 but I also have other things that I want on my investment list. Those I want to do first, so it becomes less relevant for me."

4.1.3.3 Examples of NIA practices

The examples of NIA practices are diverse and involve the actual implementation of NIA on farms. This can be on the subject of implementing protection measures for meadow birds, as well as technical innovations such as pressure drainage. Farmers with relatively high NIA receive information on examples of NIA in practice almost equally from civil and private organizations. Farmers with relatively low NIA receive information on examples of NIA in practice most from private organizations (Figure 5). The most frequently mentioned (n = 10 farmers) private organizations here are trade journals that write experiences of farmers.

Interviewee 13 "*In trade journals you find nice ideas, mostly, innovative ideas and stories of people how they do those things*"

Interviewee 3 "... in addition, I retrieve information from website of trade journals. We have an adminship and receive the journal every week. In trade journals you can read just anything, but especially nature-inclusive agriculture is mentioned more. It can be on a practice specifically, or on the broader implementation of NIA, you read all kinds of things"

In addition, farmers visit farms that implement such practices. The farmers of the following citation even implemented NIA in their farm management after visiting multiple NIA farms:

Interviewee 10 "For our transition to NIA, we allowed a NAV and a consultancy bureau to guide us. Beforehand we visited many farms that implemented NIA, and we allowed them to visit us. We went back and forth between farms to see what really works."

4.1.3.4 Information on the economic sustainability of NIA

Information on the economic sustainability of NIA is diffused among farmers. Figure 5 shows that both farmers with a relatively high and low implementation of NIA receive their information on economic sustainability of NIA mostly from private organizations.

Interviewee 11 "*There is this economic study group organized by a consultancy bureau, we visited a farmer a while ago. It was about the business financial structure, but you also learn the practical implementation on that farm. The farm was incredibly nature-inclusive, they implemented meadow bird management, and it is like the cows are in service of the meadow birds. That farm is really on top of it, more than seems financial beneficial to them".*

A minor role is played by research organizations that provide this information more to relatively high NIA farms than to low NIA farms.

Interviewee 4 "They do research on this topic [referring to a research institute], I think in the heart a lot of farmers want to do NIA, but in such a report they explain that none of the economic models that they calculated is economic sustainable. In every model, the farmer has to cut loses."

4.1.3.5 The effect on nature and climate of the NIA practices

Information about the effects of NIA on nature and climate is also shared. This mainly concerns increasing species abundance and reducing emissions. Farmers with relatively high NIA primarily receive this information from private organizations and some from research groups, whereas those with relatively low NIA obtain this information from private organizations (Figure 5).

Interviewee 2 "I join a study group via my 1:1 advisor at a consultancy firm. In this group, we talk mostly about the amount of protein that is necessary in the feed. We are searching for the right amount of protein in order to reduce ammonia emissions. But then the question becomes, how do you fertilize your ground and on what type of land?"

Interviewee 8 "In the study group we talk about the circularity on the farm, so you measure, you look at your yield, and the feed, to make this efficient as possible. If you feed efficiently, and you make sure you do not have any loses, then there is a lesser chance that unnecessary outputs affect the environment. This is a challenge".

To conclude, the alluvial diagram shows that low NIA farmers are getting almost all of their info from private organizations, and little from civil organizations, whereas high NIA farmers are getting almost all of their info from a range of organizations, and comparatively less from private organizations.

4.2 Information searching and receiving

Here, the results for the second research question are presented, focusing on how farmers initially search for information or come across new ideas. Figures 6 and 7 present the entire group of farmers, which have been divided by their degree of implemented NIA. Before exploring the specifics, the majority of the farmers noted that there is a lot of information available.

Interviewee 10 *"There is so much information, that sometimes I think about where I should go to find the information that is relevant for me"*

Interviewee 7 *"That is the issue, there is so much information of course, and so many organized evenings that you can partake in"*

A driving factor indicated by farmers for initiating the search for information is a new policy. Discussions arise regarding how to comply with new policy, with information on NIA being exchanged as a possible solution. Two policy developments often cause such discussions: 1) the derogatie, and 2) the Dutch Gemeenschappelijk Landbouwbeleid (GLB). In response to these policy changes, farmers tended to organize and discuss possible NIA measurements in study groups or during evenings organized by NAVs, TBOs and consultancy bureaus. Since there are a lot of policy changes in the Netherlands, farmers see this as a drive to also gather information on innovations and practices that could possibly be relevant for policy change in the future.

Interviewee 15 *"... NAV collectives organize different events during the year, for example for changing policies. This year there is a new agricultural policy, GLB, in which the subsidies changed. Farmers need to know what those policy changes are, and these collectives explain the policy and provide advice."*

Interviewee 12 *"We think that it will probably end up becoming a legislation in the future. That will happen, there we prefer to start already looking into it".*

In addition, information is initially searched for due to taking responsibility, but this observation is less dominant than the need to comply with policy.

Interviewee 6 *"People need to take responsibility themselves. The government comes up with unpractical regulation, but you need you to think about your own steps that you can take. Listen to nature and practice, that is the best manner for transition"*

Looking at the degree of NIA implementation, and whether there is a difference in the interaction with information sources, could infer drivers of higher NIA implementation. The question is how farmers connect with different information sources to apply NIA practices and to acquire their share of NIA information and knowledge.

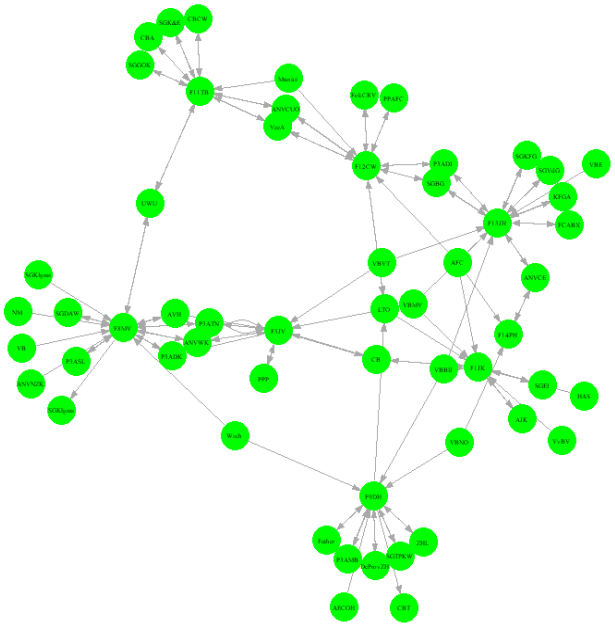

Figure 6. High NIA network

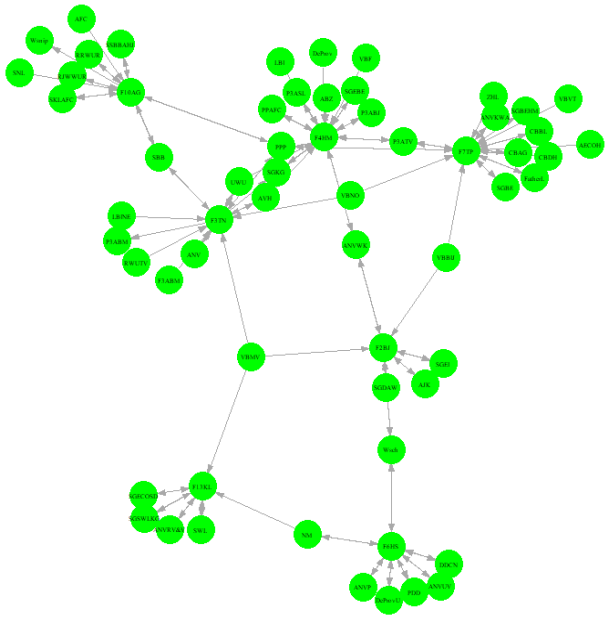

Figure 7. Low NIA network

Figures 6 and 7 present the directionality of the information exchange between farmers and the different sources. The arrows represent the directionality of the information exchange, which can be unidirectional or multidirectional. Looking at the total amount of information sources mentioned by high NIA, in 71.6% of the information sources there is mutual information exchange. Meaning that in 71.6% of the interaction with the information sources, the information was received by the farmer, but the farmer also provided information to the source. Looking at the total amount of information sources mentioned by low NIA, in only 58.3% of the interaction with the information sources there was mutual information exchange. This means that in the information network of farmers with high NIA, there is relatively higher mutual information exchange than in the low-NIA farmer network.

Here an evaluation of the difference in the farmers social networks in comparing a relatively high NIA implementation with relatively low NIA implementation is provided. The high NIA information network were slightly larger than the low NIA information networks. The network size of the high NIA is 7 farmers and low NIA is 10 farmers. The high NIA information networks were linked to more information sources (nodes). High NIA farmers reported an average of 10.71 (SD 3.25) network ties, while low NIA farmers reported an average of 10.13 (SD 3.09) ties. In addition, the density is evaluated. Density represents the proportion of possible relationships in a network that are present. The density mean of the low NIA is 0.17 (SD 0.06), the density mean of the high NIA is 0.17 (SD 0.07). Since the mean and SD are similar and overlapping, the networks do not seem to be structurally different.

4.3 Decision-making and the use of information received by farmers

The results in this chapter help answer the third research question: *How do farmers decide to use the information received in the social network?* Specifically, the farmers' identification with information sources is examined and how these sources facilitate or hinder the implementation of NIA.

This analysis aims to understand how information, from the perspective of a farmer, shapes or is shaped by influences in the personal, political and practical sphere. Depending on the source and content of information, the farmer may perceive it as either facilitating or impeding their engagement with NIA practices within one or more of these spheres. The terms "traction" and "friction" are used to denote whether the information source has a positive effect (traction) on farmers consideration of NIA or a negative effect (friction) on their decision-making process (Gosnell et al. 2019). The practical sphere encompasses behavioural and technical solutions, and addresses solutions aimed at enhancing biodiversity, preserving nature, and promoting behavioural changes that support the transition to NIA. The political sphere pertains to the "enabling/disabling" conditions within economic, political, legal, social and cultural systems that influence transformative actions. This relates to information on what solutions for NIA are allowed and the means that are provided to realize these. Lastly, the personal sphere examines the influences of individual and collective beliefs, values, and worldviews on the information experienced within the other two spheres. The farmer's identification with the information sources, and the information coming from personal, practical and political sphere can create fraction and traction. For instance, in the agricultural context, the subsequent paragraph will demonstrate how government support, market dynamics, and social acceptability within the political sphere influence the selection of new grassland or modified farm management practices in the practical sphere based on the information provided. These factors are, in turn, influenced by farmers perceptions, thoughts and emotions towards the broader system and the extent to which information is accepted as relevant or trustworthy.

Overall, farmers with high NIA adoption reported experiencing both high levels of traction and friction in interaction with information sources. Conversely, farmers with low NIA adoption had relatively low experiences of both traction and friction compared to their high NIA counterparts. In addition, information provided by other farmers act as traction when the other farmers produce for similar markets or have similar soils, which represents similarity in key farm business attributes. Moreover, information coming from NAVs and TBOs act as traction because the information may have similar values with regards to a 'fit' within the business characteristics and the search for optimal balance between agricultural production and nature conservation. Lastly, information acts also as traction when mutual information exchange takes place.

4.3.1 Traction in the personal, political and practical spheres

4.3.1.1 Personal

Information can possess inherent value-laden attributes, particularly in terms of its delivery. Findings show the significance of information received from other farmers operating in similar markets and comparable soil types. Especially when producing for similar markets, business values seem to align such as in the case of the biological markets. Farmers perceive such information as relevant, as it aligns with practices in their own business. This finding applies to both cases of high NIA adoption and cases of low NIA adoption.

Interviewee 13 *"Practical stories from farmers I find most reliable, especially when they produce with the same soil type. In the end, you need to try it for yourself to truly see if it works for your business"*

Interviewee 9 *"You learn the most from farmers who are the same as you, in my case this is study groups that are active for biological farmers. There is a neighbour biological farmer, we work together with from time to time, he also joins the study group. A TBO for example tells you what to do, but you do not really come together to discuss. With a colleague farmer, I learn the most when we have discussions about our business"*

Information perceived as relevant does not solely stem from other farmers, though. Information acquired from organizations with similar values, particularly those concerning farm operations and nature optimization, is also deemed relevant. This finding applies to cases of high NIA adoption and in cases of low NIA adoption.

Interviewee 5 *"He (1:1 advisor of NAV) has knowledge of certain businesses within a dairy company, they understand for example what the consequences are for your company, for a certain choice that you make, they elaborate on the possible consequences there are"*

Interviewee 12 *"She (1:1 advisor of NAV) has a very practical manner of application of agricultural nature management, because you need it to fit within your business. It depends on what I need, and I need for the herb-rich grassland to grow consistently. For me it is less important that I have a high production, but if for example I need to optimize my production and also optimize the herb-rich grassland, then she will provide the information that I need to optimize my production."*

4.3.1.2 Political sphere

In the Netherlands, TBOs and NAVs offer guidelines for achieving agricultural nature management. This guidance is provided through one-on-one interactions or organized by study groups. These organizations offer advice and monitor the implementation of agricultural nature management guidelines. In almost all high and low NIA cases, except one, farmers have signed contracts with TBOs or NAVs to take responsibility for implementing agricultural nature management, which includes financial compensation. In most cases, this interaction is perceived positively and leads to traction because adhering to the monitored guidelines facilitates NIA implementation

Interviewee 16 *"Here we have different agreements regarding agricultural nature management with the NAV. We discuss 1, 2, 3 times a year what contracts we have, and if we want to change or improve".*

The positive perception of these interactions stems from trust farmers have in these organizations, as they work towards increasing biodiversity and reducing emissions. As mentioned earlier, organizations such as NAVs can have similar values for farm operations in addition to biodiversity that is perceived by farmers as relevant. The strength is reinforced by active participation and integration of neighbouring farmers in similar contracts. NAVs and TBOs often customize multiple types of contracts to realize the most effective combination of nature management practice in a certain area, which aligns with the findings in the personal sphere that farmers value an understanding of farm operations and optimization of nature. This increased trust was indicated by high NIA farmers.

Another positive aspect is the prompt response of NAVs, TBOs and consultancy firms to policy changes, which has motivated farmers to seek information and knowledge through these networks. They provide information to help farmers comply with policy changes, offering potential NIA solutions as already mentioned in paragraph 1.3. It is important to note that while farmers receive support for implementing such practices, there is no guarantee of economic benefits resulting from the implementation.

4.3.1.3. practical

Environments that foster traction, although rare, are projects involving technical innovations or nature management implemented by multiple stakeholders, including research institutes, governmental organizations, and the private sector. Two cases exemplify the effectiveness of such collaborations, where mutual information sharing occurs, and knowledge of farm operations and customization to specific situations are well-implemented. The first case involved the introduction of clover grass to increase protein content in animal feed, both reducing the reliance on concentrated feed and eliminating the need for fertilized manure. Another case involved the implementation of pressure drainage, a technique to reduce nitrogen emissions on peatland.

Interviewee 6 *"In the project the NAVs, province and the Waterboard are participating. Especially the Waterboard is involved who share articles, you are in conversation with them as farmers. It is a good system to close the gap between the theory in science and the every-day practice of farmers. They also help you in understanding what rules apply, what you can and cannot do"*

Study groups play a significant role in enhancing knowledge exchange, especially among farmers sharing experiences and implementing NIA. Trust is built within these groups because potential risks associated with practice implementation are communicated, allowing farmers to discuss whether these risks are applicable to their own circumstances. Farmers with high-NIA experienced that information provided by NAVs and TBOs were customized to the specific environment and farm characteristics. Farmers indicated the presence of knowledge on how an agricultural business works and understanding of the consequences for such a system to transition. This works as traction-related feature.

Interviewee 3 *"They provide knowledge on seeds and they help with picking out specialized herb-rich mixture, which is very expensive per ha. The question is what it will yield, especially since we are not allowed to use fertilizers. This project is fortunately financed".*

Interviewee 12 *"... because of the input from farmers they also know how things work. For example, if you talk about herb-rich grassland, that is extremely difficult to seed and nurture because it is a sensitive crop, you need experience to know how to treat it, and because NAVs have a lot of members, they also share this experience."*

4.3.2 Friction in the personal, political and practical sphere

4.3.2.1 personal

Contrasting situations may arise concerning information obtained from NAVs and TBOs. Half of the high NIA farmers and low NIA farmers perceive such information as biased towards a nature-oriented approach, neglecting dependencies on weather conditions and economic aspects, and failing to consider optimal nature and practical situations. Information from these sources can therefore be regarded as biased and lacking nuance. This nature-oriented bias creates friction regarding the relevance of knowledge disseminated by such organizations.

Interviewee 5 *"Often at NAVs, they hire someone that is an enthusiastic of nature. There is nothing wrong with that, because they have an expertise in nature. They, however, are far detached from the practical workings on a dairy farm. They are too far detached from the everyday reality of a farmer for them to inform them well. They present three research publications that agricultural nature management will affect milk production, while I spoke with three neighbour farmers who oppose this claim"*

This nature-oriented bias in information also undermines the potential for change within the practical sphere, as will become clear in the following paragraph. Alongside the aforementioned factors, mutual information exchange holds value among farmers. The absence of such information exchange is noted in certain cases where NAVs and TBOs fail to consider the knowledge of farmers based on experience when implementing practices, thereby contradicting the farmers' preference for finding the most optimal or customized solution for NIA within their particular farm business. This absence of information exchange also has implications for the practical sphere, which will be elaborated on in section 4.3.2.3.

4.3.2.2 political sphere

Within the Dutch institutional system, which includes the government, the private sector and the civil society, collaborative efforts are made to realize transition in the agricultural sector. Research is conducted by institutions such as universities, private research institutes, individual researchers, dairy companies, and feed companies, often in collaboration with consultancy bureaus. Although the government initiates some research, it primarily serves as a funding entity rather than an executor. Farmers with high NIA indicate trust in research. The relevance, however, of the publications is questioned due to two factors: 1) the absence of consideration of weather conditions and farm characteristics, and 2) observations in practice that contradict the research findings.

Interviewee 7 *"The NAV showed the publication about a scientific experiment in Zegveld. They showed a graph, of a narrow plantain that in the first year had a good harvest. The next year, another good year of harvest. They showed similar results for the yield of Herb-rich grassland. They concluded that with herb-rich grassland and narrow plantain, you have better yield than regular grassland […] When I asked about yield of the following year, they could not show me figures. I have been to the experimental field in Zegveld, and there is narrow plantain. The year that there was good yield, was a dry year in which narrow plantain grows well. The year without figures was a wet year, and the narrow plantain was not there anymore."*

Most agricultural studies span three years, while drought and humidity conditions fluctuate in cycles of ten years. Additionally, research or implemented innovations become irrelevant when farm characteristics deviate from those in which the practices have been studied (e.g., soil type).

Interviewee 4 *"You could seed grass-clover, that will go well one or two years. Here we have peatland, and that is too much nitrogen for grass-clover. The grass-clover will not survive, so you have the continue to seed which is not a sustainable method. Continuously seeding is really impossible".*

Farmers also question the relevance of technical innovations supporting NIA for their farms, especially when there is uncertainty regarding the acceptance by the government. In an environment where there is little control over the future of farming, characterized by frequent policy changes and limited support from banks, they are hesitant to view information on technical innovation as relevant. Without this knowledge, farmers are reluctant to make investments contributing to emission reduction such as pressure drainage and manure biogas plant.

Interviewee 15 "the last couple of yours I only focused on replacement investments because it has been difficult with the government to know what you need to invest in. Take for example Ladies Fair, it reduces emissions but it is expensive and we are not certain whether the government will allow this practice to stay. Therefore it is easier to simply stay with replacement investments"

Information that farmers high NIA share and receive that causes friction coming from the political sphere is knowledge in which it appears that being high NIA is economically unsustainable. This knowledge is shared by reportages of research institutes and consultancy bureaus, as well as shared by amongst farmers in study groups where they visit high NIA farmers. Similarly, low NIA farmers expressed concern or experienced disabling economic conditions. In one case, this has even led to downgrading the implementation of NIA.

Interviewee 9 "With the help of the NAV we implemented a marshland system last year, then I found eleven bird nests, there were probably even more. But this year, I decided to reduce these efforts, because it affected the quality of my grassland yield to much, reducing my production"

4.3.2.3 practical sphere

As introduced above, farmers sometimes voiced concern about the strong nature-orientation bias of information from some sources such as NAVs and TBOs, which created a misalignment with the farmers' practical realities, and therefore hindered the internalization of information as trustworthy and impeded the transition to NIA.

The aforementioned values within the personal sphere can hinder or even reverse change within the practical sphere. This regard a strong nature-orientation that stands in conflict with practical reality of farmers. This becomes evident when farmers express disagreement with the implementation of agricultural nature management. In some cases, farmers indicate that NAVs and TBOs were reluctant to consider the knowledge shared by them regarding the challenges faced during implementation. These challenges often relate to the weather conditions or practical factors that hinder the successful execution of practices. Although there is a level of trust in NAVs and TBOs which is evident by the high amount of contracts between farmers and such organizations, yet this trust is questioned when mutual information sharing is absent.

Interviewee 9 *"I have 25 ha of agricultural nature management where cows are not allowed until the first of July. After the first of July, my cows are allowed to walk there. How does that work? The cows exist the entire year, not only in the autumn and at the end of the summer. The NAV understands this, but they do not change anything. They make their decisions for nature management, not for agricultural nature management or NIA"*

Interviewee 13 *"You implement the guidelines in a practical manner, but it needs to be doable for us. Shortly, before we lost the land, we had to mow ditch edges, because there were great manna gras. Unfortunately they were too far from the ditch side for the regular mower that we have to reach. Therefore a few great manna grass were left. We then received a warning that we did not measure up to the guideline that provided information that we needed to remove everything, but that was practically impossible for us. There is a certain arrogance there, 'I am a TBO and I will decide for you', you have hardly anything to communicate as a farmer"*

Furthermore, farmers have indicated a lack of information that motivates the practices between farmers, TBOs and NAVs. One explanation provided by high NIA farmers reveal that farmers often fail to comprehend how the guidelines stimulate nature protection.

Interviewee 5 *"... Yes, we have a contract with NAV. You receive a form with information on what to execute. They tell you exactly what you have to do. Where, and when, but not necessarily why."*

Interviewee 8 *"A lot of knowledge is missing… we do not receive it from the TBO. You have a contract with information on what you have to do, but they never tell you what use it has. For example, to only mow after a certain date, why do they find it necessary to mow every little grass? That is definitely something that is missing"*

The absence of mutual information exchange leads to a situation where farmers are unable to influence the NAVs and TBOs that make guidelines that steer the practices on their the land. By disregarding farmers' input, it contradicts their value of finding optimal solutions that work in harmony with both nature and practice to promote biodiversity enhancement and emission reduction, while instead imposing a strictly nature-oriented approach on farmers.

5. Discussion

5.1 Types and sources of information

Farmers draw on a range of sources to provide information on different topics related to NIA, including information on how to implement agricultural nature management on the farm; information on technical agricultural innovation; examples of NIA practices; information on the economic sustainability of NIA, and the effect on nature and climate of the NIA practices. Overall, interviewed farmers appear content with the quantity and diversity of diffused information. The subjects covered are extensive, and in certain cases farmers even feel overwhelmed by the abundance of information available.

The above findings stand in contrast with earlier publication by Cupersius et al. (2019), who contended that knowledge on NIA is dispersed, difficult to locate, and at times incomplete (as also noted by Vermunt et al. 2022). However, in concurrence with Cupersius et al. (2019), the present study observed an emphasis on information regarding nature management and the ecological impact of NIA, but in the context of nature management, explanations concerning the effect on both nature and climate, as well as the farmer's overall business, are occasionally lacking. This absence of comprehensive information may impede farmers' consideration of adopting NIA practices.

The range of sources that provide information on different topics related to NIA can be characterized as public-private interactions. The findings indicate that the most frequently mentioned sources are trade journals, agricultural nature organizations (NAVs and TBOs), study groups, other farmers, and 1:1 advisors. This outcome aligns with the broader trend observed in the Netherlands, where there is a shift towards privatization and an increasing prevalence of public-private partnerships as a model for knowledge development in environmental governance (Driessen et al., 2012). Notably, the private sector emerges as the most proactive in providing information about the actual effects of NIA practices on nature and climate, while nature agricultural organizations are most proactive in providing information on nature management.

In contrast, there are sources of information that farmers rely less on. For instance family members, consultancy bureaus, and individuals associated with research institutes are least referred to as source of information by farmers. The relatively low emphasis on consultancy bureaus and research institutes can be expected, given that much of their collaboration is channeled through 1:1 advisors and study groups, both of which are well-represented sources of information. Rather than serving as primary

sources of information influencing the decision-making, these organizations provide more indirect and supplementary information.

The absence of family members as information sources is quite surprising, given the existing literature on the social network structures does indicate family members as key actors within the farmers social network in other case studies (Ataei et al., 2019; Solano et al. 2003). The interviewed farmers did not provide a clear motive for not using family members as information sources, and therefore further investigation is necessary to understand the underlying dynamics and reasons behind the underrepresentation of family members as information sources in the Netherlands. A possible explanation could be the abundance of information provided by sources that are embedded in the their region, that farmers do not only rely on their family members for localized knowledge as they do in other publications (Ataei et al., 2019; Solano et al. 2003).

In comparing the high and low NIA networks, results show that the networks are not structurally different. In the qualitative analysis however, there is clearly differences in the type of sources of information used by farmers. The results highlight the difference in information sources between low and high NIA farmers, supporting the argument that reliance on private organizations hinders low NIA famers ability to acquire relevant knowledge for transitioning, while high NIA farmers knowledge development is more facilitated by civil organizations. Low NIA in this study predominantly receive their information from private organizations, with a smaller proportion coming from civil organizations, whereas high NIA farmers acquire information from a diverse range of organizations, with relatively less reliance on private entities.

The above findings shed light on insights provided by Vermunt et al. (2022), who discussed the challenges in knowledge transfer, attributing them in part to the underlying issue of farmers reliance on commercial actors that hinder their ability to acquire the relevant knowledge and information necessary to transition to NIA. When examining the low NIA implementation, the findings support the argument presented by Vermunt et al. (2022) that these farmers are less concerned about the type of knowledge available and are more focused on identifying which NIA information aligns with their specific agricultural operations which they predominantly receive from commercial actors. In contrast, the high NIA implementation demonstrates that farmers are not necessarily overly dependent on commercial actors, as their knowledge development is predominantly facilitated by civil organizations.

Notably in this case study, the policy shift and insecurity towards possible policy shifts in the future seem to have accelerated the search for information and the need to receive it. This in literature is explained as creating new path dependencies, in which major changes in the farming trajectory occur largely as a response to a triggering event (e.g. policy changes) on the farm level (Šūmane et al. 2018;

Sutherland et al. 2022). According to Sutherland et al. (2022) such events encourage farmers to seek knowledge, thus initiating a decision-making process. In the results, NAVs and TBOs are regarded by farmers as an information source with regards to their decision-making process. For that reason, such collectives may play a role in creating new path dependencies in transitioning to NIA.

5.2 Importance of mutual information exchange

Findings suggest that mutual information exchange is imperative for farmers to consider information trustworthy or relevant, and therefore internalize and use it to implement NIA. The reciprocal information sharing relates back to the amount of influence actors can have on one another (Ambrosius et al. 2019). Understanding how a farms work, and the dependencies that come with it will bring depth to the conversation. It is often a lack of understanding on what the effects of certain NIA implementation have on a farm, that makes a farmer hesitant to implement it. Therefore it can be indicated that the organizations that facilitate information exchange, have the most influence on farmers since they provide information that has more relevance and is more trustworthy. Organizations that provide information with a unidirectional flow are often regarded as less relevant in the farmers' opinion.

In the context of the low NIA network, the extent of mutual information exchange was found to be lower compared to high NIA network. In the high NIA network, civil organizations such as NAVs and TBOs were more frequently represented than private actors, but a lack of information exchange with both organizations sometimes prevented information from being customized to the farmer's context and is therefore regarded as not relevant or trustworthy resulting in friction.

In search of explanation, Vermunt et al. (2022) offer insights. They suggest that knowledge development is a top-down, expert driven process with insufficient involvement of farmers. Although the notion of "sufficient involvement of farmers" may require further clarification, this study understands information to become relevant or trustworthy to farmers when mutual information exchange is present. This study shows that a conducive environment for NIA implementation indeed involves engaging farmers through mutual information exchange, where the presence of civil organizations plays a significant role. In such cases, knowledge development is not strictly top-down, as it integrates practical insights from farmers alongside theoretical aspects of implementation.

The importance of mutual information exchange is not new information, since several theories and frameworks have been developed upon this notion such as AKIN (Knierim et al. 2015; Šūmane et al. 2018). Šūmane et al. (2018) studied formal and informal knowledge, regarding the latter as local

farmer knowledge. Their research shows the several ways in which formal and informal knowledge exchange remain rather separated, which is similar to the finding in this study where the practical knowledge of farmers seems in some cases to be separated other information sources. Šūmane et al. (2018) as well as this study contribute thereby to the framework of AKIN stating that in agricultural knowledge systems, both formal and informal sources of knowledge have strengths and that networking and knowledge exchange will make knowledge flexible and enhance sustainability.

However, different from the AKIN framework, this study turns attention to the cognitive barriers in initiating and accepting certain information from sources, which also hinders decision-making processes in adopting sustainable agricultural practices. To provide environments where mutual information exchange is present between 'formal' or 'informal' knowledge sources, does not guarantee that farmers will intent to use the information and vice versa. In the following paragraph, the evaluation of information by the farmer will be elaborated revealing the significance of farmers' identification with information sources. Also revealing that a simple practical solution into facilitating information exchange between farmers and other information sources may not always be enough.

5.3 The relationship between farmer identity and information use

When do farmers decide to use information in their decision-making process to consider or adopt NIA practices? The results reveal the significance of farmers identification with the information sources, which allows for the argument that recognizing the 'farmers identity' is deemed necessary for knowledge development among information sources. Especially considering the relevant business attributes (e.g. soil type) enhances the acceptance of information dissemination in the agricultural context. Defining the concept of 'farmers identity' raises questions of what it entails precisely. 'Farmers identity' is composite notion encompassing both farmers personality and their business identity, intertwined into a cohesive whole. Especially the latter part of the identity is important in considering the relevance and trustworthiness of information. The concept of 'farmers identity' entails the value of mutual information exchange resulting in exerting the ability to influence on the agricultural knowledge systems, and being able to exercise the value with regards to optimizing farm and nature, as opposed to a strong nature-orientation that in the perspective of many farmers in this study disables their agricultural practices.

The concept 'farmers identity' is different from the classical notion of social identity theory, that does not have a particular focus on the business aspects to which an identity can form. Ambrosius et al. (2015) already introduce 'farming styles' as an identity to which a farmer can conform, however, this theory is only applicable to considering ingroup and outgroup within a realm of different farming

styles, and does not allow for a comparison with entities that are not farmer. This disables an analysis of an outgroup that for instance cannot produce for similar market, but does have similar ideas on nature-orientation in agriculture. Therefore, the concept 'farmers identity' allows for analysis of an identification with information sources that do not necessarily have to be farmer. Moreover, 'farmer identity' coincides with Westerink et al. (2021) observation in the Dutch agricultural landscape that biodiversity objectives are becoming more and more a part of what it means to be a 'good farmer', however, this study shows that in searching for information to realize objectives such as NIA, practical aspects of the farm business (e.g. soil type or market) just as much constitute the identification of a farmer.

The theoretical contribution to this study posits that information can act as a source of traction and or friction through a dynamic that both shapes and is shaped by engagement with the practical, political and personal spheres. How the farmer engages with that source, depends on how a farmers identifies with the source, how it is approached, exchanged and applied. When we regard the relationship between 'farmers identity' and information coming from any sphere, it makes information act as a source of traction or friction. Finding show that when you look at information that acts as traction, in the case of information sources of other farmers, similar markets and soil types, which represent similarity in situational context are deemed relevant. Moreover, information coming from the sources NAVs and TBOs act as traction because information may be provided value-laden by similar ideas on optimal nature use and is customized to their specific farm attributes and situational context. Lastly, information can act as a source of traction when mutual information exchange is facilitated. Since the aforementioned are a part of the social identity theory; similarities between ingroup and outgroup such as values, contextual matters and mutual influence do explain the perceived relevance and trust of the information sources. Similarly accounts for the findings showing when information acts as friction, which happens mostly due to absence of mutual information exchange, indicating an absence of influence on each other and differences in values.

The findings seem to approve the significance of the social identity theory in helping to explain transition towards NIA. The transition theory allows to distill the multi-level interaction of a transition, in which individual-level behaviour as a result of decision-making processes has come to the foreground. Information received from the different scales is influenced by the perception of farmers. The 'farmers identity' in group dynamics show how perceptive circulate in the separate spheres, and in the end impact the farmers consideration to implement NIA. 'Farmer identity' allows to distill what type of group dynamics are necessary in the separate spheres for a farmer to consider information on NIA as relevant or trustworthy.

To conclude, this research underscores the significance of farmers' identification with information sources, particularly when those sources exhibit congruence with their farm or business characteristics and differ from a strong, one-dimensional nature-orientation. Recognizing the multi-faceted 'farmers identity' and considering relevant business attributes can enhance the effectiveness and acceptance of information dissemination within the agricultural context. Such insights contribute to a deeper understanding of information adoption on decision-making processes among farmers, fostering NIA practices.

5.4 Implications for policy

The social relevance of this study lies in understanding what information farmers require to consider to adopt more NIA. While there is sufficient information available for farmers, in some cases, it could be better tailored to their specific businesses. Since each farm is unique, providing every farmer with the most optimal information seems hardly possible. However, creating environments that encourage regular dialogue and knowledge exchange can improve the flow and diffusion of information. Also, possibly take away the many risks that farmers are confronted with transitioning to NIA.

Regarding the three main sources of information discovered, the ways in which they can be improved are described below. This will address the final research question: *How can information sources on NIA be improved to accelerate the transition to sustainable agriculture in the Netherlands?*

1. NAVs and TBOs could both work on a shared strategy, enhancing network capacity, and invest in a learning culture that promotes mutual information exchange, involving farmers more actively. Particularly for organizations with a strong nature-orientation, initiating conversations can help align values and contribute to the effective and prolonged implementation of their proposed guidelines. For instance Wojtynia (2023) noted that not only a shift in rules and guidelines are necessary for transition to occur, but also altering underlying values help realize transition potential. In addition, this is crucial for collectives that were established through a top-down approach, rather than originating from farmers' initiatives. Hence, it is suggested that NAVs maintain proximity in their identity as self-governing farmers groups, and TBOs or other top-down organizations could learn from their example.
2. The above approach also extends to the broader context of public-private partnerships. Collaboration between groups of farmers, government, and other organizations, as demonstrated in this study, proves effective within the network of high NIA. The implementation of the collective agricultural scheme in 2016 acted as a catalyst, by

attempting to increase farmers involvement and equality within the network of farmers (Barghusen et al., 2021; Pretty et al., 2020; Westerink et al., 2021). If mutual information exchange continues to be fostered, all stakeholders, including farmers, should be acknowledged as equal contributors to knowledge development, and different types of knowledge should be integrated, preferably in learning environments such as study groups. Further research could assess the effectiveness of this policy and explore whether its implications elsewhere could encourage more sustainable agriculture globally.

6. Limitations

Limitations in this study include categorization bias due to normative evaluation, respondent bias, and a small sample size. The first limitation stems from the normative evaluation of the differentiation between high and low NIA farmers. Not all criteria were equally weighted, as certain practices were deemed more important than others. The weighted criteria in this study is inspired by Bouma et al. (2019), but this may differ from other normative evaluations. For instance, while some individuals may prioritize reducing ammonia, others may dispute its significance due to challenges in accurately measuring ammonia pollution. Given that the different weights to the various practices are a normative decision, such choices should be made transparent.

The second and third limitations relate to the respondents in this study. The snowball method used to find respondents likely attracted individuals interested in NIA, leading to respondent bias. This might explain the relatively equal number of high and low NIA farmers in the separate networks. It is important to note that the sample size in this study does not represent the actual distribution of relative high and low NIA farmers across the Netherlands, as concluded by Vermunt et al. (2022) regarding the overall low implementation of NIA in the country. Moreover, due to the small sample size, applying any quantitative test yielded insignificant and unreliable results, leading to the decision not to include statistical tests. While the networks were not structurally different, the qualitative results (e.g. alluvial diagram) did highlight differences in types and sources of information.

7. Conclusions

In this case study, farmers identified a wide range of sources they use to consider to adopt NIA practices, with trade journals, agricultural nature organizations (NAVs and TBOs), study groups, other farmers, and 1:1 advisors being the most frequently mentioned sources. This reflects a trend of privatization and an increasing prevalence of public-private partnerships in knowledge development within environmental. The information from these sources covers various topics related to NIA, such as implementing agricultural nature management, technical agricultural innovation, examples of NIA practices, the economic sustainability of NIA, and the impact of NIA practices on nature and climate. Overall, the interviewed farmers expressed satisfaction with the quantity and diversity of the information they received.

Farmers turn to their social networks to seek information, and recent policy changes, such as the GLB and the derogatie have accelerated their search for solutions to comply with these policies, including NIA practices. It shows that triggering events encourage farmers to seek knowledge, thus initiating a decision-making process.

The decision to use the received information in their social network is likely to depend on whether it resonates with their 'farmers identity,' which includes both personal values and beliefs, as well as relevant farm and business characteristics such as soil type and market orientation. The practical application or exchange of information is determined by its perceived relevance and trustworthiness, which is more likely when it aligns with their values for optimizing nature and the practical aspects of their farm business. The relationship between farmer identity and information from different spheres influences whether information acts as traction or friction, with mutual exchange making it more relatable to the farmer, customized to their specific farm attributes and context.

The findings support the significance of the social identity theory in explaining the transition towards NIA. 'farmers identity' helps identify the necessary group dynamics in the prevailing public-private partnerships for farmers to consider NIA information as relevant or trustworthy, potentially leading to a transition towards NIA. If mutual information exchange continues to be fostered by information sources in public-private partnerships, all stakeholders, including farmers, should be acknowledged as equal contributors to knowledge development, and different types of knowledge should be integrated, preferably in learning environments such as study groups. This might help realizing a transition towards NIA in the Netherlands.

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Appendix 1.

Informed consent formulier (interview)

In deze studie willen we leren over de manier waarop boeren omgaan met informatie wanneer ze een overstap naar natuur-inclusieve landbouw als mogelijkheid zien. We willen graag inzicht in het proces van het verzamelen en gebruiken van informatie dat kan bijdragen aan een transitie naar duurzame landbouw. Meedoen aan dit interview is vrijwillig en u bent vrij om te stoppen met het interview op elk gewenst moment zonder dat daar consequenties aan verbonden worden. Uw antwoorden zullen alleen geanonimiseerd worden gedeeld met onderzoekster Natalie Davis. Alle data zal anoniem worden verwerkt. Dit doen we volgens de wetgeving inzake gegevensbescherming (de Algemene Verordening Gegevensbescherming en de Wet persoonsgegevens). Probeer zo waarheidsgetrouw mogelijk de vragen te beantwoorden. Voel u vrij om te zeggen en te schrijven wat u zelf wilt.

Alles wat u vertelt en schrijft is vertrouwd en anoniem. Dit betekent dat we niet vragen om uw naam, en niemand zal te weten komen welke respondent wat heeft gezegd.

Houdt u er rekening mee dat dit onderzoek onafhankelijk is van PPP-Agro Advies. PPP-Agro Advies representeert de inhoud en het doel van dit onderzoek niet. De data wordt individueel verzameld en geanalyseerd door Dineke Verkley onder begeleiding van Natalie Davis. De data die wordt verzameld zal niet worden gedeeld met PPP-Agro Advies.

Ik onderschrijf dat:

- Ik voldoende ben ingelicht over de inhoud van dit onderzoek;
- Ik geen verdere vragen heb over dit onderzoek op dit moment;
- Ik de gelegenheid heb gehad om goed na te denken over mijn participatie in dit onderzoek;
- Ik eerlijk antwoord zal geven op de vragen die worden gesteld.

Ik ben het eens dat:

- De data die wordt verzameld en bewaard voor wetenschappelijke doeleinden;
- De verzamelende en compleet anonieme onderzoek data kan worden gedeeld en hergebruikt door onderzoekers om andere onderzoeksvragen te beantwoorden;
- Dit onderzoek onafhankelijk is van PPP-Agro Advies. De inhoud en het doel van dit onderzoek worden gerepresenteerd door Dineke Verkley als master student van de Universiteit Utrecht.

Ik begrijp dat:

- Ik het recht heb om het eindrapport achteraf in te zien. Deze zal ook worden gedeeld met PPP-Agro Advies

Gaat u akkoord met een deelname? o JA o NEE

Informatie formulier

Introductie

U bent uitgenodigd om onderdeel uit te maken van een onderzoek naar de informatienetwerken van boeren. Het doel van het onderzoek is om te leren op welke manieren boeren omgaan met informatie wanneer een transitie naar natuur-inclusieve landbouw wordt overwogen, en welk proces van informatie gebruik bijdraagt aan een transitie naar duurzame landbouw. Het onderzoek is neutraal en heeft geen standpunt wat betreft de juiste manier van landbouw. De studie wordt uitgevoerd door Dineke Verkley. Zij is student in het Master programma Earth System Governance van het departement Duurzame Ontwikkeling aan de Universiteit Utrecht. De studie wordt begeleid door Natalie Davis.

Deelname

Uw deelname aan dit interview is volledig vrijwillig. U kunt op ieder moment stoppen met het interview zonder dat hier consequenties aan verbonden zijn. Uw bijdrage aan dit onderzoek is belangrijk voor ons en we waarderen dat u de tijd neemt om dit interview af te nemen. Naar schatting zal het interview ongeveer 50 minuten duren. De vragen worden door de interviewer voorgelezen. Sommige vragen zijn snel te beantwoorden, andere vragen kunnen meer tijd nodig hebben om te beantwoorden vanwege zorgvuldige overwegingen. Voelt u zich vrij om vragen over te slaan waarbij u zich niet prettig voelt deze te beantwoorden. U kunt de interviewer vragen om vragen die onduidelijk zijn te verhelderen voordat u antwoord geeft. Uw vragen zullen worden genoteerd door de interviewer in een antwoord template. De data die u voorziet zal worden gebruikt om een master thesis report te schrijven en zal mogelijk worden gebruikt voor het schrijven van een artikel in een wetenschappelijk blad of gepresenteerd worden in academische kringen. Alleen patronen in de data worden gerapporteerd. Directe citaten kunnen worden gebruikt om patronen te onderbouwen. De citaten zullen anoniem zijn en kunnen daarom niet worden terug herleid naar de individu van wie het citaat is. Later in het proces zullen deze patronen ook worden gedeeld met experts voor verdere verheldering, maar hierbij zullen geen specifieke voorbeelden, citaten of informatie dat kan worden teruggeleid naar een individu worden gedeeld met derden.

Gegevensbescherming

Het interview wordt met uw toestemming opgenomen en getranscribeerd (afgeluisterd en omgezet naar getypte tekst). De opnames komen in handen van de Master student. We zullen uw persoonlijke data anoniem verwerken. We doen we volgens de wetgeving inzake gegevensbescherming (de Algemene Verordening Gegevensbescherming en de Wet persoonsgegevens).

- De opnames worden verwijderd zodra het dataverzamelingsproces is voltooid en alle interviews zijn getranscribeerd.
- Alles wat u in dit interviews zegt, is vertrouwelijk en volledig anoniem. Dit betekent dat we niet zullen vragen naar uw naam, geboortedatum of andere persoonlijke informatie die door ons of een derde naar u herleidbaar is. We zullen uw gegeven vertrouwelijk en in overeenstemming met de wetgeving inzake gegevensbescherming (de Algemene Verordening Gegevensbescherming en de Wet persoonsgegevens) verwerken.

Appendix 2

DEEL I (circa 20 minuten)

1. **Introductie**
2. **Vraag om of alles duidelijk is en toestemming om het interview op te nemen**
3. **Leg uit dat het interview twee delen heeft (20 minuten + 30 minuten)**
4. **Indeling naar type landbouwer**

- Wanneer ben u boer geworden?
- Waarom ben u boer geworden?
- Wat is uw opleidingsniveau?
- Wat is de grootte van uw boerderij in hectare?
  Bedrijftyperingen:
  → aantal melkkoeien
  → aantal stuks jongvee
  → hoeveel hectare gras
  → hoeveel hectare snijmaïs.
  → grondsoort
- Welke soorten vee worden op uw bedrijf gehouden? (sla over indien al besproken)
- Wat is het totaal aan vee wat wordt gehouden? (sla over indien al besproken)
- Teelt u naast gras ook andere gewassen? Zo ja, is dit teelt voor eigen gebruik of voor verkoop aan andere boeren?
- Voor welke markt produceert u voedsel? Voor de reguliere markt, biologische markt, direct aan de consument, etc (heeft u certificeringen? E.g. Skal, planetproof, kringloopwijzer)
- Hoe lang produceert u al voedsel voor deze markt?

5. **Landbouwmanagement**. Nu volgen een aantal stellingen die betrekking hebben om type landbouwer. Voordat ik deze voorleg, zou u in uw eigen woorden kunnen beschrijven wat voor een type landbouwer u bent en hoe u zich onderscheidt van andere type landbouwers. Geef aan in hoeverre u het eens bent met de volgende stellingen:

Tabel 1. Kenmerken van type landbouwer onderverdeeld in ondernemer, ambacht en idealist

Stellingen + vragen	Strongly agree (4)	Agree (3)	Disagree (2)	Strongly disagree (1)
1. Ik boer als manier om in het levensonderhoud te voorzien, maar niet om de winst te maximaliseren. (versterking van verdienvermogen van landbouwbedrijven gebeurt immers in de regel vooral door schaalvergroting (meer dieren en/of meer omzet) en intensivering (hogere productie per ha en/of per dier)				
2. Ik streef naar maximale winst				
3. Ik optimaliseer regelmatig mijn bedrijfsvoering, bijvoorbeeld door nieuwe producten te proberen of mijn processen te veranderen (niet ambacht). → Vraag: Wat heeft u in het afgelopen				

	jaar veranderd? Bijv. Managementmaatregelen (rantsoenen, bemisting) of investeringsmaatregelen (machines, stal).				
4.	Ik streef naar een lage kostprijs door mijn 'eenmalige investeringen' te verminderen. → Vraag: hoe frequent waren de laatste investering en wat waren de veranderingen op de boerderij? (machines, stalaanpassingen, extra land)				
5.	Ik streef naar een lagere kostprijs door mijn dagelijkse aankopen te verminderen → Vraag: op welke manier probeer jij je dagelijkse kosten te verminderen? Bijvoorbeeld in aankoop van voer.				
6.	Ik maak winst door hoge productiviteit bijv. Intensivering door vergroten van veestapel en/of dagelijke groei van de melkproductie (anders dan ondernemer). Effectief en/of extensivering Kan ik de vraag ook toespitsen op kijken naar: - toepassingen die schaalvergroting realiseren (meer dieren en/of meer omzet) - toepassing van intensifering (hogere productie per ha en/of per dier) - Geen verhoogde productiviteit: toepassing van verhogen opbrengsten door hogere prijs voor het product of een vergoeding voor ecosysteemdiensten - Toepassing van het verlagen van kosten (bijvoorbeeld lagere grondkosten en minder input) - (niet direct hogere productie) toepassing van schaalvergroting door meer grond te kopen				
7.	In de landbouwmethoden die ik gebruik, verwerk ik het dierenwelzijn in de dagelijkse bedrijfsvoering (de instrinsieke behoeften van dieren in het ontwerp en beheer van de boerderij). → Kunt u enkele praktijkvoorbeelden noemen die bijdragen aan dierenwelzijn?				
8.	Ik optimaliseer schaalvergroting en marktintegratie. → vraag: Op welke manier realiseert u				

	schaalvergroting en hoe realiseert u marktintegratie. Wat is bijv. Uw relatie met uw grootste afnemer? Veel melkveehouders laten hun melk ophalen door de melkfabriek en doen hier zelf weinig mee. Is er direct verkoop aan de consument?				
9.	Ik ben tegen de regeuliere landbouwmethoden, ik geef voorkeur aan biologische of regenerative landbouw (waar natuurlijke hulpbronnen worden versterkt in plaats van uitgeput zoals Wij.Land doet) waarbij ik meer ruimte geef aan de natuur. → Vraag: kunt u uitleggen waarom?				
10.	Ik beschouw mijn boerderij als mijn terrein waarbij ik zoveel mogelijk invloed wil hebben op opbrengsten (maximale natuurmanagement.)				

Note. . 1, 4, 5, 7, 9 = idealist; 2, 7, 8, 10 = craftsmen; 2, 3, 6, 8, 10 = entrepreneur.

6. Houding tegenover landbouw

- Haalt u plezier uit het produceren voor [genoemde markt], of bent u ook geïnteresseerd in het produceren voor andere markten?
  → Zo ja, welke?
  → Zo ja, waarom?
- > Zo nee, waarom niet?
- Eerder hebben we al besproken welke veranderingen er zijn toegepast op uw boerderijen via investeringen (ga verder als dit al uitgebreid is besproken)
  → wanneer zijn deze veranderingen toegepast?
  → waarom zijn deze veranderingen toegepast?
  → Merkt u dat deze veranderingen hebben geresulteerd in voordelen? Was dit direct of indirect?
  → vindt u het belangrijk dat u direct resultaat merkt zodra u investeringen maakt?

7. **Kennis van natuur-inclusieve landbouw** *laat evt. lijst zin met toepassingen*

- Bent u bekent met de term natuur-inclusieve landbouw en wat verstaat u daaronder
- Zo ja, welke natuur-inclusieve landbouw toepassingen kent u?

Ik versta voor dit onderzoek onder natuur inclusieve landbouw: [verdere toelichting onderaan]

NIA is een poging om een positieve, wederkerige relatie na te streven tussen bedrijfsvoering en natuurlijk kapitaal (Van Doorn et al. 2019). In de conceptualisering van deze definitie, de volgende dimensies worden onderscheiden:
1. zorgen voor natuur, wat betekent dat landschap en natuur management is gefocust op het behoud van specifieke soorten en het creëren van diversiteit in het landschap;
2. gebruik maken van functionele biodiversiteit, wat betekent dat er wordt gezorgd en gebruik wordt gemaakt van ecosysteem diensten zoals bestuiving, pest control en nutriënt circulatie i.p.v. chemische

inputs;
3. reduceren van impact op het milieu door een efficiënt gebruik van bronnen en het verminderen van emissies. Het bestaat dus uit innovaties in de bedrijfsvoering, management van het land, technologie en gebruik van bronnen die gericht zijn om de biodiversiteitsafname tegen te gaan

8. Past u deze vorm van natuur-inclusieve landbouw toe op uw land?
   → Zo ja, vraag naar de toepassing van NIA in detail
   → Zo ja, waarom is er gekozen om deze toepassing toe te passen.
   → Zo nee, ga door met deel II van het interview.
9. Slootkant, ecologisch baggeren, weidevogelbeheer

Tabel 2. Algemene omschrijving van praktijken die NIA zijn (Vermunt et al. 2022).

Nature-inclusieve landbouw toepassingen	bekent	Toegepast, hoe, wanneer, waarom?
Mestmanagement (zoals het gebruik van vaste mest in plaats van drijfmest) om de bodemstructuur en bodemgezondheid te verbeteren	Ja/nee	Uitleg
Locale voedselproductie om overzeese impact van voerproductie te elimineren (voornamelijk ontbossing van sojaproductie).	Ja/nee	Uitleg
Hoofdzakelijk voeding op basis van gras vanwege het hogere organische gehalte in de bodem van grassland ten opzichte van bouwland (voedergewas)	Ja/nee	Uitleg
Diversificatie van de zode en meer blijvend grassland voor verbeterde boven- en ondergrondse biodiversiteit en koolstofopslag in de bodem	Ja/nee	Uitleg
Begrazing om de botanische samenstelling en biodiversiteit van weilanden te verbeteren, stikstofkringlopen te sluiten en de ammoniakemissies te verminderen	Ja/nee	Uitleg
Gebruik van lichtgewicht machines om bodemverdichting te verminderen	Ja/nee	Uitleg
Gefaseerd maaien om de directe impact op grondbroedende vogels (e.g. grutto) te verminderen en de overlevingskansen van kuikens te verbeteren	Ja/nee	Uitleg
Het aanleggen van landschapselementen zoals moerrassystemen, Dijken, slootoevers, levende hekken en bomengangen als leefgebieden voor soorten	Ja/nee	Uitleg
Extensivering van het bedrijf, d.w.z. vermindering van het aantal grootvee-eenheden per hectare grasland	Ja/nee	Uitleg

Table 3. Voorbeelden van NIA praktijken, overgenomen uit onderzoek X. het is een spectrum aan maatregelen die kunnen worden toegepast. Deze studie onderscheidt de volgende:

Natuur-inclusieve landbouw doelen	Toegepast	Methode
1. Bodem		
Bodemverdichting tegengaan		
OS-gehalte verhogen/ CO2 opslag		

Bevorderen bodemleven (niet kerende grondbewerking van akkers (bevordering van bodemleven en watervasthoudend vermogen)		
2. *water*		
Uit en- afspoeling naar grond- en oppervlaktewater tegengaan		
Mestkwaliteit en -toediening verbeteren (max. 50-100 kg N/ha, meer in de vorm van ruwe stalmesti).		
Water conserverend vermogen		
Natuurvriendelijk slootbeheer gefaseerd schonen van sloten (niet alles tegelijk) met natuurvriendelijke apparatuur (bevordering vissen, amfibieën, insecten, waterplanten).		
Slootkantbeheer		
Verhogen waterpeil (tijdelijk)		
Gebruik van natuurlijke waterzuivering		
3. Landschap		
Verbeteren van het erf: erfbeplanting		
Bevorderen structuur elementen landschap		
Bevorderen diversiteit grasland		
Bevorderen randenbeheer akkerbouwmatige teelt (minder bemesten van perceelsranden (versterking botanische waarden, insecten ed.) niet-meemaaien van slootkanten (versterking botanische waarden, amfibieën, insecten, weidevogelkuikens), met nauwelijks vermindering van de graslandoogst;		
agroforestry		
Benutten van bruikbare ruimte		
Bevorderen aanleg & beheer houtmatige landschapselementen		
Bevorderen aanleg natte landschapselementen		
Bevorderen inscharen vee in natuurgebieden		
4. Biodiversiteit		
Bevorderen diversiteit rassen		
Management van het vee		
gewasdiversificatie		
Bevorderen fauna op het erf (rond erven en gebouwen plaatsen van nestkasten en ruimte geven aan ‘rommelhoekjes’ (voor kerkuil, steenuilen, ringmus, bunzing, egel);)		
Bevorderen bestuivers		
Bevorderen natuurlijke vijanden		
Bevorderen van bodemfauna (o.a. regenworden)		
Bevorderen weidevogels		
Bevorderen vlinders		
5. management		
Gebruik van natuurlijke ziektewering		
Gebruik van natuurlijke plaagwering		
Gebruik van natuurlijke bestuiving		
Gebruik van natuurlijke bodemvruchtbaarheid		

Het verminderen van chemische bestrijdingsmiddelen		

DEEL II wat voor informatiebronnen en type informatie worden geïdentificeerd door boeren dat volgens hen hun besluitvorming om NIA te overwegen beïnvloed (circa 30 minuten).

In het tweede deel van dit interview willen we graag een netwerk van informatiebronnen op papier tekenen. Dit kunnen bronnen zijn waar de boer in het verleden mee in contact is geweest, of momenteel in contact mee is dat voorziet in informatie over natuur-inclusieve landbouw. Het doel is om een landschap van informatiebronnen in kaart te brengen met een vaste structuur – nodes, edges in een bepaalde tijd, met paden, componenten en afstanden. Het is belangrijk om zoveel mogelijk bronnen te noemen (minimaal 5-10) waarin zowel formele als informele, objecten en individuen worden genoemd. De verhouding doet er niet toe.

10. **Type node (object of persoon) dat de boer noemt als bron en waarmee hij een relatie toe heeft (10 of meer)**

- Algemene vraag om het netwerk van bronnen in kaart te brengen: Hoe heeft u kennis genomen van NIA? Kunt u een aantal bronnen van informatie noemen, dit kan een persoon zijn, een instelling, een website etc.
- Per bron, geef aan of u zelf initiatief hebt genomen om deze bron op te zoeken of dat u werd benaderd

11. **Inhoud informatie (website dat informatie geeft over NIA, een studiegroep). Voor elke bron.**

- Kunt u in detail kunnen vertellen waar de informatie over ging?
- Wat was het onderwerp van de informatie?
- Bevatte het informatie over technieken en materialen?
- Bevatte het informatie over financiering, subsidies, wet- en regelgeving?
- Bevatte de bron objectieve informatie of bevatte het meningen en perspectieven van individuen?

12. **Type relatie (familie lid, bankier, naburige ondernemers, partijen in de keten) stakeholders). voor elke bron,**

- Kunt u omschrijven wat voor een relatie er is tussen u en de bron, is het een buurman/vrouw, familie lid, vriend, etc.?

13. **Frequentie contact en richting van de interactie en uitwisseling van informatie [hoeveelheid contact in uur/maand]. Voor elke bron,**

- Hoe lang ken u elkaar/ bent u bekend met het object? (gebruik naam of titel van het object)
- Hoe vaak komt u in contact met elkaar/ het object?
- Hoe bent u in contact gekomen met elkaar/het object?
- Voorziet u de persoon of het object ook van informatie, of ontvangt u alleen informatie?
- Hoe zou u het niveau van interactie met de persoon/object omschrijven? Zou u belangrijke zaken met betrekking tot uw bedrijf bespreken, of is het waarschijnlijker dat u spreekt over persoonlijke onderwerpen?
- Hoe zou u het niveau van formaliteit beschrijven met elkaar/ het object?

14. **Indeling naar relatie tot bron (ingroup or outgroup). Voor elke bron,**

- Ideologische indeling → In hoeverre vindt u dat uw manier van boeren overeen komt met de stijl of gewenste stijl van anderen (bronnen).
  → waargenomen persoonlijke gelijkenissen tussen jou en de ander?; sterk mee eens/ mee

eens/ mee oneens/ sterk mee oneens
→ waargenomen situationele gelijkenissen in context tussen jou en de ander? sterk mee eens/ mee eens/ mee oneens/ Sterk mee oneens
→ waargenomen gelijkenissen in status tussen jou en de ander? sterk mee eens/ mee eens/ mee oneens/ Sterk mee oneens

- Van alle bronnen die zijn genoemd, als u vragen zou willen stellen over NIA, naar wie zou u als eerste raadplegen? Kan die persoon/object u toegang geven tot bepaalde informatie?

15. Kwaliteit van de tie (weighted directed network) hoe wordt de mate van relevantie, betrouwbaarheid en waarheidsgetrouw beschreven.

- Is de informatie die u heeft ontvangen bruikbaar? Waarom en op welke manier vindt u het bruikbaar?
- Is de ontvangen informatie ervaren als relevant? Leg uit waarom.
- Is de ontvangen informatie ervaren als waarheidsgetrouw? Leg uit waarom
- Is de ontvangen informatie ervaren als betrouwbaar? Leg uit waarom

16. Toepassing van informatie. Voor elke bron,

- Heeft u de informatie over NIA gedeeld met derden?
- Heeft u informatie over NIA toegepast in de praktijk? Zo ja, hoe ging dat?
- Heeft u nog andere adressen waar ik terecht kan?