

# **Knowledge interaction in food production systems**

*A thesis employed in the Bono East and Upper West regions of Ghana*

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## **Abstract**

There is a growing need for integrating endogenous and exogenous knowledge systems to combat global challenges such as food security and biodiversity conservation. However, endogenous knowledge is often recognized insofar to help western knowledge systems, leading to failed attempts of knowledge integration. The aim of this thesis was to explore the roles of endogenous and exogenous knowledge in relation to farming systems in the Bono East and Upper West regions of Ghana. In addition, this thesis assessed the extent to which these forms of knowledge could be integrated. Transdisciplinarity was proposed as framework by introducing a novel model to facilitate knowledge integration and enable a more holistic and inclusive approach towards knowledge integration. Next, qualitative methods such as participatory observation and semi-structured interviews were employed. Convenience and snowball sampling were used to select participants. In addition, data analysis involved content analysis and coding of the interview transcripts. The findings show that endogenous farming practices, such as shifting cultivation and crop rotation, are pressured by changing cultural values, land pressure and potential absence of knowledge transfers. Nevertheless, interviewees continue to employ endogenous farming practices as they are considered a way of life. Furthermore, exogenous applications such as fertilizers and chemicals are widely used while not being accompanied by knowledge on how to use them, thereby leading to farmers making decisions with limited information. Subsequently, tensions between farmers arise who employ exogenous applications and those who do not. Moreover, the findings highlight the importance of knowledge integration and transdisciplinarity in the domains of knowledge documentation, lack of knowledge in utilizing exogenous applications, and implementation of exogenous technologies to improve existing farming practices. However, there seems to be no set of prerequisites for when research is correctly applying the concept of knowledge integration while fully acknowledging two knowledge systems. Therefore, this thesis recommends establishing criteria for correctly executing knowledge integration in endogenous settings.

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# Table of Contents

<b>ABSTRACT</b> .....	<b>2</b>
<b>ACKNOWLEDGEMENTS</b> .....	<b>3</b>
<b>LIST OF ABBREVIATIONS</b> .....	<b>5</b>
<b>GLOSSARY</b> .....	<b>6</b>
<b>1. INTRODUCTION</b> .....	<b>8</b>
1.1 PROBLEM STATEMENT .....	8
1.2 RESEARCH OBJECTIVE .....	9
<b>2. THEORETICAL FRAMEWORK</b> .....	<b>10</b>
2.1 TOWARDS TRANSDISCIPLINARITY.....	11
2.2 DEFINING KNOWLEDGE .....	12
2.3 BALANCING ENDOGENOUS AND EXOGENOUS KNOWLEDGE FOR SUSTAINABLE AGRICULTURE .....	14
2.4 KNOWLEDGE INTEGRATION.....	18
2.5 BALANCING KNOWLEDGE: THE ROLE OF TRANSDISCIPLINARITY .....	20
<b>3. METHODOLOGY</b> .....	<b>23</b>
3.0 RESEARCH SITUATED CONTEXT.....	23
3.1 RESEARCH DESIGN .....	24
3.2 DATA COLLECTION .....	25
3.3 ETHICS.....	28
<b>4. RESULTS</b> .....	<b>30</b>
4.1 ENDOGENOUS FOOD PRODUCTION PRACTICES .....	30
4.2 EXOGENOUS KNOWLEDGE IN FOOD PRODUCTION SYSTEMS .....	39
4.3 TENSIONS AND OPPORTUNITIES WHEN KNOWLEDGE SYSTEMS INTERACT .....	43
<b>5. DISCUSSION</b> .....	<b>49</b>
5.1 IMPLICATIONS OF THE RESULTS .....	49
5.2 LIMITATIONS OF THE RESEARCH .....	54
5.3 RECOMMENDATIONS FOR FUTURE RESEARCH .....	55
<b>6. CONCLUSION</b> .....	<b>57</b>
<b>REFERENCES</b> .....	<b>58</b>
<b>APPENDIX A. PARTICIPANT LIST</b> .....	<b>69</b>
<b>APPENDIX B. QUESTIONNAIRE SET-UP</b> .....	<b>70</b>

## List of abbreviations

<b>Abbreviation</b>	<b>Definition</b>
ABOFAB	Abrono Organic Farmers Association
AGRA	The Alliance for Green Revolution in Africa
ALI	African Learning Institute
CIKOD	Centre of Indigenous Knowledge and Organizational Development
IK	Indigenous knowledge
INTV-number	Referring to the interview participant to ensure animosity
SSI	Semi-structured interviews
WUR	Wageningen University and Research

# Glossary

<b>Term</b>	<b>Definition</b>
<i>Axiology</i>	Place of values in the research process, about what is considered good research (Chilisa, 2012)
<i>Bono East region</i>	Central province of Ghana, capital Techiman
<i>Crop rotation</i>	The cultivation of specific crops on a different area of land each period.
<i>Decolonizing research</i>	Moving away from a Eurocentric approach of doing research, equally viewing and appreciating different knowledge systems
<i>Endogenous food practices</i>	In the context of this research: the use of crop rotation and shifting cultivation
<i>Endogenous knowledge</i>	Based on the definitions of Mathez-Stiefel, Boilat, and Rist (2007) and Havekort et al. (2012): knowledge that is generated from within with an oral character, accumulated over long periods of time
<i>Epistemic failure</i>	A dominant knowledge system that imposes their knowledge system on another knowledge system, failing to fully recognize and appreciate the existing knowledge system, further marginalizing indigenous people (Chilisa, 2019)
<i>Epistemology</i>	The way of knowing and related philosophical underpinnings (Hedlund, 2013; Chilisa, 2012)
<i>Exogenous applications</i>	Agricultural inputs such as fertilizer, chemicals, tractors that do are created in the west
<i>Food security</i>	“Secure access by households and individuals to nutritionally adequate food at all times and procured in conformity to human aspirations and dignity” (Yaro, 2006, p.23).
<i>Food sovereignty</i>	In the context of this thesis: food sovereignty relates to the notion that people have their own rights to determine what adequate and cultural appropriate food is; spiritual, traditional, medicinal or economic means that needs to have equitable access and in which “governments must respect, protect and fulfil the right to food as right to adequate, available, accessible, culturally acceptable and nutritious food” (International Planning Committee, 2023)
<i>Generational knowledge transfer</i>	The transfer of knowledge from one generation to the next, having an oral characteristic
<i>Indigenous knowledge</i>	Knowledge that it is largely tacit, verbally communicated, experiential, unique, and largely embedded in the knowledge, actions, and traditions of

	communities that have a lengthy history of closely interacting with the natural environment, spanning various cultures and geographical regions (Lwonga, 2010)
<i>Indigenous research paradigm</i>	An approach to research that reasons from an African perspective in terms of epistemology, ontology and axiology (Chilisa, 2012)
<i>Interdisciplinarity</i>	“Any study or group of studies undertaken by scholars from two or more distinct scientific disciplines.” (Aboelela et al., 2007)
<i>Interpretivism paradigm</i>	An approach to research that acknowledges the unique reality of individuals that reality is socially constructed, also known in other research as the postmodern paradigm (Scott & Lewis, 2017; Leeuwis & Aarts, 2011)
<i>Knowledge documentation</i>	Capturing knowledge in a written form or a way in which it can be preserved
<i>Knowledge integration</i>	Synergizing two or multiple knowledge systems into one
<i>Knowledge systems (2)</i>	In the context of this research: (1) a system of knowledge with customs, habits and underpinnings based on western ideology and (2) a system of knowledge with customs, habits and underpinnings based on African ideology
<i>Modernization</i>	The idea that underdeveloped countries should follow a five-step model proposed by Rostow (1959) in order to become enlightened and become developed.
<i>Non-organic</i>	In the context of this research: cultivating crops with the use of synthetic chemicals or fertilizers
<i>Ontology</i>	The perspective on the nature of reality (Hedlund, 2013)
<i>Oral tradition</i>	A way of transferring knowledge by word which is characterized by “folklore, folktales, legends, and mythical stories, stories in song and poetic forms” (Chilisa, 2019, p.125)
<i>Organic</i>	In the context of this research: cultivating crops without the use of synthetic chemicals or fertilizers
<i>Shifting cultivation</i>	An agricultural technique in which land is cultivated for a certain period and then cleared or left uncultivated to later move to the same area when the soils fertility has restored
<i>Social justice</i>	In the context of this research: doing right to populations that have been oppressed, marginalized and neglected in research
<i>Transdisciplinarity</i>	Transdisciplinarity involves interactions between, across and beyond disciplines and tries to understand the present world (Nicolescu, 2014)
<i>Upper West region</i>	Most north-west province of Ghana, capital Wa

# 1. Introduction

## 1.1 Problem statement

Consistent food provision on the African continent remains an issue as 282 million people on the African continent continue to struggle with food insecurity (United Nations, 2022). Yaro (2006) defines food security as “secure access by households and individuals to nutritionally adequate food at all times and procured in conformity to human aspirations and dignity” (Yaro, 2006, p.23). Food insecurity is a complex phenomenon influenced by various factors such as climate variability, diseases, conflicts, and political-economic challenges (Yaro, 2006; Ngcamu & Chari, 2020). However, addressing food insecurity goes beyond ensuring access to food; it requires a broader approach that acknowledges the importance of local knowledge, cultural traditions, and self-determination in shaping food systems (Pimbert, 2009; Akram-Lodhi, 2015). This broader framework is known as food sovereignty, which emphasizes the right of individuals, peoples, communities, and countries to define their own policies and circumstances related to food (Pimbert, 2009; Akram-Lodhi, 2015). Unfortunately, efforts to counter food insecurity often neglect the principles of food sovereignty, failing to align with the needs, demands, culture, and ways of living of indigenous populations (Laborde, Porciello, & Smaller, 2021; Klerkx & Leeuwis, 2008). This misalignment is partly a result of the historical asymmetrical relationship between the West and Africa, with implications for the social, economic, and political domains of post-colonial Africa (Alemazung, 2010; Rodney & Davis, 2018)

Therefore, there is increasing recognition of engaging local actors within the agroecological domain to provide crucial information about local circumstances, traditions, and co-create ways to sustainable development (Hansen et al., 2019; Tengö et al., 2021). Furthermore, engaging local actors can increase sustainability of local policies, monitoring biodiversity in rural areas, and consideration of the most affected populations by land degradation and conservation (Burgess, Jensen, & Pirhofer-Walzl, 2010; Farhan Ferrari, de Jong, & Belohrad, 2015; Danielsen et al., 2007). However, research regularly neglects, marginalizes, and suppresses endogenous knowledge and indigenous people (Chilisa, 2019; Makere, 2013). To be able to fully recognize endogenous knowledge in the process of overcoming the misalignment of actions regarding food poverty, a transdisciplinary research approach can contribute to do so. This can be achieved by both connecting knowledge producers with end users and by closing the gap between the academic system, which has been established as the centre of colonial dominance, and endogenous knowledge, which has been described as unimportant, and inferior to western academic science and having adverse effects on the environment (Chilisa, 2017; Kapoor & Shizha, 2010; Brandt et al., 2013). Moreover, Ludwig et al. (2021) note that transdisciplinarity can surmount the described epistemic difficulties by “including heterogeneous stakeholders in the process of knowledge production” (Ludwig et al., 2021, p.24).



## 1.2 Research objective

The aim of this thesis is to explore how different kinds of knowledge interact within the domain of food production systems in the regions of Bono East and Upper West of Ghana. The emphasis of this thesis constitutes of describing the roles of endogenous and exogenous knowledge in relation to farming systems to be able to see to what extent these forms of knowledge can be integrated. There is a growing need to integrate endogenous and exogenous knowledge systems in order to address complex and interrelated global issues such as food security and biodiversity conservation (Gagnon and Berteaux, 2009). Especially as endogenous knowledge is often marginalized and neglected, while having promising effects on biodiversity and conservation in agriculture (Hansen et al., 2019; Tengö et al., 2021). Moreover, in the field of development studies, there is often an overemphasis on exogenous knowledge which can lead to epistemic failures causing loss of biodiversity and further marginalization of indigenous people (Chilisa, 2019). Transdisciplinarity can facilitate such integration by providing a framework for shared understanding and communication across knowledge systems (Scholz et al., 2006). By combining these approaches, knowledge integration can enable a more holistic and inclusive approach to addressing global challenges, while also valuing and respecting the unique perspectives and contributions of endogenous and exogenous knowledge systems. Therefore, the main research question of this research is:

*How do different kinds of knowledge interact within the domain of food production systems in the regions of Bono East and Upper West, Ghana?*

The following sub-questions were formulated to help answer the main research question:

1. What is the role of endogenous knowledge in food production systems in the Bono East and Upper West regions of Ghana?
2. What is the role of exogenous knowledge in the context of food production systems in the Bono East and Upper West?
3. What tensions and opportunities arise in the interaction between endogenous knowledge systems and exogenous knowledge systems?

## **2. Theoretical framework**

### **Reading guide**

The purpose of this reading guide is to provide readers with a framework for engaging with this chapter. It will do so by summarizing the main concepts that will be discussed in the following sub-chapters.

In sub-chapter 2.1, transdisciplinarity is examined as a means of addressing food insecurity. The concept of transdisciplinarity is defined, the difference with interdisciplinarity in agricultural and intercultural contexts, and its relevance to food systems research is explored. The challenges of implementing a transdisciplinary approach are also discussed.

Sub-chapter 2.2 defines indigenous knowledge, endogenous knowledge and exogenous knowledge and their multiple interpretations and applications.

In sub-chapter 2.3, explores the roles of endogenous knowledge and exogenous knowledge in the context of agriculture. In addition, the role of modernization and rural development are discussed and consequently this thesis will be positioned in this discussion.

Sub-chapter 2.4 examines knowledge integration as a means of synthesizing the insights gained from the previous chapters. This sub-chapter discusses the challenges of integrating different types of knowledge and experience.

Last, sub-chapter 2.5 concludes by presenting a novel model for integrating the various concepts discussed throughout the literature, to provide practical guidance for synthesizing and applying these insights while also describing the models' limitations.

## **2.1 Towards transdisciplinarity**

During the late 1970's, the term interdisciplinarity arose within the academic world. Aboelela et al. (2007) refer to Interdisciplinarity as “any study or group of studies undertaken by scholars from two or more distinct scientific disciplines.” (Aboelela et al., 2007). However, the shortcomings of interdisciplinarity became evident as the framework used in interdisciplinarity only regards an academic standpoint in which other information needs to fit (Nicolescu, 2014). Moreover, interdisciplinarity often results in the self-containment of disciplines without much cross-fertilisation between them (Hadorn, 2008). In addition, in the context of African development studies, interdisciplinarity does not concern knowledge, traditions and circumstances of locals (Hansen et al., 2019; Tengö et al., 2021). Furthermore, within the socio-agricultural domain it does not consider the most affected populations of land degradation and conservation (Burgess, Jensen, & Pirhofer-Walzl, 2010; Farhan Ferrari, de Jong, & Belohrad, 2015; Danielsen et al., 2007). An example of an interdisciplinary failure which did not incorporate local knowledge, traditions and circumstances of locals is that of a study in Swaziland. In the study of Mehta et al. (2013), researchers were investigating to what extent fertilizers could increase crop yield in farmer communities in Swaziland, combining the fields of agriculture and development studies. The results of the research did not show significant impact which was attributed to the women failing to weed the crops thoroughly. Later however, a student conducted research at the same location, studying diets of these farmer communities which resulted in the discovery that what previously was called ‘weeds’ was a daily consumed plant which was rich in vitamin A. The failure of the initial research to identify the nutritional value of these plants highlights the limitations of an exclusively interdisciplinary approach, which may overlook the importance of local traditions and practices.

### **Transdisciplinarity**

In the context of African development studies, it is essential to overcome the barriers of interdisciplinarity to achieve more holistic and inclusive approaches. This is where transdisciplinarity comes in as an appropriate approach. Transdisciplinarity involves interactions between, across and beyond disciplines and tries to understand the present world (Nicolescu, 2014). According to Ludwig et al. (2021), transdisciplinarity can add to redefining development and innovation by means of consideration of dissimilar actors. It is important to note that transdisciplinarity does not simply include dissimilar actors but allows for a more comprehensive level of expressing concerns (Ludwig et al., 2021). In addition, social-environmental issues call for inclusion of situated knowledge instead of an interdisciplinary approach (Brown, Harris, and Russel, 2010). Nevertheless, the process of going beyond disciplines and striving for transdisciplinarity includes barriers and pitfalls apart from bounded finances, language barriers, and different time frames. According to Ludwig et al. (2021), transdisciplinarity involves the incorporation of diverse forms of knowledge, which creates the need

to combine them, thereby leading to knowledge integration. However, it is important to note that while knowledge integration is a component of transdisciplinarity, it does not encompass the entirety of it. Second, power relations within transdisciplinary work are often overlooked because of its focus on equality, resulting in a diverging perspective of reality.

## **2.2 Defining knowledge**

### **Indigenous knowledge**

Indigenous knowledge (IK) and endogenous knowledge are two distinct forms of knowledge that are frequently discussed in academic literature. According to Grenier (1998) the term IK refers to a type of knowledge that is unique, long established, and developed by indigenous people in a specific local area. Kaniki and Mphahlele (2002) consider it a cumulative body of knowledge that has been produced and advanced in due course by communities to deal with a protean environment. Further, Payle and Lebakend (2006) define IK as a type of knowledge that arises from the environmental interactions of the local population. In addition, Sillitoe, Dixon and Barr (2005) refer to IK as knowledge that is deeply rooted in the local culture and is held jointly by people to understand various aspects of life. This knowledge is unique to different regions and is derived from various sources. It is a dynamic blend of indigenous practices from the past and modern inventions with a focus on shaping the future. Last, Jessen et al. (2021) conclude that IK is a collective term that encompasses the diverse knowledge systems developed within specific cultural contexts over generations and is referred to as place-based knowledge. The definition of IK, which is most agreed upon according to Lwonga (2010), is that it is largely tacit, verbally communicated, experiential, unique, and largely embedded in the knowledge, actions, and traditions of communities that have a lengthy history of closely interacting with the natural environment, spanning various cultures and geographical regions (Ngulube 2002; Lwonga, 2010). However, Millar (2014) states that IK may not have a uniform distribution within a community, and the individual capacity to create and accumulate this knowledge can vary, resulting in limitations to its adaptability to present needs despite the lengthy history of close interaction with the natural environment.

The concept of indigenous people, their values, and knowledge has gained significant political importance and serves as a valuable resource in the fight for an increase in independence, and ability for disadvantaged communities to make decisions for themselves. Nevertheless, as a result of the roots of IK in particular cultural and historical backgrounds, it can create a distinction between indigenous people and other marginalized communities (Rist et al., 2011). This distinction becomes particularly significant in African or Asian settings where some native people may identify themselves as indigenous, while others may identify themselves by their religious affiliations. Even though the latter may not consider themselves indigenous, their worldview and resource management practices may be just as indigenous as those who consider themselves as indigenous groups

(Naamwintome & Millar, 2015). However, in discussing the term IK, Emeagwali and Dei (2014) argue that indigeneity can only be discussed outside of the Eurocentric theoretical perception of the word which can relate to “all groups across time and space” (Emeagwali and Dei, 2014, p. x) and should include the “holistic, organic, and multidimensional interconnections of body, mind, soul and spirit, as well as the interface of society, culture, and nature” (Emeagwali and Dei, 2014, p. xii).

### **Endogenous knowledge**

Endogenous knowledge is in line with the definition of IK and understood by Mathez-Stiefel, Boilat, and Rist (2007) as a communal process of social construction in which a group interacts based on a shared worldview that includes symbolic representations, epistemology, norms and values, and practices. Devisch and Crossman (2002) propose that endogenous knowledge is all the knowledge that is outside the prevailing scientific tradition in the western world and is locally applicable to the community. They define it as knowledge being produced within the community and based on social practises, norms, values that are rooted in the community’s ontology and epistemology. However, there is a duality of shortcomings to the definition given by Devisch and Crossman (2002). First, the centralization of western science by naming everything outside this domain as endogenous knowledge, it creates the distinction between ‘us’ versus ‘them’. Second, not all knowledge outside academia are endogenous as non-academics can also hold exogenous knowledge. Rist et al. (2011) state that endogenous knowledge and IK are close to interchangeable. Furthermore, Velthuisen (2015) asserts that academic scholars prefer the use of endogenous knowledge over IK because of the notion that knowledge has a non-static nature. In addition, Join and Hountondji (1999) state that endogenous knowledge can become IK under the influence of globalization. Last, Havekort et al. (2012) describe that endogenous knowledge plays a significant role in shaping people's understanding of the world, learning processes, decision-making about their lives, resource utilization, and livelihood development in diverse cultures.

In contrast to exogenous knowledge, where written knowledge has a prominent role, endogenous knowledge often relies on oral traditions in knowledge production, knowledge transfers and way of life as most of African sage philosophy remains unwritten (De Sousa Santos, 2014). A significant amount of African knowledge is developed by oral means in which knowledge is transferred from generation to generation (Zegeye & Vambe, 2006). Zegeye and Vambe (2006) argue that oral knowledge carries a complexity that is the base of the written word and should be viewed equal to written knowledge. These oral traditions and forms of knowledge are expressed in stories and proverbs, which create value and codes of conduct by means of “folklore, folktales, legends, and mythical stories, stories in song and poetic forms” (Chilisa, 2019, p.125). Their importance runs wide as stories fulfil the role of creating, storing, analysing, and spreading information (Chilisa, 2019). In turn, these stories are embedded in indigenous languages which are frequently not been described or

formulated (Kouega, 2017). Therefore, there is a need to overcome the emphasize on written knowledge and should be shifted to an incorporation of both oral and written knowledge.

In my thesis, I have opted to use the concept of endogenous knowledge instead of indigenous knowledge, as the latter carries certain political and academic connotations as described in the previous paragraph. Moreover, indigenous knowledge is often recognized insofar to help western knowledge systems (Ludwig, 2016; Chilisa 2019). Additionally, endogenous knowledge allows for the integration of exogenous knowledge (described in the next paragraph) within a given context of knowledge integration (described in the next sub-chapter). In defining endogenous knowledge, this thesis will rely on the definitions put forth by Mathez-Stiefel, Boilat, and Rist (2007) and Havekort et al. (2012), emphasizing the idea that endogenous knowledge is generated from within. Moreover, this thesis underlines the prominent role of oral communication in endogenous knowledge and its generational character.

### **Exogenous knowledge**

Opposed to the term endogenous knowledge, exogenous knowledge refers to the external knowledge and technologies that can be transferred in a particular context from outside sources. It is interchangeably used with terms like non-traditional knowledge, international knowledge or exotic knowledge (Brodt, 2001). According to Hislop, Bosua, and Helms (2018) in the context of organizational knowledge, exogenous knowledge refers to “knowledge acquired from external sources such as customers, suppliers, partners, consultants, universities, research centers, and other sources outside the organization” (Hislop et al., 2018, p.22). Stevenson (1996) speaks about exogenous knowledge in the context of agriculture in India referring to exogenous knowledge as a vast array of unconventional knowledge that individuals in a local community obtain through their dealings with external entities and establishments, contemporary media platforms such as television, and education in reading and mathematics. Lwonga (2010) acknowledges that many definitions of exogenous knowledge are similar but differ in the perspective of the origins of exogenous knowledge. She proposes that exogenous knowledge refers to information that is supplied to rural communities from sources beyond their boundaries, with the goal of facilitating development through the process of knowledge transfer (Lwonga, 2010). Exogenous knowledge in the definition of Lwonga (2010) places a significant emphasis on written communication as a primary means of validating knowledge, intelligence, and its role in education. De Sousa Santos (2014) argues that modern science has been deemed superior to other forms of knowledge, such as oral traditions, due to the prominence of academically written communication forms.

## **2.3 Balancing endogenous and exogenous knowledge for sustainable agriculture**

### **Endogenous farming systems**

According to Warren and Cashman (1988), endogenous farming systems in Africa are regarded as an endogenous system that has evolved over time, with farming practices guided by endogenous knowledge system and expressed in the regional language. This system is perceived to be in dynamic balance with the environment and is influenced both by innovations arising from within the system and those adopted from other indigenous systems, as well as from national and international agricultural systems. Chikaire et al. (2012) view endogenous agriculture as a crop production system that can withstand ecological changes and disruptions. It has evolved over time to prioritize production security, emphasizing low risk by adapting to the local environment. This type of agriculture fosters a close relationship between people and their surroundings. Subsistence farmers rely heavily on their crops for survival, therefore, ensuring crop security is of utmost importance for them. Endogenous farming systems achieve this through a complex system that includes diverse crops, widely spaced plantings, genetically diverse resources, reduced tillage and diverse periods of leaving land uncultivated (Chikaire et al., 2012). Similarly, Altieri and Nicholls (2017) state that endogenous agriculture often is site-specific while transforming over time within the frames of livelihood and culture. Overarching, endogenous agriculture has similar agroecological characteristics which improve resilience and resistance to unexpected events. Nevertheless, endogenous farming systems have their constraints. Starting, a significant raise in population stresses the food production of smallholder farmers to produce more yield which in turn results in agricultural expansion consequentially affecting biodiversity (Abate, Van Huis & Ampofo, 2000). Furthermore, smallholder farmers, especially women, typically lack power and may face insecure land ownership, limited market distribution, and insufficient economic and political influence to adapt to changes in their environment, society, or technology (Cook, Satizábal, & Curnow, 2021; Wanjala and Muradian, 2013).

### **Modernization and rural development**

Within the academic field there is a debate about the extent of which colonialism has negatively impacted development and agriculture in Africa. The concept of modernization in the domain of development concerns itself with the idea that the underdeveloped countries should follow a five-step model proposed by Rostow (1959) in order to become enlightened. This involves sharing knowledge, technologies, and production methods that are external to the local context (Matunhu, 2011). In the agricultural domain, these technologies consisted of hybrid seeds, genetically modified food, fertilizers, insecticides and many other 'modern' technologies with the intent to replace indigenous farming practises.

Modernization is widely critiqued because of its exogenous character, which ignores and marginalizes endogenous knowledge in development, and its neglect of the impact of the colonialist past (Bull & Bøås, 2012; Emeagwali & Dei, 2014; Matunhu, 2011; Chilisa, 2019). In moving away from

modernization in agriculture, Van Der Ploeg (2000) proposes to regard to rural development in which different activities can be combined with agricultural production instead of being segregated from it. Subsequently, it opens the floor for integration of knowledge due to a more holistic approach compared to the theory of modernization. In line with rural development, the concept of endogenous development is referred to as “based mainly, but not exclusively, on locally available resources, knowledge, culture and leadership. It has openness to integrating endogenous and exogenous knowledges and practices. It has mechanisms for local learning and experimenting, enhancing local social, material and spiritual structures, and retaining the benefits in the local area.” (Havekort et al., 2012, p. 11).

This thesis positions itself in line of thought with rural development and endogenous development. These concepts stimulate transdisciplinarity and due to their holistic approach, creates possibilities to integrate knowledge.

### **Colonial impact on agricultural systems**

Indigenous farming systems have been heavily influenced over time which had far-reaching effects on the food production and social resilience of communities in Africa (Altieri & Nicholls, 2017; Bjornlund, Bjornlund, and Van Rooyen, 2022). According to Bjornlund et al. (2022) the continued struggle for food production has its roots in “export-oriented colonial agricultural systems that were established in the past” (Bjornlund et al., 2022, p. 845). These systems prioritized the needs of corporations and consumers in the Global North, and as a result, they caused scarcity of arable land, water, and labour. Furthermore, colonialism also disrupted the social contract between indigenous leaders and communities, which had previously helped manage food scarcity. Post-independence, agricultural policies still emphasised exporting goods while essential research was overlooked. The overlooked research focused on incorporating food production systems a part of the local economic framework, creating networks for distribution along with building infrastructure for storage, adding value, establishing markets and technological innovations (Bjornlund et al., 2022).

### **Endogenous knowledge in agriculture**

The idea that incorporating endogenous knowledge and indigenous people can increase sustainability in the agroecological field has received growing attention within the scientific community (Agrawal 1995; Danielsen et al., 2007; Burgess, Jensen, & Pirhofer-Walzl, 2010; Rist et al., 2011; Farhan Ferrari, de Jong, & Belohrad, 2015; Hansen et al., 2019; Tengö et al., 2021). For example, the concepts of food sovereignty and agroecological approaches have emerged as rapidly growing areas of scientific interest in recent years (Altieri & Nicholls, 2017). While it is true that endogenous knowledge can contribute to better environmental practises, it is unrealistic to think that incorporating endogenous knowledge will always have positive impacts on the (local) environment. Although the



role of endogenous knowledge within the agroecological field gets increasing acknowledgement, biodiversity management approaches are largely unaffected by its involvement (Chikaire et al., 2012).

### **Exogenous knowledge in agriculture**

The adoption of exogenous knowledge in agricultural domains where endogenous knowledge is predominant has often led to (epistemic) failures as a result of insufficient integration of endogenous knowledge into projects (Lansing, Cox, Downey, Janssen, & Schoenfelder, 2009; Boogaard, 2021). According to Ngulube and Lwoga (2009), food poverty can be reduced by incorporating “exogenous knowledge into indigenous knowledge systems to enhance agriculture productivity.” (Ngulube & Lwoga, 2009, p. 96). Additionally, Kilongozi, Kengera, and Leshongo (2005) state that implementing exogenous knowledge in the domain of indigenous farming systems can add value and produce more yield. Moreover, incorporating exogenous knowledge into endogenous knowledge is crucial because local agricultural practises can encounter obstacles that farmers may not have the expertise to tackle (Hart & Mouton, 2005; Reij & Waters-Bayer, 2014).

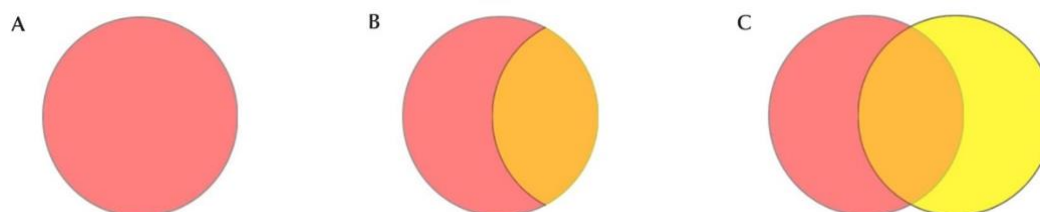
## 2.4 Knowledge integration

According to Gagnon and Berteaux (2009), there is a growing need to integrate endogenous and exogenous knowledge systems in order to address complex and interrelated global issues such as climate change, food security, and biodiversity conservation. Additionally, Rist et al. (2011) state that in order to investigate the potential for a discourse between these knowledge forms, it is crucial to distinguish their key discrepancies and the circumstances that interconnect them. Transdisciplinarity can facilitate such integration by providing a framework for shared understanding and communication across knowledge systems (Scholz et al., 2006). By combining these approaches, knowledge integration can enable a more holistic and inclusive approach to addressing global challenges, while also valuing and respecting the unique perspectives and contributions of endogenous and exogenous knowledge systems.

### Integrating knowledge systems

In the discussion of knowledge integration, endogenous knowledge is often recognized insofar to help western knowledge systems (Ludwig, 2016; Chilisa 2019). Ludwig and El-Hani (2020) propose to tackle this issue by creating a model to help researchers integrate knowledge from endogenous and exogenous knowledge systems (see figure 1). These different knowledge systems occur due to (1) different epistemic and social goals and (2) because multiple properties and regularities can be found in different domains (Ludwig and El-Hani, 2020). Furthermore, Atran (1998) illustrates that endogenous knowledge regularly focuses on supporting regional practises and ecological relationships which exogenous knowledge often disregards. Below different knowledge integration scenarios are explained.

**Figure 1:** *Different knowledge integration scenarios by Ludwig and El-Hani (2020)*



Stage A symbolises the complete neglect of another knowledge system and reasoning and validation by means of the dominant knowledge system. Stage B reflects the acknowledgement of another knowledge system as long as it is in line with the dominant system regarding its views, practises and can fit the epistemological and ontological assumptions within which is also called ‘knowledge mining’ (Kimmerer, 2012). Last, stage C visualises the acknowledgement of another knowledge system which surpasses the problems discussed about stage A and B. Nevertheless, the

question emerges to what extent variances between these systems should be dealt with in the domains of politics and policies.

### **Pitfalls of knowledge integration**

According to Ludwig and El-Hani (2020), there are four major challenges to overcome when integrating knowledge. Initially, the epistemological challenge exists of a significant difference between the methods employed by endogenous communities and scientists who have received academic training to produce and authenticate knowledge. While endogenous communities rely on spiritual standards of ecological interaction, scientists tend to use computational models to understand ecological dynamics (Wilson, 2008). Additionally, the ontological challenge comes down to different beliefs about reality, for example, Ellen (2016) discusses the mental states of forests and plants, or how rivers can be considered as beings. Furthermore, there is an ethical component to be considered as different assumptions regarding knowledge and reality are entangled with varying value systems, leading to different approaches to considering the moral obligations of human and non-human actors (Whyte, 2012). Lastly, stakeholders frequently have divergent levels of influence to assert their epistemic, ontological, and ethical viewpoints in collaborative practices, leading to political challenges.

The aspects mentioned above all relate to the practical implications of knowledge integration as method. However, there are some considerations to be made when applying the method of knowledge integration. For example, Nadasdy (2011) states that an overly optimistic approach towards knowledge integration can delude the differences between knowledge systems as they might be non-integrable. In addition, Ludwig and El-Hani (2020) describe that knowledge integration often leads to being dismissive of the other or towards the other knowledge system. Lastly, Ludwig et al. (2021) argue that endogenous knowledge is deemed legitimate only if it is supported by academic validation, whereas academic knowledge is considered legitimate without needing to meet the standards of endogenous and local knowledge.

## 2.5 Balancing knowledge: the role of transdisciplinarity

Drawing on the discussed theory in the previous sub-chapters, the following model was made and is depicted as figure 2.

**Figure 2:** *Balancing endogenous and exogenous knowledge: A Two-by-Two Model*

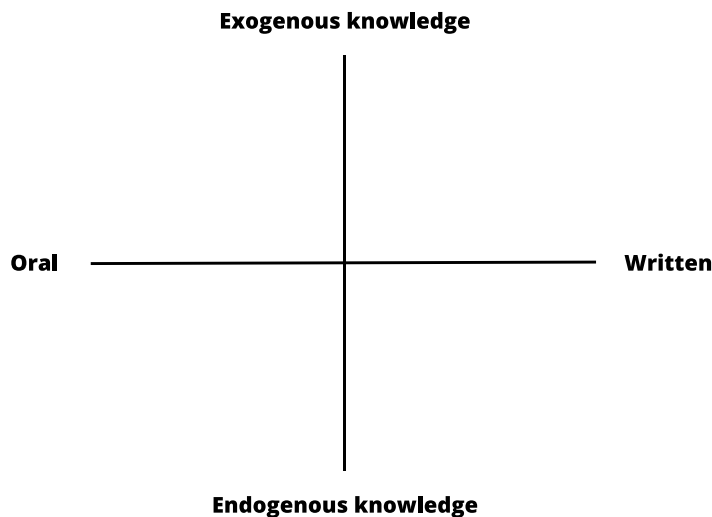


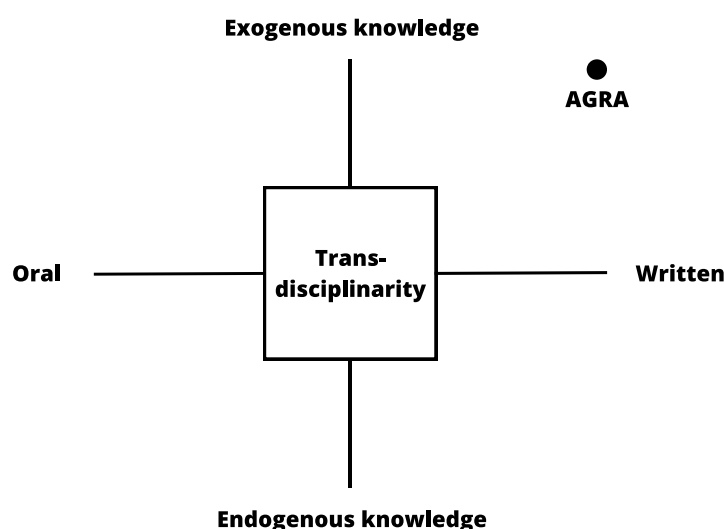
Figure 2 presents a ‘two-by-two’ mapping of previously discussed literature. The spectrum on the x-axis ranges from oral to written communication and formulation of knowledge. At one end, knowledge is conveyed and developed solely through oral means, while at the other end, it is conveyed and developed solely through written means. The spectrum on the y-axis ranges from endogenous to exogenous knowledge. As previously mentioned, endogenous knowledge is seen as a communal process of social construction in which a group interacts based on a shared worldview that includes symbolic representations, epistemology, norms and values, and practices and focusses on knowledge from within (Mathez-Stiefel, Boilat, and Rist, 2007). Exogenous knowledge refers to information that is supplied to rural communities from sources beyond their boundaries, emphasizing the external character (Lwonga, 2010). This model illustrates that when projects, initiatives or organizations solely focus on one of the four key concepts, they would likely neglect the other side of the respective spectrum. For example, if an organization focuses purely on exogenous knowledge in a local setting, it will overlook endogenous knowledge and practices that are crucial to the community. Let me further illustrate this with a practical and actual example.

The Alliance for Green Revolution in Africa (AGRA) aims to “catalyze and sustain an agricultural transformation in Africa through innovation-driven productivity and access to markets and finance that improve livelihoods of smallholder farmers.” (AGRA, 2022). They try to fulfil this aim, in the context of several African countries, by focusing on “availability, awareness, and access of improved technology, such as seed, fertilizer, market infrastructure, and innovative finance which will lead to

large-scale adoption, driving systemic changes that will result in improved farmer livelihoods.” (AGRA, 2022). The emphasis of AGRA on technologies and innovation relate to a dominant use of exogenous and written knowledge. Consequently, in the domains of agriculture and development this often leads to epistemic failures, the neglect and marginalization of local people, reduction in sustainability and disregarding the most affected populations by climate change (Hansen et al., 2019; Tengö et al., 2021; Burgess, Jensen, & Pirhofer-Walzl, 2010; Farhan Ferrari, de Jong, & Belohrad, 2015; Danielsen et al., 2007; Chilisa, 2019). Furthermore, an emphasis on written and exogenous knowledge does frequently not align with the needs, demands, culture, and ways of indigenous populations (Laborde, Porciello, & Smaller, 2021; Klerkx & Leeuwis, 2008).

The model above is used to illustrate the epistemic difficulties that arise when there is an emphasis on written and exogenous knowledge over endogenous and oral knowledge, as demonstrated by the example of the AGRA. However, it is important to note that a focus on endogenous knowledge and oral communication can also lead to a one-sided perspective, which might miss opportunities to improve agricultural practices. Nevertheless, in practice this happens far less than an emphasis on exogenous knowledge, as endogenous knowledge is often deeply rooted in local communities which are targeted by development projects. As endogenous knowledge is essential for sustainable agricultural practices, a balanced approach that incorporates both endogenous and exogenous knowledge is necessary for effective agricultural development and to ensure that the needs and perspectives of local communities are properly addressed. This balanced approach is found in the middle of the model where transdisciplinarity is situated, as can be seen in figure 3.

**Figure 3:** *Balancing endogenous and exogenous knowledge extended: the role of transdisciplinarity*



Transdisciplinarity and opportunities for knowledge integration are situated in the middle of the model. By moving towards transdisciplinarity, complex and interrelated global issues such as climate

change, food sovereignty, and biodiversity conservation can be addressed (Gagnon & Bereaux, 2009). In addition, transdisciplinarity can surmount the described epistemic difficulties by “including heterogeneous stakeholders in the process of knowledge production” (Ludwig et al., 2021, p.24). Knowledge integration can enable a more holistic and inclusive approach to addressing global challenges, while also valuing and respecting the unique perspectives and contributions of endogenous and exogenous knowledge systems. Furthermore, it can help move from the problematic narrative that endogenous knowledge is only used in supporting exogenous knowledge to an equality between both knowledge systems (Ludwig, 2016; Chilisa 2019).

However, this model has certain limitations, namely oversimplification, limited applicability, and lack of empirical evidence. First, the relationship between endogenous and exogenous knowledge and oral and written communication might be oversimplified. It may not capture the complexities and nuances of the relationship between these factors in different contexts. Second, as this thesis positions within the domains of agriculture and development, the applicability of the model may not be generalized to other domains or other contexts. Last, although this model is based on recent studies, the model itself has not been empirically tested.

### 3. Methodology

In this chapter, the research method is described and choices regarding data collection and data analysis are explained. The theoretical framework guides the methodology, which is developed in alignment with the research questions and objectives of this thesis. The following topics will be discussed in the paragraphs below: research strategy, data collection, data analysis, and ethics. These topics will be discussed in the context of the main research question:

*How do different kinds of knowledge interact within the domain of food production systems in the regions of Bono East and Upper West, Ghana?*

#### 3.0 Research situated context

From October to December 2022, I conducted research in Ghana as student from Wageningen University for Research (WUR) and in partnership with the Centre of Indigenous Knowledge and Organizational Development (CIKOD). I had the opportunity to conduct research on knowledge interaction and integration in farming systems after being invited to attend an African Learning Institute (ALI) training titled “Reviving indigenous knowledge to enhance agrobiodiversity in Ghana’s agroecological food systems” organized by WUR and CIKOD. I travelled with Juliette van Vliet, who was doing her internship for CIKOD. After a week of adjusting to the culture in Accra, we moved to Forikrom where we met Nana Adams, a sub-chief in the community. Nana Adams helped me settle in the community by assigning me housing and an office, and I was welcomed and introduced to the community by the head chief during a ritual.

A week later, the five-day ALI training took place. During the ALI training I spoke with participants, listened to panel discussions, and participated in activities. I also set up initial contact points creating a shortlist of names, emails, and mobile numbers of potential interview participants for my thesis. After the training, I worked with Maggie, my contact person at CIKOD, and Nana Adams to create a questionnaire for my research, which was then evaluated by Bern Guri and Dan Banuoku, the Executive Director and Deputy Executive Director of CIKOD. Following this, Juliette and I travelled through the Bono East and Upper West regions of Ghana using public transport to conduct interviews. Juliette focused on evaluating the ALI training, while I conducted interviews for my thesis. For more details on the data collection process, refer to sub-chapter 3.2.

During the research and data collection, there were four main external effects in Ghana that were identified: the Ukraine-Russia war and its effect on import, the aftermath of COVID-19, heavy inflation, and mitigated precipitation during the data collection. To the opinion of this thesis, these elements negatively affected the attitude towards exogenous knowledge. For example, monocropping

can result in larger yields and a more financial incentive, however, because of mitigated precipitation these fields were all dried up. In addition, heavy inflation caused increasing food prices which also promoted farming for household consumption which likely increases positive attitudes toward endogenous practices.

### **3.1 Research Design**

The research design for this thesis is based on the interpretivism philosophy of research, which acknowledges the unique reality of individuals that reality is socially constructed, also known as the postmodern paradigm (Scott & Lewis, 2017; Leeuwis & Aarts, 2011). This philosophy places emphasis on the ways in which individuals and groups conceptualize and communicate social phenomena through the creation and distribution of texts, narratives, and discourse. These modes of communication are integral to their experiences and perspectives and are thus regarded as central to the interpretation of their social worlds. According to Zoller and Kline (2008) this construction process mostly takes place through interpersonal interactions and engagements, as actors attribute significance and interpretation to their personal experiences and environment. In line with an interpretivism philosophy, this thesis employs qualitative methods as they help to explore the research units in depth and shine a light on different perspectives and attitudes regarding knowledge integration in food farming systems. Qualitative research involves all forms of research that are aimed at collecting and interpreting linguistic material to make statements about a social phenomenon (Bleijenbergh, 2013). The social phenomenon in this thesis is the coming together of endogenous knowledge systems and exogenous knowledge systems in agricultural systems in two regions of Ghana.

The interpretivism philosophy has been critiqued for its subjectivity in research and to what extent claims within this approach can be seen as truthful (Sandberg, 2005; Salvador, 2016). When attempting to justify the findings of interpretive approaches, relying on positivistic criteria presents a challenge because these criteria do not align with the underlying ontology and epistemology of the interpretive paradigm. Positivistic criteria such as validity and reliability are often employed to validate knowledge generated within this approach, but these criteria are rooted in an objectivist epistemology that assumes the existence of an objective, external reality that is separate from human experience, and a correspondence criterion of truth (Havekort et al., 2012). Such assumptions are inconsistent with the interpretive perspective, which emphasizes the importance of understanding how individuals create and interpret meaning in their subjective experiences (Sandberg, 2005; Alharahsheh & Pius, 2020).



In addition to the interpretivism philosophy of research, an indigenous research paradigm has been incorporated in this thesis to promote transdisciplinarity, and to strengthen the holistic approach towards understanding different perspectives, experiences, and knowledge in the Bono East and Upper West regions of Ghana (Chilisa, 2019). In doing so, this thesis tries to shift its view from exclusively listening to perspectives of the West, breaking with a long history of silencing and opening up to diverse viewpoints, moving away from a monochromatic view of the world (Denzin & Lincoln, 2005). Therefore, this thesis regards to the principles of indigenous research methods put forth by Chilisa (2012). These principles are credibility, reflexivity and dependability. Credibility refers to the extent to which multiple realities of participants are adequately represented (Chilisa, 2012). Reflexivity assesses the background of the researcher and one's feelings during the process. Subsequently, the background and feelings during the process have to be recorded to ensure that "overinvolvement of the researcher is not a threat to the credibility of the study" (Chilisa, 2012, p. 147). Therefore, apart from writing this thesis, a reflective journal is kept about feelings and processes during the data collection phase. Last, dependability represents an alternative for reliability in qualitative research. However, due to the dynamic nature of human behaviour, repetition of behaviour during scrutiny is concerning. Therefore, dependability emphasises a thorough written methodology to align results with data that is collected (Chilisa, 2012).

## **3.2 Data collection**

### **Theoretical framework**

The theoretical framework of this thesis is based upon a literature study on the theories of transdisciplinarity (Ludwig et al., 2021) and knowledge integration (Ludwig, 2016) in the context of farming in Ghana. The aim of this thesis is to explore how these concepts apply to the context of two regions in Ghana and to illustrate how different kinds of knowledge interact in the domain of food production systems. Concepts of endogenous knowledge, exogenous knowledge, oral and written communication in relation to farming systems are discussed in depth which are then synergized into a novel model which guides the process of data analysis.

### **Participatory observation**

In addition to creating a theoretical framework, I engaged in participatory observation during a 10-week stay in Ghana. Living in Forikrom, a local community where Twi is the native language and participating in daily life helped me conceptualize the life worlds of individuals in their regular daily activities, which may not be discussed in conversations (Clark et al., 2009). I attended work meetings with Abrono Organic Farmers Association (ABOFAB) and went to ceremonies such as a welcome ceremony, Dunbar, fundraising ceremony, and a local wedding. During the ALI training, I informally spoke with participants about cultural differences, decolonizing mindsets, (organic) farming, and other topics. I also participated in activities such as reflection with seed mandalas, speaking about

one's totems, dancing, listening, and collaborating to understand local contexts during a two-day community home stay. Participatory observation can promote an approach that does not reinforce power imbalances, which can even be emancipatory (Kesby, 2000; Pain, 2004). This is especially important in the context of knowledge integration, where endogenous knowledge is often recognized to help western knowledge systems (Ludwig, 2016; Chilisa 2019). During interviews, my interviewees invited me to their homes to show me their farms, offices, and homes, and we often shared a meal which gave a glimpse of their daily reality.

### **Semi-structured interviews**

The main method of collecting data consisted of semi-structured interviews (SSI) with participants of the ALI training and community members of Forikrom. SSIs promote variability and responsiveness to opinions and experiences of interviewees while staying within the domain of the topic (Miles & Gilbert, 2005). Furthermore, SSIs are more suitable when discussing sensitive information by allowing to let interviewees answer at their own pace (Miles & Gilbert, 2005). Last, SSIs stimulate reciprocity between interviewer and interviewee (Galletta & Cross, 2013). However, SSIs can be time-consuming, and their quality relies heavily on the nimbleness and skills of the researcher (Adams, 2015). The SSI format for this thesis was developed before travelling to Ghana, and it was informed by an initial review of prior studies. However, the format was later modified due to participatory observation following the ALI training. Furthermore, discussions with local contacts helped to construct a morally and culturally just SSI content (see appendix B). The content of the SSI differed slightly for each interviewee as interviewees had different backgrounds. Initially, the plan was to carry out fifteen interviews with ALI participants and community members of Forikrom. However, during a two-month period, thirteen interviews were completed. Out of these thirteen interviews, one was conducted in Twi with an interpreter and twelve were conducted in English. Out of these twelve interviews, four were accompanied by a local contact person.

The difference between the desired fifteen interviews and thirteen interviews conducted can be attributed to several factors. First, communication difficulties such as poor reach and a non-existing internet connection limited communication with potential participants. Another factor that limited the availability of time was the requirement to travel to remote areas in order to conduct interviews with the respondents. Furthermore, emotional fatigue due to cultural adaptation and climate conditions made it challenging to conduct interviews at the desired pace. Last, the pace of research was hindered by relying on a local interpreter for identifying new interviewees and providing initial introductions.

### **Sampling method**

The sampling methods this thesis employed consisted of convenience sampling and snowball sampling which are both forms of non-probability sampling. Convenience sampling took place during the ALI training in which participants were asked whether they wanted to participate to interviews about endogenous knowledge in agriculture. The assumption was that they all shared the interest in the domain of agrobiodiversity by coming to the training. Subsequently resulting in eight ALI participants willing to be interviewed. This group consisted of NGO employees, academics, religious leaders and farmers. In addition, a combination of snowball and convenience sampling was executed in the community of Forikrom. In consultation with my local contact, five interviews with varying community members were held ranging from farmers, teachers, female students and community elders. The advantage of using non-probability sampling is that it is cost efficient and easy to execute as participants only have to be at the right place at the right time. However, as sampling is not randomized, the generalizability of the thesis results will be reduced (Jager, Putnick, & Bornstein, 2017; Acharya et al., 2013). Moreover, the risk of biased answers was present due to being dependent on Maggie who worked for two organisations promoting organic agriculture and endogenous development (Jager, Putnick, & Bornstein, 2017; Acharya et al., 2013). Nevertheless, my local contact helped creating a trust relationship with interviewees which can have resulted in enhanced reciprocity.

### **Population sample**

The collection of biographic information from interviews was not conducted comprehensively due to the established trust between interviewees and interviewer, which made it unnecessary and insulting to explicitly ask for such information. It was assumed that this information was already known due to the existing mutual relationship. Subsequently, certain details were indeed known, such as the age range of interviewees, which varied from 25 to 72. Additionally, five interviews were conducted with females and eight with males. It is worth noting that family members, school friends, and children were also present during these interviews, making it less distinct to categorize them solely based on gender or number of people. Please refer to Appendix A for a comprehensive summary of the participants, including their respective regions, genders, age ranges, and the number of individuals present during the interviews.

### **Data analysis**

Experiences from participatory observations were discussed with local contacts, Julliete van Vliet and both supervisors to reflect on the observations and their application to the context. The SSIs were (mostly) recorded and at return in the Netherlands transcribed. After transcribing, the transcripts were uploaded to ATLAS.ti to be able to apply codes. First, the main themes in the transcripts were identified by means of content analysis looking into the frequency of specific themes. After, the

emphasis was put on the elements making up these themes and categorizing them. Last, these codes were reviewed in the light of the research questions and noted down in the results chapter.

### **3.3 Ethics**

Given the substantial differences in epistemologies, ontologies, and axiology between myself, a west European researcher, and my Ghanaian interviewees and research environment, it is important to address the ethical implications of our divergent perspectives in the context of my thesis.

Foremost, there is a perceived asymmetrical situation in power balance between myself and interviewees, but also in my interactions with other locals, elders, youth and workers. This asymmetrical relationship is formed by differences in status, group affiliations, sex, ethic and distribution of wealth (Asouzu, 2005). Inevitably, these factors impacted conversations, interactions and relationships with interviewees and others without consistently being conscious of this asymmetrical relationship. In trying to cope with this asymmetrical relationship, introductions were often guided by locals as intermediaries like the head chief, sub-chief, community leaders and my local contact

Second, the interpretation and meaning of data are strongly influenced by epistemological and ontological factors as western worldviews differ from African worldviews. These differences can be found in ways of knowing (epistemology) and how existence is understood (ontology). It is important to recognize that the examples provided below are not comprehensive representations of the epistemologies and ontologies of these worldviews, but rather serve to highlight fundamental differences that have ethical and practical implications for this thesis. Drawing on Kelbessa (2015), African worldviews emphasize that “human beings, nonhuman animals, and the cosmos are complementary, interconnected, and interdependent. Self-realization can only be attained by associating oneself with other cosmic beings.” (Kelbessa, 2015, p.388). The philosophy of Ubuntu forms the centre of being in relation to all other things, as “to be a human be-ing is to affirm one’s humanity by recognizing the humanity of others and, on that basis, establish humane relations with them.” (Kelbessa, 2015; Coetzee & Roux, 2004, p. 272). This informs the axiology of research which is centred around relational accountability (Chilisa, 2019). In contrast, western worldviews derive meaning from Descartes “I think, therefore I am” (Descartes, 1637) in which existence forms around individuals’ beings in connection to themselves instead of relationality. In western worldviews, epistemology can roughly be categorized into a traditional, modern and partly, postmodern worldview in which the modern worldview is the most dominant (Hedlund, 2012). The modern worldview emphasizes that reality is singular (ontology) and nature is instrumental. Epistemologies consist of empiricism and reductionism which tries to search for objectifiable truths (Hedlund, 2012). As shown in studies by Mehta et al. (2013) on fertilizer use in Swaziland, Boogaards’ (2021) critical analysis of

goat husbandry in Mozambique, and Lansing's (2009) research on rice farms in Bali, conflicting worldviews can lead to misunderstandings and communication breakdowns. These failures in understanding can be traced back to my thesis, which emphasizes the importance of adhering to academic standards and integrating knowledge to seek objective truths, a perspective that clashes with the African worldview of relationality.

## 4. Results

In this chapter the findings to three sub-questions of this thesis are presented. Opening with answering the sub-question “*What is the role of endogenous knowledge in food production systems in the Bono East and Upper West regions of Ghana?*”. Here, the role of endogenous knowledge in endogenous food practices will be discussed, focusing on the benefits, restraints, underlying values and integration of endogenous food practices in the lives of the interviewees. Subsequently, the role and characterization of exogenous knowledge will be discussed by answering the second sub-question “*What is the role of exogenous knowledge in the context of food production systems in the Bono East and Upper West?*”. In this regard the absence of exogenous knowledge is discussed and the use of exogenous applications. Last, the third sub-question “*What tensions and opportunities arise in the interaction between endogenous knowledge systems and exogenous knowledge systems?*” will be answered. In this sub-chapter, interactions between both knowledge systems are analysed using the two-by-two model of the theoretical framework.

### 4.1 Endogenous food production practices

During data analysis, it became evident that endogenous knowledge is embedded in endogenous practices and its importance is shown through these endogenous practices. Practices serve as a means of transmission, preservation, and adaptation of endogenous knowledge in a cultural/social context. To describe these endogenous food production practices in the Bono East and Upper West regions of Ghana, it is essential to differentiate them from exogenous practices. The distinction lies in the deep-rooted nature of endogenous knowledge and practice, which derives from within the communities in contrast to exogenous practices that form outside community borders. Moreover, the intergenerational transmission of knowledge further contributes to the characterization of endogenous food production practices. When identifying such practices, both the intrinsic nature of knowledge and the continuity of its transfer across generations are considered. By analysing thirteen interviews and incorporating participatory observation, the findings showed two endogenous practises in food production, namely: shifting cultivation and crop rotation. It is crucial to emphasize the holistic character of endogenous knowledge and its practices. However, sometimes it is necessary to segregate information in the sections below. Zooming in or providing an overview of information helps to create understanding. In the sections below, information shared by interviewees is coded as INTV-(number).

This sub-chapter first briefly discusses the role of shifting cultivation as endogenous practice and its restraints. Next, the endogenous practice of crop rotation is explained. Afterwards, the benefits of crop rotation compared to monocropping are considered. Furthermore, the restraints of crop rotation are discussed and how these impact the practice of crop rotation. Subsequently, the underlying values

of employing crop rotation are explored. Last, a brief overview of the discussed topics will be given at the end of this sub-chapter.

### **Shifting cultivation**

Shifting cultivation is an agricultural technique in which land is cultivated for a certain period and then cleared or left uncultivated to later move to the same area when the soils fertility has restored. Especially older interviewees (age 60-65) remarked upon the utilization of this technique by their parents. INTV-13 spoke about his dad having the endogenous knowledge to balance crops and move to other fields utilizing shifting cultivation. Subsequently, his dad knew how to prepare new lands using farm residue by turning it into manure for planting new crops which he remembers until this very day. However, also younger interviewees recall the use of shifting cultivation. When INTV-11 was asked why past generations did not use pesticides or fertilizer he answered the following:

“Previously we used to have luxury of lands and so the practice of shifting cultivation was very predominantly for years. I think the fertility level of the soil is reducing. So I moved to another area, do some two, three acres there. After three or four years I return with the intention that you'll have had natural regeneration of your soil microbial activity through propping up the debris and compose in about three or four years. In recent time, because of land pressure, people are beginning to get stuck to particular piece of land for a rather longer period of time.”

The example above shows the pressure on the technique of shifting cultivation. The luxury of land is no longer self-evident due to population growth, land degradation, and commercial farming. For example, INTV-1 illustrated that when the land's soil is depleted, one cannot move or shift your cultivation as there is no place for one to shift to due to an increasing number of farmers staying at the same place for a longer time. Furthermore, NTV-1 discussed that his father did not use fertilizer, but to farm today, a farmer will have to apply fertilizer to your land as large tracks of lands have depleted soils. In line, INTV-12 spoke of chemicals negatively affecting the soil composition which makes many pieces of land unusable. Moreover, INTV-13 talked about the impact of large commercial farming of rice in the Upper West which resulted in the cutting down of trees creating unusable parts of land. Another factor in restricting land cultivation is the increase in export of produce. INTV-7 stated that many farmers are converting their lands into cashew and cocoa for export to, for example, India. In addition, INTV-9 illustrated that Ghana is the second-largest producer of cacao and substantial producer of cashew while Ghanaians do neither eat cashew nor chocolate. Although land scarcity is seemingly an increasing problem according to multiple interviewees, according to INTV-8 from the Upper West, land is not a problem as there is a lot of land to farm.

### **Crop rotation**

Another endogenous practice in which endogenous knowledge is embedded, is the practice of crop rotation. Crop rotation is the cultivation of specific crops on a different area of land each period. Crop

rotation plays a crucial role in mitigating land degradation, pests, and weeds by employing diverse crops on the same plot of land.

***The benefits of crop rotation: diversification and increased soil fertility***

INTV-11 explained that crop rotation involves cultivating a mixture of crops such as maize, soya, yam, and tree crops like cashew. The benefits of such diversification become evident in the event of failed harvests of a particular crop, as it minimizes the impact of climatic factors by relying on multiple cropping systems. For example, in the event of extreme drought, certain crops can withstand the increased heat, while others cannot. By diversifying crops, farmers can reduce the risk of crop failure and ensure food provision even in challenging conditions. In other words, INTV-5 described it as the following:

“It (referring to endogenous approach of farming) is not easy, but it is okay. It is better than one-way farming. If the rain this year does not come again, we will be in hell as there will be no food in the country. Because we do not have these kinds of farms anymore. With monocultures you will have no food and no money to buy food.” (INTV-5).

In the Upper West region, INTV-8 spoke at length about the use of crop rotation techniques. Farmers engage in a systematic process of land preparation, rotating crops like groundnuts, cowpeas, maize, and sorghum. They select flat areas for planting certain crops and create mounds for others, like yam, ensuring a continuous cycle of cultivation. INTV-8 emphasized the importance of incorporating crop diversity and employing different land formations to maintain the fertility of the soil. However, it is important to note that the way of crop rotation described above does not one-on-one correspond with crop rotation in the Bono East region due to a different number of rainy seasons. In the Upper West there is one rainy season whereas in the Bono East there are two rainy seasons.

INTV-13 discussed the role of climate change and its effects on communities, culture and farming. In his lifetime he observed communities who moved as they were dependent on water bodies that disappeared completely because of drought. INTV-5 talked about farmers who own farms containing monocultures sitting under a tree crying because rain would not come. She explains that she is less dependent on precipitation because of her diversified crops than neighbouring farmers who employ monocropping. INTV-2 and -8 stated that the way of endogenous farming practices help to adapt to climate change. INTV-8 used his knowledge about indigenous crops to strategically place crops according to their water needs, resulting in his crops having enough water even when rainfall patterns change. INTV-2 summarized how Ghanaians in the Upper West deal with climate change:



“We don't have the resources to mitigate, but we can adopt because our traditional practices have always been skewed, always adopted. So we can always adopt those practices, our farming practices, our food systems and all those things. But to a very large extent we normally link it with our belief system and our sites, we link it with our belief oh, it's our grandfathers and he said this. [...] They tell you it was our grandfathers who did it. Give me a history. Because we tend to link our livelihoods, our medicine, our culture, everything to our ancestors.”

***The restraints of crop rotation: community labour and labour intensity***

INTV-12 spoke about the labour-intensive nature of crop rotation, which arises from the need to employ multiple weeding methods and manual labour using hoe or cutlass. This is because different crops have distinct weeding requirements, unlike monocrops that can be weeded uniformly. Additionally, INTV-1 recognized that the organic character of crop rotation without the use of fertilizers or chemicals necessitate the production of manure and manual pest control.

As endogenous food practices require a substantial amount of labour, communal support is crucial to be able to cultivate land. However, over a generation, the availability of labour has reduced drastically because of labourers owning farms and increasing individualism. The importance and decline of communal labour are illustrated by INTV-8:

“The family and community labour support has reduced drastically, and therefore I am not able to farm as much as my father used to do. But at that time, people were willing to help one another. The social support system was active and powerful, and people drew on that as a strength to the farms all over. And it was good for the broader community because everybody was secured. But now, community labour and farming labour have reduced, and people have tended to become more individualistic and less supportive in common labour.” (INTV-8)

Other interviewees recognized the labour intensity of crop rotation. INTV-12 highlighted that it a substantial amount of work to weed five or ten acres of land by cutlass, especially when there is no available labour. However, community labour was not always a problem. INTV-8 and -13 illustrated a time in which communal labour was common as on Saturdays you exchange labour with neighbouring farms in a rotational system, this concept was named *potler (Dagbani)*. Together with friends, you went to farms to provide labour to farms within the community. It provided a sense of togetherness and recognition for your contribution to the community.

Collectivism, the sense of togetherness, is a recurring theme in interviews. For example, INTV-5 said that when a farmer does not have land, he depends on others to bring food: “that is how we used to

live, you don't live for yourself, you live for others too.”. Another illustration of this collectivistic approach is illustrated by the following interviewee:

“See, seed was shared, you know, or exchanged among farmers. So my father gave seed to other farmers but he also took seeds from other farmers. You know, so that changed, later I have learned why they did that, even though they didn't explain to me. But I think it kept that cycle, that support community support system going.” (INTV-13)

The availability of community labour and its role in crop rotation is under pressure due to shifting values in communities. Its role is vital to be able to employ crop rotation and interviewees struggle with the changing attitude of community members. In addition, exogenous products such as fertilizer and chemicals make it possible for everyone to farm their own piece of land, contributing to increasing individualism in communities.

### **Endogenous knowledge**

Endogenous knowledge is embedded in endogenous practices. Different interviewees spoke about the use of endogenous knowledge in the domains of food storage, land cultivation, pest management, fertilization and many more. For example, in the domain of pest management, INTV-8 spoke about protecting immature yam by mixing acacia roots, animal droppings, and water by spreading it over the newly planted yam. Subsequently, the pungent smell repels birds and other species from coming near the yam. In addition, INTV-8 talked about increasing the lifetime of beans by using earth pots and layers of *temele* (Dagbani) to preserve beans and protect against bugs and other insects like weevils. Besides, INTV-12 spoke about using ash for fertilization and pest control for crops like pepper, tomatoes and okra. Furthermore, INTV-2 spoke about keeping water cold by using a hole in a dark room to preserve the coldness of water.

### ***Endogenous knowledge: an oral intergenerational transfer***

The examples above relate to the use of endogenous knowledge in farming practises. When asking interviewees how they obtained their knowledge, interviewees mentioned deriving knowledge from their elders as main knowledge transfer. These intergenerational knowledge transfers are illustrated in the section below where interviewees were asked from whom they learned to farm:

**Table 1:** *Intergenerational knowledge transfers of farming*

	<b>Intergenerational knowledge transfer</b>
INTV-1	“I am actually a farmer myself; I was born a farmer because my father farms, I have been farmer myself all my life.”

INTV-2	“So, I go to the farm. I take decisions about the farming, the land, what to plant. That was just part of my own past and my father was educated, but this was how he trained us.”
INTV-3	“Farming is an integral part of our culture. When the child goes to school, the society expects them to become farmers. At the end of the day, you can be a banker whilst farming. We come to Ghana here. Even the ministers, someone having large farm of cocoa and cashew, then coconuts, a whole lot. And so the primitive work in Ghana is farming.”
INTV-5	“When my parents used to go to the farm, we followed them, because that is the only work that they do to sustain the family. Without that farm there is nothing for you to eat. So, when they went to the farm, we go. Sometimes from school we had to go to the farm, I learned from them.”
INTV-7	“My parents doing the indigenous way of farming. That's how do we do farming, so when we're young we're going to farm.”
INTV-8	“So, my father and grandfather were good farmers, and I grew up to meet my father learning from his father to farm.”
INTV-9	“I learned from my parents. My parents both were farmers so that time too in school curriculum we were taught to farm as well.”
INTV-11	“So, I suspect that interest was actually passed on some reason to my father's father and once my father was there, you definitely have to do some farming.”
INTV-12	“My mother was a farmer. So that’s how I became a farmer
INTV-13	“Researcher: How did you obtain knowledge in agriculture or how did you learn in that regard? Interviewee: By practice. By practice that I was going to the farm with my father and I did.”

Table 1 shows the intergenerational character of endogenous knowledge in the responses of interviewees. Intergenerational knowledge transfers are reflected in family members being the main sources of knowledge regarding learning how to farm. INTV-1 explained that learning crop rotation techniques involves a hands-on approach where farmers gradually acquire knowledge and skills by observing and practicing alongside parents, grandparents, or elder community members. Oral communication serves as a vital conduit for intergenerational knowledge transfers. The interviews conducted revealed that the transmission of knowledge from one generation to the next predominantly occurred through spoken word and verbal exchange. As illustrated in the responses provided in Table 1, interviewees emphasized the significance of learning directly from their parents, grandparents, and elder community members. The intergenerational knowledge transfer relied heavily on face-to-face interactions, storytelling, and hands-on involvement in agricultural activities. Through oral

communication ancestral wisdom, farming techniques, and endogenous practices were shared, ensuring the preservation and continuity of intergenerational knowledge. The reliance on spoken communication underscores the value placed on personal connections and the cultural importance of passing down wisdom from older to younger generations. The oral character of endogenous knowledge becomes evident. Moreover, one of the drawbacks becomes apparent when this knowledge is not orally communicated: the loss of endogenous knowledge.

### ***Endogenous knowledge: the absence of knowledge transfers***

As mentioned, endogenous knowledge is mostly transferred orally. Interviewees identified the risk of knowledge disappearing by not orally transferring knowledge. An example is given by INTV-2:

“We need to open up and share knowledge. So, you're going to have a situation where people will still be keeping some knowledge, information, and they are not ready to share with you. [...] We have the information, but it has not been documented.” (INTV-2)

In addition, INTV-5 thinks that if endogenous ways of farming are not transferred “everything will be messed up”. INTV-2 and 11 agreed that some knowledge was known by their parents but not transferred to them. For example, in introducing one’s totems during the ALI training, INTV-11 did not know his communities’ totem. Another example is that the parents of INTV-2 had roots that could cure cancer, asthma, and other diseases, which was never transferred to him. INTV-2 sheds light on the hesitancy of sharing knowledge as endogenous knowledge has been misused. For example, he explained that Chinese visitors arrived to inquire about the process of crafting traditional clothing. Once they obtained the necessary information, they departed and proceeded to replicate the traditional clothing. Subsequently, the Chinese shipped these replicated clothing items back to Ghana, selling them at a lower price compared to the local market. This instance exemplifies knowledge mining, as the Chinese claimed to assist in the local production of traditional clothing while negatively impacting endogenous populations by exporting the replicated traditional clothing.

### **A way of life**

Although endogenous practices are under pressure because of the lack of communal labour, shifting cultural values, application of exogenous inputs and the potential risk of loss of endogenous knowledge due to a lack of knowledge transfers, interviewees continue to farm using endogenous practices. When being asked why interviewees continue using endogenous practices, despite their difficulties, INTV-5 answered the following: “We should go back to our history, the food that our ancestors ate and preserving our way of life”. This way of life relates to the use of endogenous practices and their relationship with traditions and food sovereignty. To put it in the words of one of the interviewees:

“There are all kinds of stories around about food, expression of sovereignty. Express that reverence of connection to your ancestors, of sacrifice, of food and expression, of individual and family dignity.” (INTV-13).

In the words of INTV-5 “As without food, you cannot live. Food is medicine, food is money, it is spiritual, food is important.” It becomes evident that food does not just encompass its nutritional contents but refers to reverence to food in connection with ancestors, medicine and dignity. This way of life stimulates the use of endogenous practices such as shifting cultivation and crop rotation. The section below illustrates the importance of ancestral connections with food and its integralist characteristic with endogenous food practices.

In the Bono East and Upper West regions, the ancestral connection with food is not just sporadic, but rather an integral part of food sovereignty. Before beginning the farming season, INTV-8 brings an offer in the form of a fowl to his ancestors which must be accepted before he can start with sowing seeds. Therefore, INTV-2 explained, that black fowls and black sheep are very costly as they are sacrificed to the ancestors. INTV-13 illustrated that food sovereignty in that “Food was not just your food, but it was also the food of the ancestors. Your forebears who have gone before you. If you did not have food, you could not sacrifice”. INTV-1 talked about the cultural connotation of food, that you need indigenous crops in order to keep the cultural connotation of food going when sacrificing in ceremonies or households. INTV-12 stated that at the yam festival, the early yams will not be used for consumption as they will be used by their chiefs for the festival to give reference to the ancestors. Last, INTV-1 told the story of the reincarnated child. He told that when the community assumes that one of the ancestors has come back, the child has to receive the name of the ancestor after which specific food has to be prepared. The examples above show an integration of ancestral connections with food. This ancestral connection would get lost when endogenous practices are not employed.

Apart from the ancestral connection with endogenous practices, there are also medicinal connections to be made. For example, INTV-5 talked about cooking cocoa yam with its peel to later feed the peels to someone who is sick:

“This cocoa yam, if you have a child that is sick and lying down, you take cocoa yam and you do not peel it, you cook it and use the peel to feed, if the child does not eat it, he will die, but when he does, he will live. Its medicine. We are throwing away our knowledge.” (INTV-5)

Last, INTV-2 explained that his dad knew how to cure all kinds of diseases using roots of plants and how his community never needed a healer.

### **Summarizing: the role of endogenous practises in food production systems**

The role of endogenous practises in food productions in the regions of Bono East and Upper West has multiple functions. First, practises such as shifting cultivation and crop rotation improve soil fertility and by diversifying crops mitigates the effect of extreme climatic factors. Nevertheless, shifting cultural values impact the availability of communal labour. Communal labour is needed because of the labour intensity of endogenous practices. In addition, endogenous knowledge is heavily embedded in endogenous practises, and because of its oral characteristic, these practices face the danger of disappearing by not transferring knowledge to the next generation. Despite the difficulties of the continuation of endogenous practices, interviewees continue to employ endogenous practices as it is a way of life. This way of life encompasses the reference to food in a spiritual, medicinal and socio-economic state. Overall, endogenous knowledge plays an overarching role in food practices by offering a holistic and spiritual way of life.

## **4.2 Exogenous knowledge in food production systems**

To describe exogenous knowledge in the context of the Bono East and Upper West regions, it is important to note that the terminology ‘exogenous knowledge’ has not been used by interviewees. Subsequently, the consideration of whether something is considered exogenous knowledge is based on the theoretical framework and participatory observation. As mentioned before, exogenous knowledge refers to information that is supplied to rural communities from sources beyond their boundaries (Lwonga, 2010). This sub-chapter starts by discussing the effects of exogenous applications such as synthetic chemicals and fertilizers. Afterwards, the absence of exogenous knowledge in relation to exogenous applications is discussed. Finally, there is a brief overview of the main points discussed in this sub-chapter.

### **Agricultural inputs**

The main reoccurring theme during interviews and participatory observation was the role of synthetic chemicals and fertilizers in food production systems in the Bono East and Upper West regions. Interviewees spoke at length about the role, impacts and generational differences between their parents and themselves in the use and view on these exogenous applications.

### **Application of chemicals**

The practice of using synthetic chemicals in agriculture is a widespread phenomenon in western countries. Pesticides, including herbicides and rodenticides, are included when speaking about chemical use. When asking interviewees about the use of chemicals, interviewees talked about the generation of their parents who were not using chemicals. When being asked when people started using chemicals, INTV-12 answered that while he started farming in 1973 without using chemicals, during the 21<sup>st</sup> century around 2010, you would not get labour, and many would farm using chemicals. INTV-11 told that their family never knew something like herbicides or pesticides, and they always had labour on the fields to help back in the day.

Due to the combination of lack of labour and not being able to shift cultivation due to land pressure, chemicals were being introduced in farming. However, the effects of using chemicals on land did not go unnoticed. INTV-9 explained that, for example, the herbicide came from Europe which kills other species alongside the targeted weeds. Therefore, using cutlass or the hoe makes you able to kill “the bad ones and leave the good ones”. In line, INTV-5 spoke about using chemicals when having diversified crops. According to her, when someone uses chemicals on a field with groundnuts and maize, it might help the groundnuts, but it kills all the maize on your field. INTV-12 discussed the effect of spraying chemicals on the soil composition. Chemicals will get into the ground and affect the microorganisms within which is recognized by INTV-9 as well. The attitude of INTV-7 towards chemicals is not completely negative. According to him, spraying of non-organic chemicals

negatively affects your farm but creating organic sprays to use on your farm will help community members as it is much better for your health. In addition, INTV-7 and -9 raised the concern that community members who spray influence others who do not employ the technique of spraying chemicals as chemical dust can hover over neighbouring farms. Last, INTV-1 illustrated his relationship with chemicals when buying produce of others while having visitors over:

“I remember one time in Koforidua I was moving with some of my PC's (peace corps volunteers) when we saw a banana seller and we said how this one is chemical, watch out don't buy it, these days everything has chemicals, but at least what I am saying will draw the attention to do not eat this because it has these consequences.” (INTV-1)

### **Application of fertilizer**

Just like the use of chemicals, synthetic fertilizers are used around the globe. However, before 1972 the use of fertilizers in the Bono East and Upper West regions was not prominent according to INTV-13. He still remembers the introduction of fertilizers in the country.

“When I saw fertilizer coming in large streams was in 1972. When the government operation ‘Feed Yourself program’ was based on commercial agriculture, which was accompanied by externally driven input systems, especially fertilizer.” (INTV-13).

He further explained that the campaign came with large billboards and radio programs about the use of fertilizers and that back then, fertilizers were so cheap, almost like a giveaway. Consequently, people adopted the use of synthetic fertilizers and could no longer do without them. Then the prices of fertilizers were going up. Before that time, he never heard of anything like fertilizer. Looking back at that time he notices that this campaign was “not accompanied by proper education”. Later, INTV-13 explained, there was the shift from using compost or local manure on farms to fertilizer, resulting in large tracks of land which cannot be used anymore because of soil depletion. INTV-1 recognizes the story of INTV-13 and conversed about his father not applying fertilizer during his time. In addition, INTV-12 discussed the use of fertilizer during his childhood and adulthood saying that in the past you would get big foods and good yield without fertilizer. However, nowadays it would be very hard to get the same results. Therefore, he is learning to make compost to fertilize his land.

When visiting and walking on the farms of one of the interviewees, it stood out that most of the neighbouring farms were using chemicals and fertilizer. Therefore, I asked interviewees whether they had conversations with these farmers with different views. INTV-5 discussed the matter with women in her community: “I raised this issue; they say that what I'm saying is very true. They have to start doing that. I said, fine, I will help you.”. In contrast, INTV-12 discussed the issue with community



members but said that they continue using fertilizers as it gives them more yield and subsequently, more money. INTV-1 expressed that markets do not incentivise organic produce as they do not differentiate between organic and non-organic produce in pricing. INTV-11 identified a connection between colonization and the use of fertilizer:

“I would say it fits into the colonization of the mindset that without fertilizer I can't get anything or what I'm getting is not enough, fertilizer would have given me more. So I have to apply fertilizer and not just organic fertilizer, but inorganic because I'll get to see results. So I would say maybe during my father's time they were not so much exposed to some of these colonization issues and I can't remember that the markets were flooding with fertilizers. I never saw fertilizer during my senior high school education. I never saw fertilizer like a fixed physical fertilizer. But we were taught in school. So I think that is capturing of our mindsets over a period and colonizing it to the extent that what we're doing was not productive enough and that there was a need to employ a lot more external use of agricultural inputs into our agriculture production system to be able to get a lot more produce or improve our productivity in that regard. So I would say during my fathers time, the mindsets were not that colonized compared to now.” (INTV-11)

### **Use of market inputs**

As briefly mentioned in the past sections, differentiation within local markets between organic and non-organic produce has not been established within the Bono East and Upper West regions. According to INTV-4 and -6, this separation has to be created because organic produce is much smaller (size) and less attractive than non-organic foods, while organic foods are healthier. INTV-10 posed the thought that people do not farm organically because of having no separate market for organic produce. For the past years she has been trying to establish organic markets with a set price to avoid competition. INTV-4 agreed that organic produce is not being financially incentivised and that it impacts organic farmers. In line with INTV-4 and -10, INTV-1 talked about being unable to distinguish organic from non-organic when buying foods for his own household. When asking who is responsible for creating these markets, INTV-12 indicated that government must help create separate markets for organic products.

Another external influence when discussing the role of markets are imported foodstuffs. INTV-9 remarked that rice is produced within the country but is also imported. When the consumer has to decide which rice to buy, the imported one is often chosen above the local one because of packaging and filtered out little stones within these packages. According to INTV-9 the difference is created by mono-cropping systems which can produce rice on large scale compared to the local produce. Aside,

it is remarkable that households sell non-organic foods while mostly consuming organic foods themselves according to INTV-5 and -6 and -9.

### **Summarizing: exogenous knowledge vs exogenous application**

The main finding of this sub-chapter relates to the absence of exogenous knowledge in relation to the presence of exogenous inputs such as synthetic chemicals, fertilizers, and their effects on local markets. As illustrated before, interviewees grapple with these exogenous applications. They learn about the short- and long-term effects after trial-and-error, observing or learning from others. These learning methods share an oral character. This oral transmission of knowledge implies a lack of written information about exogenous applications or the efficiency of written communication within the cultural context. For example, neighbours often put emphasis on the short-term financial incentive or do not know the long-term effects of exogenous applications. INTV-13 spoke about a large governmental campaign, launching fertilizers into the country without much education about their effects other than the promise to increase yield. The absence of exogenous knowledge, while exogenous applications are widespread, is concerning as it questions the sustainability of these applications. Subsequently, farmers may be more susceptible to negative consequences such as environmental degradation, decline in soil fertility or health risks. The lack of knowledge on exogenous applications takes away the ability of farmers to make an informed decision towards the use of exogenous applications. Twelve out of thirteen interviewees spoke at length about exogenous applications. This may show the widespread integration of exogenous applications in the daily lives of farmers in the Bono East and Upper West regions and the importance of increasing exogenous knowledge accompanying these exogenous applications.

### 4.3 Tensions and opportunities when knowledge systems interact

Previously the roles of endogenous practices and exogenous knowledge in food systems were discussed. Subsequently, this sub-chapter will shed light on the interaction of these knowledges in the Bono East and Upper West regions. It will do so by describing both tensions and opportunities when endogenous and exogenous knowledge interact using the two-by-two model of the theoretical framework (figure 2, see page 22). Last, a summary of the discussed tensions and opportunities will be provided.

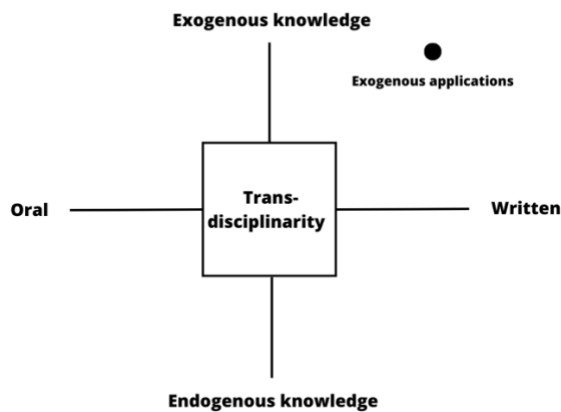
#### Tensions

The following sections relate to the tensions that arise when endogenous knowledge and (the absence of) exogenous knowledge interact in food production systems.

#### *Tensions: exogenous applications*

As discussed in the previous sub-chapter, interviewees noted an absence of exogenous knowledge while having diverse exogenous applications available. The discrepancy between the presence of exogenous applications and absence of exogenous knowledge accompanying these applications create tensions within food production systems in the Bono East and Upper West. These exogenous applications are placed on the two-by-two model, see figure 4 below.

**Figure 4:** *Exogenous applications placed on the two-by-two model*



Exogenous applications contain exogenous knowledge and are introduced in Ghana without proper education according to INTV-12 and -13. Although interviewees did not mention any oral or written information accompanying the introduction of exogenous applications, it might be argued that these applications are normally accompanied by written guides, handbooks or manuals. Especially as exogenous knowledge places a significant emphasis on written communication to validate knowledge or its role in education (Lwonga, 2010). Introducing written communication in an endogenous

population with oral traditions might relate to the absence of exogenous knowledge that interviewees and neighbours experienced. It may be, because of the absence of any information (either oral or written), or people not being able to read, or not being used to reading manuals – due to their oral traditions - that (should) accompany such exogenous applications. This information deficit creates tensions between farmers applying these exogenous applications and those who do not. Or in the words of INTV-5:

“In my observation, 20 years from now, Ghana will be hell because the way of farming, this modern type of farming is destroying.... It is destroying our lives, our seeds, everything is just going to be off.” (INTV-5)

Within farming systems in the Bono East and Upper West there are also tensions between farmers who adopt endogenous knowledge and exogenous applications in a varying way. Because what happens when some farmers employ more endogenous practices and others more exogenous applications? For example, when a neighbouring farm is using chemicals, chemical dust will float on to spread along neighbouring fields who might not use chemicals raising concern at neighbouring farms. In addition, INTV-9 elaborated that next to negative impacts of chemicals and fertilizers, tractors also negatively affect microorganisms and the cutting of trees. He explained that within the endogenous farming system you always replant a tree when you cut one, but the introduction of the tractor has led to destroying biodiversity of whole fields. Last, INTV-12 spoke with community members applying exogenous applications who did not take his knowledge on these applications into consideration because monocropping results in bigger yields and more money than employing diverse cropping schemes.

### ***Tensions: inferiority of endogenous knowledge***

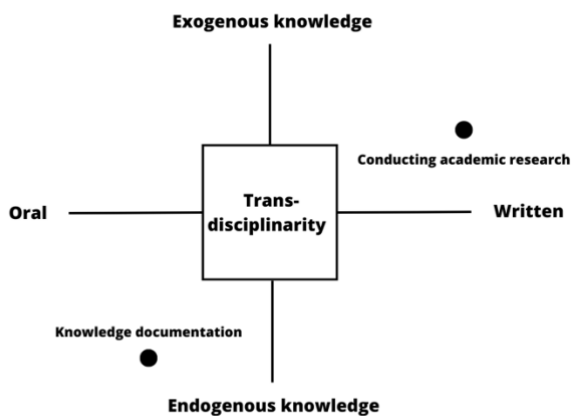
Both the literature and interviewees state that endogenous knowledge is often seen as inferior compared to exogenous knowledge. For example, Ludwig (2016) and Chilisa (2019) note that endogenous knowledge is often recognized insofar to help exogenous knowledge systems. In addition, INTV-2 and -9 discussed that Africans, in general, have the belief that anything from the west is deemed superior.

This inferiority is reflected in two areas where tensions form. These two areas consist of conducting academic research in local populations and knowledge documentation. Two interviewees mentioned upcoming tensions when conducting academic research in food productions in local contexts. For example, INTV-11 talked about development in the context of spirituality. Consequently, he stated the question how spirituality can ever be measured or can be reported on, trying to measure a concept that does not fit exogenous/written context, failing to have a successful knowledge integration.

Further, INTV-13 illustrated the same problem in a different context. When discussing the effects of climate change on communities, he conversed about observations he made throughout his lifetime, explaining ways in which communities moved and water sources being laid bare. During his explanation he said, “forgive me, they may not look very scientific, but I am just observing the changes within my lifetime” (INTV-13). The same issue is expressed by implying that observations do not align with being ‘scientific’. These issues relate to the inferiority of endogenous knowledge compared to exogenous knowledge as exogenous knowledge is used as framework in which endogenous knowledge has to fit. Subsequently, knowledge integration fails because of the overemphasis on exogenous knowledge and written communication (see figure 5).

As discussed in sub-chapter 4.1, endogenous knowledge runs the risk of disappearing by not transferring knowledge to the next generation. Due to its oral characteristic, it is difficult to sustainably document the knowledge for communities or regions. Together with ‘conducting academic research’, figure 5 shows the placement of these elements on the two-by-two model:

**Figure 5:** *Conducting academic research and knowledge documentation placed on the two-by-two model*



## **Opportunities**

The following sections relate to the opportunities that arise when endogenous knowledge and exogenous knowledge interact in food production systems.

### ***Opportunities: implementing technology***

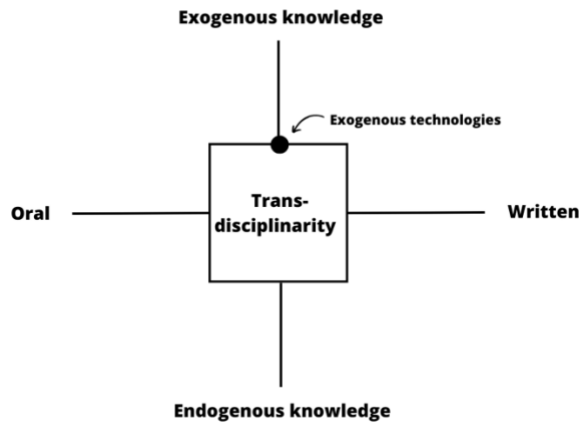
The main opportunity that was identified regards to the integration of exogenous knowledge in the domain of value addition. Some of these integrations relate to a status quo in which exogenous knowledge is withheld from/not integrated into endogenous communities. The integration of exogenous knowledge often refers to the use of exogenous technologies (knowledge as well as machinery).

For instance, during one of the interviews (INTV-7), the interviewee discussed exploring alternative ways of sourcing feed for chickens. Recognizing the rising cost of maize, the interviewee proposed processing cassava peels into chicken feed, which would require exogenous technologies embodied by machinery. By introducing exogenous technology and the accompanying knowledge, such as the process of converting cassava peels into feed, endogenous farmers can enhance their practices and reduce dependency on expensive inputs. This example highlights the potential benefits of integrating exogenous knowledge in terms of economic efficiency and labour optimization within the local context.

Furthermore, other interviewees also emphasized the role of exogenous knowledge in accelerating production processes. INTV-2 highlighted the use of crushers, dryers, and extracting machines, which can significantly speed up various production stages. By incorporating these technologies, farmers can enhance their productivity and meet the demands of a growing population more effectively. In addition, technologies such as solar driers and shuffle techniques can improve endogenous practices, enabling farmers to add value to their products and access new markets. This integration has the potential to boost local economies and empower endogenous communities by leveraging their existing knowledge alongside exogenous innovations.

Based on the above examples, the implementation of exogenous technology, accompanied with the exogenous knowledge to use them, is incorporated into the two-by-two model

**Figure 6:** *Implementation of exogenous technologies placed on the two-by-two model*



The implementation of exogenous technologies in food production systems presents significant opportunities for transdisciplinarity, where endogenous knowledge and exogenous knowledge interact. Figure 6 depicts the integration of these technologies, along with the accompanying information required to utilize them effectively. Although these technologies primarily consist of exogenous knowledge, their application is driven by a bottom-up approach that benefits from endogenous knowledge. In order to fully achieve transdisciplinarity, it is crucial that the knowledge accompanying these technologies adopts a hybrid form, combining both oral and written information.

By incorporating exogenous technologies and knowledge, figure 6 demonstrates the potential for transdisciplinarity in food production systems. The integration of various disciplines beyond agriculture, such as engineering, information technology, and processing techniques, can lead to holistic approaches to address the complex challenges faced by the food production sector. This collaboration between and beyond disciplines, and the exchange of knowledge between endogenous and exogenous communities can foster innovation, resilience, and sustainability in food production systems. For example, interviewees spoke about the successful integration of various exogenous technologies in endogenous contexts. They named the use of incubators to hatch eggs (INTV-7), hermetic bag for prolonged food storage (INTV-9), herbal knowledge from India (INTV-2) or the potential of controlling bush fires by implementing knowledge from Burkina Faso (INTV-13).

### **Summarizing: tensions and opportunities between endo- and exogenous knowledge**

Interviewees negatively perceived the long-term use of fertilizers and chemicals. These agricultural applications are seen as exogenous knowledge which interrupts food production systems and can create tension between changing circumstances and tensions between farmers who employ different

knowledges in food production systems. In addition, interviewees noted that conducting academic research within endogenous context can be negatively influenced by exogenous knowledge as measurements or objectiveness may differ between cultures and that endogenous knowledge is often deemed inferior in comparison to exogenous knowledge. Nevertheless, interviewees also recognized opportunities to integrate exogenous knowledge within endogenous systems. In the domain of knowledge documentation, exogenous knowledge can help to accelerate the documentation of endogenous knowledge. Next, the implementation of exogenous technologies, accompanied with the exogenous knowledge to use them, is identified as opportunity. The bottom-up request of these technologies can help to overcome barriers for transdisciplinarity by considering endogenous contexts. These technologies can increase productivity, reduce costs and tackle diverse problems such restoring soil fertility, countering bush fires or expanding knowledge bases.



## **5. Discussion**

### **Problem statement and methodology**

The wider problem addressed in this thesis is the persistent food insecurity on the African continent and the marginalization of endogenous knowledge in addressing this issue. The research objective established is to explore the interaction between endogenous and exogenous knowledge within the domain of food production systems in the Bono East and Upper West regions of Ghana. By understanding the roles, tensions, and opportunities associated with the interaction between these knowledge systems, this thesis aims to provide a deeper understanding on knowledge integration and transdisciplinarity. Transdisciplinary approaches and engagement with local actors are proposed as means to bridge the gap between exogenous knowledge and endogenous knowledge, leading to a more inclusive and holistic approach to addressing food insecurity. This thesis employed various methodologies such as a review of prior studies, participatory observation, and semi structured interviews.

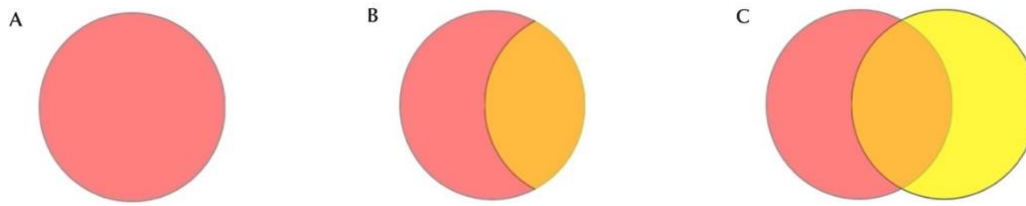
### **5.1 Implications of the results**

In the following sections, the main findings will be discussed, integrating relevant literature and interpretations to synthesize a comprehensive understanding of the topic.

#### **Transdisciplinarity and knowledge integration**

The main concepts of this thesis revolve around transdisciplinarity and knowledge integration. Transdisciplinarity involves interactions between, across and beyond disciplines and tries to understand the present world (Nicolescu, 2014). Knowledge integration is part of transdisciplinarity as it synthesizes multiple knowledge systems into one. According to Ludwig et al. (2021), transdisciplinarity can add to redefining development and innovation by means of consideration of dissimilar actors. In addition, social-environmental issues call for inclusion of situated knowledge instead of an interdisciplinary approach (Brown, Harris, and Russel, 2010). Nevertheless, there seems to be no set of prerequisites for when research is correctly applying the concepts of transdisciplinarity or knowledge integration while fully acknowledging two knowledge systems (stage C of figure 7). The identified areas within this thesis where knowledge integration can have a positive impact include knowledge documentation, implementation of exogenous technologies and the need for exogenous knowledge accompanying exogenous applications. In the examples above it can be that the researcher and interviewees lack sufficient knowledge about both knowledge systems to state that two distinct knowledge systems have been equally recognized when integrating knowledge, following the risk that knowledge integration originates from a dominant knowledge system (Stage B of figure 7).

**Figure 7:** *Different knowledge integration scenarios by Ludwig and El-Hani (2020)*



However, transdisciplinarity can substantially help to improve existing practices when carried out correctly as dissimilar actors and knowledges can strengthen each other. The role of knowledge integration can help promote knowledge documentation by providing accessibility to endogenous knowledge. In addition, spreading exogenous knowledge about the short - and long-term effects of exogenous applications can strengthen farmers decision-making processes. Last, exogenous technologies can, when incorporating transdisciplinary approaches, enhance endogenous food practices by decreasing labour input, increasing yields, and fastening processes.

#### **The role of land pressure on the dwindling use of endogenous practices**

According to literature, one of the main reasons causing the dwindling of endogenous food practices like crop rotation and shifting cultivation is land pressure. Although Africa is viewed as land abundant with 52% of the worlds' lasting fertile land, this fertile land is concentrated in only eight countries which are mostly affected by civil wars (Deininger et al., 2011). The other countries, like Ghana, have increasing population growths and have high concentrations of rural populations in small regions creating land constrained areas (Chamberlin et al., 2014). These countries experience land scarcity which changes dynamics of endogenous food practices. According to the literature, these changing dynamics encompass multiple factors. These factors include the increased use of exogenous applications, transitioning workforce to rural non-agricultural pursuits, migration to urban and other rural regions, and the decline in soil fertility (Bilsborrow, 1987; Headey & Jayne, 2014). In line, this thesis identified the increased use of exogenous applications and decline of soil fertility, however, the other three factors were not recognized within this thesis.

The pressure on land has a substantial impact on the soil fertility. First, smallholder farmers react to land pressure by consistently cultivating their fields all year around as smallholder farmers are stuck on one piece of land (Jayne et al., 2014). Consequently, farmers employ an increasing number of exogenous applications to maintain soil fertility. Many African based studies identify the occurrence of soil degradation arising from the increased use of exogenous applications and continuous cultivation of land, even though Jayne et al. (2014) argue that soil depletion does not necessarily result from these practices when soil is managed correctly (Stoorvogel & Smaling, 1990; Drechsel et al., 2001; Tittonell & Giller, 2013). There are two possible reasons for this difference. First, theory

assumes that fallow periods can be employed to regenerate soils. However, fallow periods cannot be employed by smallholder farmers as they would decrease yields significantly which makes smallholder farmers unable to sustain their families. Second, there might be a knowledge gap in sustaining fertility of the soil after applying fertilizer as fertilizers decrease the pH of the soil. Subsequently, soil acidification can take place which “locks up phosphorus in the soil and prevent it from being available to the plant, thereby depressing crop response to nitrogen application” (Jayne et al., 2014, p. 6). This can be the reason that interviewees complain about the long-term effects of fertilizers as they can cause soil depletion when not raising the pH value of the soil. This knowledge gap can be created by the fact that, in the past, farmers used to shift their cultivation to let soils regenerate naturally.

### **Knowledge integration**

All interviewees recognize interaction between endogenous knowledge and exogenous applications in food production systems. In doing so, they identify tensions as well as opportunities. Surprisingly, half of the interviewees are positively opinionated about exogenous knowledge and its opportunities when being integrated into endogenous contexts. This is surprising as literature is very critical regarding knowledge integration and puts forth prerequisites to integrate exogenous knowledge in endogenous contexts (Ludwig et al., 2021; Chilisa, 2016). The difference between literature and the findings of this thesis might revolve around the viewpoint of both. Research might view the integration of knowledge from a historical context in which the global South has been colonized, oppressed, marginalized, and neglected (Chilisa, 2016). Subsequently, literature may focus on the social justice aspect of knowledge integration in these contexts. On the other hand, over half of the interviewees emphasize the advantages of how exogenous knowledge can help them improve their practices, increasing yields and gaining economic advantages. In contrast to the literature, interviewees might focus on the profound impact exogenous knowledge can have on their daily lives. However, when integrating exogenous knowledge in endogenous settings, tensions arise. The tensions that were identified within this thesis regarded the use of exogenous applications without being accompanied by exogenous knowledge and the intricacies of knowledge documentation. The literature identifies general problems of knowledge integration: overly optimistic approaches towards knowledge integration as knowledge might be non-integrable, the legitimization of endogenous knowledge, and the epistemically and ontological challenges when integrating knowledge (Ludwig et al., 2021; Ludwig and El Hani, 2010; Nadasdy, 2011).

## **Knowledge documentation**

First, documenting knowledge can help strengthen endogenous populations to preserve oral knowledge as it is at the risk of misappropriation and loss (Poorna et al., 2014). In addition, next to preserving knowledge, documentation can aid to accessibility of these forms of knowledge (Balogun & Kalusopa, 2021; Swanepoel, 2008). Digitalisation of endogenous knowledge can substantially increase accessibility of knowledge. Knowledge documentation can help distributing endogenous knowledge among communities to increase food production practises. Knowledge documentation is a means to a long-term preservation of endogenous knowledge and its benefits of centuries of experimentation and knowledge accumulation (Boon & Hens, 2007). Before addressing possibilities of knowledge documentation, it is important to note that approaching knowledge documentation entails inherent risks, nevertheless, the loss or misappropriation of endogenous knowledge is an unacceptable alternative.

Initially, the risk of knowledge mining and recognizing knowledge insofar to aid western knowledge systems have to be tackled as well as the unwillingness of populations to share their knowledge (Kimmerle, 2012; Ludwig, 2016; Chilisa 2019, Boon & Hens, 2007). These problems have in common that they relate to a western centric and colonial approach of doing. To document knowledge, Eyong (2007) proposes to question elderly leaders, with use of local translators, on their identity and the shared information in their communities and its origin. Next, he suggests to document data, and share it with local communities through workshops and seminars. Last, he states the final outcomes should be taught in schools to ensure continuity. Nonetheless, this approach entails the focus on an externally led research, neglecting the needs and demands of the communities. Therefore, this thesis suggests employing a bottom-up approach that follows the needs and demands of local communities, incorporating informed consent, trust relationships, and ensuring control over the documentation and maintaining of the knowledge to endogenous populations. The suggestion below presented for knowledge documentation aligns with the findings and literature explored in this thesis, although it does not provide a comprehensive perspective on the topic. A first step to knowledge documentation would be to gather insights into the needs and demands of knowledge documentation in communities, especially targeting elders, traditional healers and farmers. If there would be a need to document knowledge, a next step would be to ask community leaders how they want to document knowledge (e.g., written, spoken, and recorded or digitalized). Following, communities should be supplied with the knowledge and technologies to achieve the aims to their means, without conditions limiting or taking over control of the process. Created knowledge bases should be made available for the regions they were created in and validated by various community members to ensure its value for communities. During knowledge documentation there should be an emphasis on the copyright/patent of the documented knowledge to combat knowledge mining as the west has often repackaged existing knowledge from Africans (Eyong et al., 2004). This approach

would combat the issues of knowledge mining by copyrighting endogenous knowledge and creates more trust to share information by approaching knowledge documentation from communities and their leaders. The study of Balogun and Kalusopa (2021) on digital knowledge documentation in South-Africa found that long-term preservation of knowledge comes with issues such as “technological obsolescence, lack of awareness, financial sustainability, policies, legislation, politics, security, and privacy.” (Balogun & Kalusopa, 2021, p. 660). Because of the long-term risks of knowledge documentation, governmental action is needed to support bottom-up approaches to ensure the sustainability of these practices (Eyong, 2007). Subsequently, there should be advocated for knowledge documentation and its advantages regarding biodiversity, preservation of knowledge, and endogenous farming practices for endogenous populations towards governments.

### **Exogenous applications unaccompanied by exogenous knowledge**

All interviewees are positively opinionated about endogenous knowledge in farming practices and often utilized organic ways of farming. They raise concerns about the effects of exogenous applications in forms of fertilizers and chemicals. However, neighbouring farmers often do not employ organic ways of farming and implement exogenous applications extensively. The difference between both groups in the utilization of exogenous appliances may lie in a knowledge gap between both groups and market differentiation.

First, all interviewees relate in some way to NGO's, external influences, or academic education which all emphasise organic ways of farming. For example, interviewees in Forikrom hold close ties with Abrono Organic Farmers Association (ABOFAB), a local NGO which supports organic farming and is led by a sub-chief of Forikrom. Another example is that two interviewees went abroad to farming universities which taught to employ organic ways of farming and the negative long-term effects of the modernization of agriculture. In addition, two interviewees worked for foreign NGO's which focus on organic farming. In contrast, neighbouring farmers might not be related to these influences which makes them dependent on endogenous knowledge which was obtained by generational knowledge transfers. These transfers may not include the long-term effects of exogenous applications as they were introduced in 1972 without education about their use. Therefore, these farmers might be positively opinionated about the use of exogenous applications as they have positive short-term effects as they increase yields and income. Another problem is that exogenous applications are not effectively accompanied by exogenous knowledge on the use of these applications. To tackle the knowledge gap between farmers, oral communication channels such as radio or television can be used to address the effects of exogenous applications. According to May et al. (2007), agricultural knowledge regarding exogenous applications is highly relevant for small-scale farmers to enhance and maintain their farming activities. In addition, social media or phone related communication may help to address the knowledge gap between interviewees and neighbouring farmers (Iacoella et al., 2022).

In addition, Ajani (2014) states that public institutions should be engaged for distributing agricultural information to farmers to facilitate in their decision-making processes.

Another cause for the disparity in use of exogenous applications between interviewees and neighbouring farmers might revolve around the absence of market differentiation of organic and non-organic produces. Half of the interviewees spoke about that markets do not employ differences in pricing for organic or non-organic produce. Although non-organic produces expire quicker and may have negative influences on health as well as their negative effects on soils, their prices are not differentiated from organic produces. Over half of the interviewees, in line with the literature, explain that endogenous practises improve climate resilience, biodiversity and soil fertility (Agrawal 1995; Danielsen et al., 2007; Burgess, Jensen, & Pirhofer-Walzl, 2010; Rist et al., 2011; Farhan Ferrari, de Jong, & Belohrad, 2015; Hansen et al., 2019; Tengö et al., 2021). Although the economic impact of organic farming is not explicitly addressed in the literature being referenced, its role becomes apparent when considering the reasons behind choosing organic or non-organic farming methods. Income can be generated quicker when employing non-organic ways of farming as utilizing exogenous applications requires less labour than organic ways of farming. This might be a reason for neighbouring farmers to employ non-organic ways of farming compared to interviewees of this thesis. Attempts are being made to establish market differentiation by local initiatives. For example, INTV-10 was piloting three marketspaces which establish different pricing between organic and in-organic produces.

## **5.2 Limitations of the research**

The main limitation of this thesis are the multiple risks associated with western academic research in the context of endogenous populations. For example, Ludwig and El Hani (2020), Ludwig et al. (2021) and Kimmerer (2012) conclude that endogenous knowledge is often used to fit the context of exogenous knowledge or research, resulting in knowledge mining. To avoid knowledge mining, this thesis employed different methods. First, this thesis tried to be culturally sensitive through including elders, locals, African worldviews and validating interview scripts with local guidance. In addition, interview transcripts were shared with interviewees, and results will be shared with interviewees as well. Last, during the writing process of this thesis, sources were explicitly checked on background of authors, past works and nationality to ensure an inclusive view on the topic.

Second, most interviews were held in English and otherwise guided by an interpreter. Although this quickened the research process, interviewees might not have been able to fully express themselves without speaking their native language. Connotations or interpretations to the meaning of their words can have been missed or misinterpreted.

Zooming in on the process of data collection, one of the interviewees (INTV-10) criticized the guidance of ABOFAB during the thesis. According to INTV-10 it would bias the results negatively because of the position of the sub-chief in the community, who also has a position in ABOFAB, and is a strong advocate for organic agriculture. It could be that this affected the results of the thesis with interviewees in Forikrom. Nevertheless, Millar (2014) explains that accepting local guidance of local leaders during research ensures that “information collected will be in the interest of the community, thus respecting traditional intellectual property rights.” (Millar, 2014, p. 643).

During data analysis, the process of coding consisted of identifying themes, creating code groups and categorizing them to answer research questions. Nonetheless, the process carries subtleties regarding applying codes. For example, the use of code labels ‘exogenous knowledge’ and ‘endogenous knowledge’ followed the definitions provided in the theoretical framework. However, judging whether knowledge is created from within or outside of rural communities brings the implication of knowing how concepts were evaluated and developed over time. When contrasting views emerge, this can lead to wrongly attributing codes. For example, in school systems the development of the curriculum, according to interviewees, was not much influenced by the west. Nevertheless, van Vliet (2023) in her report speaks about education in Forikrom as ‘rather technocratic’ and ‘promoting monocropping’ without considering endogenous ways of farming.

A minor point of discussion is that the regions of the Bono East and Upper West differ in language, climate, and number of rainy seasons which substantially affect inhabitants. Nevertheless, these differences have not been made explicit in this thesis due to its size and scope. Therefore, results may not apply to both regions equally or some tensions or opportunities might apply in varying degree in both regions.

Last, two points of discussion are the asymmetrical relationship between the researcher and interviewees and their difference in epistemology, ontology and axiology (refer to sub-chapter 3.3).

### **5.3 Recommendations for future research**

The purpose of this section is to look at how the results and conclusion of this thesis can further be implemented in the domain of food production systems and future research.

Starting, when conducting academic research in endogenous population, transdisciplinarity should be centred to combat marginalization, neglect and stigmatization of these populations in research. Transdisciplinarity helps researchers prioritize building trust, obtaining informed consent, respecting traditional intellectual property rights, and ensuring that the research benefits the communities involved. In addition, it strikes a balance between ways of communicating and different knowledge

systems. Ethical guidelines and frameworks should be developed to guide researchers in their interactions with endogenous communities.

Second, future research should aim to employ methodologies that include social justice in the form of postcolonial indigenous methods (Chilisa, 2012). For example, the interview method assumes an individualist characterization of society in which an individual ‘has’ knowledge, this characterization mostly neglects “the context dynamics in which meanings emerge, and within which they continue to exist” (Roos, 2088, p. 661). Experienced researchers in this domain could teach their skills and experience to novice researchers within the research domain of African agriculture.

Third, it is crucial to combine the practical aspects of effectively implementing transdisciplinarity and knowledge integration, as there is a perceived lack of established criteria for determining whether research is correctly applying these concepts while fully recognizing the presence of two distinct knowledge systems. Addressing this gap could assist novice researchers in navigating the application of these concepts when the need arises.

Fourth, future research can look into the interaction between endogenous knowledge and exogenous knowledge for non-organic farmers. This could provide a broader understanding of how different farming practises and knowledge systems coexist and interact in the Bono East and Upper West regions.

Fifth, when discussing interactions between endogenous and exogenous knowledge, the importance and difficulties of knowledge documentation became evident. Future research should look into how knowledge documentation can take place while ensuring intellectual property rights of endogenous populations. This could strengthen endogenous knowledge and its appliance in-country.

Last, future research should look into how to effectively incorporate exogenous knowledge when selling exogenous applications in local settings. This can increase informed decision making for farmers and help sustain soil fertility, biodiversity and enhance endogenous



## 6. Conclusion

This thesis aimed to explore the potential of knowledge integration in farming systems in the Bono East and Upper West regions of Ghana. In doing so, it addressed the gap between attempts to integrate knowledge while inadvertently marginalizing endogenous populations in the process. As a result, the following research question was formulated:

*How do different kinds of knowledge interact within the domain of food production systems in the regions of Bono East and Upper West, Ghana?*

Based on a qualitative analysis of interviews and participatory observation it can be concluded that knowledge interactions in the Bono East and Upper West regions of Ghana are complex. The model used to analyse these interactions showed that while transdisciplinary research has the hypothetical promise to ensure a harmonious blend between endo- and exogenous knowledge. However, this study showed that while there are certainly opportunities, tensions are numerous. These tensions occur when knowledge interaction takes place with an overemphasis on endo- or exogenous knowledge or when power imbalances are created between knowledge systems. To address these tensions, it is essential to acknowledge and value both knowledge systems equally, prioritize the leadership of endogenous populations, and undertake efforts to decolonize academic research. Subsequently, if these tensions are to be overcome, opportunities occur in the domains of knowledge documentation, use of exogenous applications such as fertilizers and chemicals, and implementation of exogenous technologies. In turn, these could improve the preservation and accessibility of endogenous knowledge, strengthen farmers' decision-making processes, and add value to endogenous practices by increasing yields, fastening processes and decreasing labour.

This study makes a contribution to the academic field by shedding light on the complexities of knowledge integration in food production systems in the Bono East and Upper West regions of Ghana. Nonetheless, it is important to acknowledge the main limitation of this study, which is the potential risk of knowledge mining and misinterpretation of words and meanings during interviews by employing western academic research in an endogenous population context. The findings of this study suggest the need for future research to establish criteria for determining the correct application of knowledge integration. This will help ensure that future research integrates knowledge of different knowledge systems in a meaningful and culturally sensitive manner.

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## Appendix A. Participant list

<b>INTV number</b>	<b>Region</b>	<b>Gender of main interviewee</b>	<b>Age range</b>	<b>Number of people engaged in interview (excluding interviewer)</b>
1	Tamale	Male	30-40	1
2	Upper West	Male	35-45	1
3	Bono East	Male	30-35	2
4	Bono East	Female	12-16	20
5	Bono East	Female	30-40	3
6	Bone East	Male	30-35	1
7	Bono East	Male	30-35	3
8	Upper West	Male	65-70	8
9	Bono East	Male	60-70	3
10	Bono East	Female	30-35	3
11	Upper West	Male	25-30	1
12	Bono East	Male	65-70	3
13	Upper West	Male	60-70	1

## Appendix B. Questionnaire set-up

### Introduction

This interview will be conducted for my master thesis for Wageningen University (the Netherlands). The topic of my research relates to different kinds of knowledge which are used in food production systems in Ghana. There are no wrong answers, and you are not obliged to answer any question. When answering questions try to relate to food production systems in which you are situated. If you have any topics that come up during the interview, feel free to elaborate on them. Do you mind if I record the session so that I can later recall what we talked about? Do you have any questions before we begin?

### Part 1

**Objective: To create a trustworthy dialogue between the interviewee/interviewer and to establish a base from which knowledge was obtained/exchanged**

Initial question	Follow up
Introduction	Whatever might come up
What is your profession?	<p>What motivated you to become [profession]?</p> <p>What was the process of becoming/how did you become [profession]?</p> <p>(if applicable) If you compare your work with that of your parents, how do they correspond/differ?</p>
If you would speak to a layman about your work, what would you think would be the most important thing(s) to tell?	
Could you describe a regular day of your life or can you describe what you did yesterday?	<p>Who do you talk to mostly during a regular day?</p> <p>What for?</p>

## Part 2

**Objective: To see what different kinds of knowledge are in place in Ghana**

<b>Initial question</b>	<b>Follow up</b>
Where did you grow up?	How was growing up here?  What were the things taught to you at a young age? By whom?
Did you receive any kind of formal education? (go to school?)	In Accra I saw billboards of scholarships with an English teaching program.  In what language was the education you received?  What would be your preferred language in school? Could you explain that?  What language did or do your parents speak?
What are stories/anamchechem told to you about local/traditional food when you were young?	What stories were you told about food related topics?
Were there differences with what you were taught in school and with your upbringing? (related to food systems or indigenous ways and western ways)	Could you tell me about them and how you felt about that?
Has there been a person in your life that you hold high?	What do you think are the most important insights/lessons you learned from that person?

### Part 3

**Objective: To see how knowledge integrates within the participants life and see the use of different kinds of knowledge**

Initial question	Follow up
<p>Have friends of yours, or yourself, lived abroad?</p> <p>For farmers: regarding food production systems, techniques, information, adapted</p> <p>For others: regarding indigenous knowledge and 'other' knowledge</p>	<p>Did they return to Ghana?</p> <p>Were there ideas they brought with them/ you thought about differently when you/they came back?</p> <p>How come you or that friend thought about those things differently, how did people around you/him/her receive these ideas?</p> <p>What struck you most about how they lived at the other place/what he/she told you?</p>
<p>During the ALI training we talked about 'decolonizing minds in food systems', what topics do you think should be decolonized in food production systems (only for ALI participants)</p>	<p>Why? How did you view this before the training?</p>
<p>In your opinion, has traditional/indigenous knowledge changed regarding food production systems over the past decade(s)?</p>	<p>Why do you think that changed? What do you think of that change?</p>
<p>What traditions do you think should be preserved?</p>	<p>Why?</p>
<p>What are the main differences between generations (e.g. youth and elders) in the practise of your profession?</p>	<p>How come that these differences are there?</p> <p>What is your opinion on these?</p>



#### Part 4

**Objective: To discover barriers and opportunities when different knowledge systems interact**

<b>Initial question</b>	<b>Follow up</b>
Are their topics that you and your colleagues of [profession] think differently about?	How come you differ in opinion?  Do you talk about these differences? What do you talk about in those cases? How do these talks go?
Are their friends of yours that are also [profession]?	What are the similarities and differences with your practise?
What things do you struggle with on your farm?	Are there solutions for these problems? Have you tried them? Why or why not?
Are there any things you would like to do differently in 10 years?	
Could you tell me how the cycles works for (indigenous food and non-indigenous food) from planting to harvesting and what the plant needs/barriers you encounter?	

#### Part 5

**Objective: How does knowledge transfer within the participants life**

<b>Initial question</b>	<b>Follow up</b>
What are you proud of in your community?	Why?
Are there any proverbs related to food productions systems?	Could you explain what they mean for you?
How do you transfer knowledge to the next generation?	What are your most important messages?
Are there still things that you would like to express?	
Is there someone else that I should really talk to?	How can I reach them?

At the end: ask whether their names can be used or whether the data should stay anonymous, also whether they want a transcript of the interview and if they want to change anything afterwards. When they speak about neighbours or family ask whether consent from them is needed as well.