

Cultivating the seeds of change: how intersectional identities are embedded in the spread of Zero Budget Natural Farming in Andhra Pradesh, India



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Abstract

This research set out to investigate how gender and economic class were embedded in Zero Budget Natural Farming (ZBNF) practices and their livelihood outcomes in Andhra Pradesh, India. Andhra Pradesh is characterised by any aspects of the agrarian crisis and as a response to these problems adopted the agroecological practice of ZBNF. I applied the sustainable livelihood framework in combination with intersectionality during this research. In addition, I investigated several steps of the research on different scales of analysis to unravel otherwise hidden (power) dynamics.

The methods used consisted of semi-structured interviews with ZBNF farmers and experts. Additionally, participatory rural appraisal methods have been used during women's self-help groups. At last, participant observation was used to create a more complete image of ZBNF in Andhra Pradesh. The research was executed in the Tenali and Madakasira regions of Andhra Pradesh, which have distinct agroclimatic and socioeconomic characteristics.

The results showed that on a household level, livelihood capitals consisting of indigenous cows, social capital and land ownership/tenancy affected the adoption of ZBNF practices nuancedly. Improving health, cutting cultivation costs and improving soil health were the primary motivations for adopting ZBNF practices. Zooming in showed that women had different livelihood capitals compared to the household level. Women's self-help groups appeared to increase knowledge of ZBNF practices, providing financial and physical capital. However, no evidence was found that these individual livelihood capitals consistently translated into adopting ZBNF. The double time burden of women (especially from the low economic class) might hinder translating individual livelihood capitals into ZBNF adoption. Additionally, intra-household work division and decision-making did not change after adopting ZBNF practices. At last, ZBNF farmers perceived changes in household livelihood outcomes such as improved well-being, especially health, cultivation cost reduction, improved soil characteristics and decreased vulnerability to external shocks. However, the well-being of women from a lower class might be affected differently due to the increased workload associated with ZBNF.

Concerning the broader field of agroecology, this research has found some evidence for its transformative aspects confronting industrial (inter) national food systems. It showed how intersectional identities are embedded in multiple aspects of ZBNF, such as intra-household decision-making and women's involvement in agriculture. At last, this research shows the usefulness of investigating sustainable livelihood from multiple levels of analysis, unravelling otherwise hidden (power) dynamics.

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చాలా ధన్యవాదాలు,

Joris Holleman

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Chapter One: Introduction

Green revolution technologies found their way to India, gradually implemented during the 1960s to respond to food scarcity and food aid dependency (Lerner, 2018). After this first wave of agricultural intensification, liberalisation of the Indian agricultural sector was promoted during the 1990s introducing international market dynamics and cash crops (Eashvaraiah, 2001). Although yields increased and dependency on food aid decreased, this intensified and commercialised way of farming has been identified as the cause of a deepening agrarian crisis in India (Dorin, 2020). The crisis expresses itself in a plethora of ways, such as land erosion (Bhattacharyya et al., 2015), health problems (Tudi et al., 2022), high rates of indebtedness and farmer suicides (Khadse & Rosset, 2019; Kennedy & King, 2014).

When zooming in, Andhra Pradesh faces several major problems associated with the agrarian crisis. It is the state with the second-highest percentage of males and the highest percentage of females who are in debt compared to the other states in India (Ministry of Statistics and Programme Implementation, 2023). The state is highly dependent on nitrogen chemical inputs and faces issues with water shortage (Veluguri et al., 2021; 2019). Chemical farming practices in this state have been associated with high rates of farmer suicides and multiple health issues, such as stunted children (Veluguri et al., 2021).

To mitigate these adverse effects, agroecological practices are promoted as a sustainable and equitable alternative to the current food systems. Agroecology is a broad concept trying to bring sustainability to all parts of the food system. This is done through a holistic approach towards agriculture, considering many disciplines and forms of knowledge. It is transformative and tries to address the politics and inequalities of the food system (Gliessman, 2018; Isgren, 2016). Agroecology has entered the policy arena by offering high productivity, environmental resilience and economic opportunities (Altieri et al., 2011). Agroecological practices also resulted in a more diverse diet and higher food security for farmer households (Madsen et al., 2021).

However, since the concept of agroecology is broad, multiple outings are tailored to specific contexts. Zero Budget Natural Farming (ZBNF) is one of these outings, which aims to dramatically reduce input costs by cutting all agricultural loans and eliminating external synthetic inputs (Bharucha et al., 2020). The grassroots movement originates in several groups of (rural) people and is often associated with Guru Palekar's teachings (Khadse & Rosset, 2019). As of late, the potential of ZBNF has been noticed by the government of Andhra Pradesh and is becoming increasingly institutionalised (Khadse & Rosset, 2019). The Indian state adopted ZBNF as a major agricultural framework and aims to convert six million farmers in the upcoming years.

To achieve this goal, the government of Andhra Pradesh has appointed the Rythu Sadhikara Samstha (RySS), a not-for-profit organisation, as the executive body. The RySS programme is the successor of previous initiatives aiming to transition farmers towards more sustainable livelihoods

addressing the many problems faced due to the agrarian crisis (Bharucha et al., 2020). ZBNF adoption has been associated with a reduction of production costs (Koner & Laha, 2021), increased soil fertility (Saharan et al., 2023), increased mental well-being and absence of high input costs (Meek & Khadse, 2022), absence and presence of a yield drop (Duddigan et al., 2022; Koner & Laha, 2021).

A key role in the spread of ZBNF principles is given to the so-called women's self-help groups. These groups are part of an earlier established development programme striving to empower women. Each group comprises ten to fifteen women who live nearby and come from comparable economic and ethnic backgrounds (Sato et al., 2022). Key aspects of the programme include economic empowerment and poverty reduction (Deininger & Lui, 2009). In 2011, the National Rural Livelihood Mission started cooperating with self-help groups to address rural poverty (Finnis, 2017; Desai & Joshi, 2013). Moreover, self-help groups aim to establish improvements for women in the social, political and community domains (Kumar et al., 2021; Kalra et al., 2013).

Andhra Pradesh has an extensive network of self-help groups, with the first groups dating back to 1979 and currently reaching 90% of rural households (Galab & Rao, 2003). RySS employees attend the existing women's self-help groups to distribute information about ZBNF (Khadse & Rosset, 2019; Galab et al., 2022). In contrast to mainstream agricultural programmes, the RySS stresses the importance of participatory learning. The goal is to achieve the so-called 'co-creation' of knowledge where participants arrive at context-specific knowledge through discussion and comparison in contrast to top-down, one-way expert knowledge distribution (Kumar et al., 2021).

Considering the importance of women's self-help groups within the programme, it is important to establish how women's livelihood assets have been shaped through self-help groups. The next step is to establish if and how this livelihood capital enables adopting ZBNF practices. Another reason for focusing on women is that they are important for the livelihoods of agricultural households, spending 32% of their time at the farm engaging in activities such as weeding, transplanting and harvesting (FAO, 2011). More recent evidence suggests that their agricultural involvement is increasing, a phenomenon named 'the feminization of agriculture' (Pattnaik et al., 2018; ILO, 2016). Although women increasingly work in agriculture, their decision power remains limited (Goudappa et al., 2012). In contrast, women's decision power increases with higher education levels and male farmers' outmigration (Pattnaik et al., 2018; Farnworth et al., 2021).

Another important aspect of the programme is the inclusion of the Poorest Of the Poor farmers (POP). These farmers have low socioeconomic status, do not possess land, and are often from a low social class or caste (Khadse & Rosset, 2019). These people are actively targeted to convince them applying ZBNF practices. Although doubts exist about the effectiveness of pro-poor policies based on civil society organisation in agricultural reform programmes, the programme reports a higher degree of marginal and tenant farmers than non-ZBNF farming (Galab et al., 2022; Brown, 2016).

This research focuses on three core aspects derived from the above-described dynamics (see Figure 2 for the conceptual model). The first is what household livelihood capitals make it easier to

adopt ZBNF practices. In addition, motivations for why farmers have adopted ZBNF practices are investigated. This provides insight into what factors are important for adopting ZBNF practices. In the later stages of the research, these findings will be linked to how women's livelihood capitals shape household livelihood capitals' availability and motivations for ZBNF adoption. The second core aspect describes how women's self-help groups have affected the women's livelihood capitals. To investigate if and how women's livelihood capital translates into adopting ZBNF practices, intra-household labour division and decision-making are investigated. This aspect is key to understanding if the strategy of spreading ZBNF practices through women's self-help groups is effective in scaling up agroecology in Andhra Pradesh. The third core aspect discusses the impact of ZBNF practices on livelihood outcomes. This last step is key to understanding if farmers perceive agroecological practices as a viable alternative to the industrial and input-intensive agricultural system.

The analysis is done on various levels to reveal otherwise hidden (power) dynamics on a smaller scale than the household level. An example is how women's self-help groups have affected women's livelihood capitals, which requires an analysis on the personal instead of household level. A more comprehensive image of the programme is created by including multiple levels of analysis. Regional context and intersectional inequality are relevant across all stages of the research, and both will be discussed when applicable. I will try to answer the following research question and sub-questions with this approach.

How are inequalities of gender and economic class embedded in the dissemination of ZBNF and its livelihood outcomes in Andhra Pradesh, India?

1. What household livelihood capitals enable the adoption and practice of ZBNF?
2. What are the motivations of households to adopt ZBNF?
3. How have self-help groups affected women's livelihood assets concerning ZBNF practices?
4. What is the role of women, intersected with socioeconomic class, regarding livelihood activities and decision-making within farmer households?
5. How do ZBNF practices affect the household livelihood outcomes of ZBNF farmers?

While intersectional inequalities are fundamental to agroecology, limited research exists analysing the impact of practices on farmer household livelihoods through an intersectional lens (Bezner Kerr et al., 2022). Intersectional lenses are applied in agricultural research (see Ravera et al., 2016; Leder et al., 2019), but to my knowledge, no such research has been performed investigating intersectionality within a rural agricultural development programme such as ZBNF in Andhra Pradesh. Additionally, the research will enrich existing literature by identifying drivers for the scaling of agroecology (for example, Mier y Terán et al., 2018).

On a methodological level, this research links intersectionality and sustainable livelihoods, which is, to my knowledge, seldom done. Concerning the broader field of international development, this combination of intersectionality, the SLF and multiple levels of analysis could serve as inspiration

to overcome the weaknesses associated with the widely used SLF.

The social relevance of this paper lies in the deepening agricultural crisis taking shape in multiple parts of India and the world (Dorin, 2020). It is essential to investigate what strategies alternative forms of agriculture use to come to scale so its potential to transform livelihoods can be realised. It is equally important to understand how agroecological practices affect the livelihoods of farmers to see if it addresses the problems associated with the industrialised and input-intensive food system (Khadse et al., 2018; Koner & Laha, 2021; Meek & Khadse, 2022). This research shows how female household members disseminate ZBNF practices while, on the other hand showing the impact of ZBNF practices on household livelihoods. In effect, this research could contribute to understanding if and how agroecological practices can be an answer to the agrarian crisis.

To answer these questions, I will introduce the Andhra Pradesh region and ZBNF. Second, I will introduce the applied theories and their critiques. Moreover, I will provide an overview of existing research surrounding ZBNF and intersectionality in Indian agriculture. Third, I will introduce my conceptual framework and methodology. Subsequently, results are discussed with one chapter per sub-question. The last phase of this paper comprises the discussion section, where results are placed in the context of other research regarding agroecology. At last, I will answer the research question, make policy recommendations and discuss opportunities for further research in the conclusion.

Chapter Two: geographical contextual framework

In the following section, I will elaborate on the context of this research. First, the agroclimatic characteristics of Andhra Pradesh will be discussed. Second, the origins and principles of ZBNF will be discussed.

Description of Andhra Pradesh

Andhra Pradesh is located on India's east coast, spanning 163,000,000 hectares. Its population contained 49.6 million inhabitants in 2011, with 997 females per 1000 males. Most of the population lives in rural areas (35 million) compared to urban areas (14.6 million). Agriculture is the state's most important sector, making up 25.4% of the total gross added value. 44.71% of the state's surface is in agricultural production, of which 52.3% is irrigated. 62.2% of the working population depends on agriculture and its related activities.

The state has a mean precipitation of 966 millimetres. The rainfall is spread over the year showing maximum average precipitation during monsoon (June to September) (556 millimetres) and minimum rainfall during winter (January to February) (15.7 millimetres). Due to the state's considerable acreage, precipitation differs between different regions. The coastal regions generally have an average rainfall of 1078.2 mms, while the inland Rayalaseema averages 714.1 mms yearly. The state is divided into six agroclimatic zones,¹ of which the Krishna and Godavari zone are irrigated, while the High-altitude, Northern, Southern and Scarce rainfall zone are rain-dependent (Galab et al., 2022). For specific information about the study areas, see 'sample regions' in chapter three.

Cereals and millets cover the largest amount of agricultural land with (2,894,000 ha), followed by pulses (1,251,000 ha), then fruits and vegetables (1,089,000 ha), then other crops² (981,000 ha) and at last, oilseed crops (853,000 ha). Land holdings are divided into five categories, 1) Marginal landholders, up to 0.99 ha; 2) small landholders, 1-1.99 ha; 3) semi-medium 2-3.99 ha; 4) medium 4-9.99 ha and 5) large 10 + ha (see table 5).

Size class	Number of holdings (x1000)	Percentage of total holdings	Average size (in ha)	Percentage of the total area
Marginal	5094	69.3%	0.4	29.2%
Small	1646	19.3%	1.4	29.1%
Semi-medium	770	9%	2.6	25.2%
Medium	189	2.2%	5.5	13%
Large	15	0.2%	18.7	3.5%

Table 1: Average agricultural land sizes in Andhra Pradesh (revised from AP-DES, 2019)

¹ High-altitude zone, North Coastal, Southern Zone, Scarce Rainfall Zone, Godavari Zone and Krishna Zone

² Chillies, cotton, tobacco and sugarcane

What entails ZBNF?

ZBNF's origins are often linked to guru Subhash Palekar who arrived at a set of agroecological practices for sustainable agriculture. Palekar noticed how the green revolution and liberalisation of the food market negatively affected farmers. The intensified and chemical-dependent agriculture has been associated with, amongst others, high suicide rates (Kennedy & King, 2014; Dandekar & Bhattacharya, 2017), land erosion (Bhattacharyya et al., 2015) and health problems (Tudi et al., 2022). As a response to this 'exploitative system', he proposed a new set of agroecological practices substituting external (synthetic) inputs with inputs that could be created with the available resources on the farm (for practices, see Table 6).

These practices attracted the interest of the peasant group Karnataka Rajya Raitha Sangha in Karnataka which started to organise workshops spreading the practices of Palekar. These workshops came when the adverse effects of the green revolution and liberalisation of the food market became increasingly evident. The practices taught during these workshops aimed to reduce dependency on transnational corporations and to farm in harmony with nature (Khadse & Rosset, 2019). Both aims were achieved by eliminating the need for external synthetic chemicals and agricultural credit (Bharucha et al., 2020).

Wheel and practices	Intended impacts
<i>Jivamrita</i> : This is a mixture of fermented microbial culture made from cow dung, soil, pulse flour and jaggery (local brown sugar).	Improve soil conditions <ul style="list-style-type: none"> - Enhances the microbial activity - Provides nutrients to the soil - Increases earthworm activity - Preventing fungal/bacterial plant disease.
<i>Bijamrita</i> : A seed treatment based on cow urine/dung and soil.	Protecting seed and early roots <ul style="list-style-type: none"> - Protection from soil-borne and seed-born diseases
<i>Acchanda</i> : Mulching comes in three forms 1) Soil mulching (avoiding tillage), 2) straw mulching, 3) live mulching (using living crops)	Improving (top) soil <ul style="list-style-type: none"> - Increasing organic matter - Promoting aeration and water retention - Increasing soil activity
<i>Whapasa</i> : increasing soil aeration and irrigating only at noon	Reducing the need for irrigation and decreasing total water use.

Table 2: ZBNF practices (revised from *La Via Campesina*, 2016)

ZBNF in Andhra Pradesh

ZBNF attracted attention from several Indian states facing similar issues. Andhra Pradesh has been one of these states adopting ZBNF as a central pillar of the state government's agriculture development plans. It is not executed by the government directly but through the non-profit organisation Rythu Sadhikara Samstha (RySS) (Bharucha et al., 2020). The RySS aims to convert six million farmers to ZBNF, while current estimates report that 630,000 farmers practice ZBNF (RySS, n.d.). The programme consists of nine universal principles, namely 1) soil is crop covered for 365 days a year, 2) use of indigenous seeds, 3) multi-cropping (15-20 different crops), 4) integration of farm animals, 5) use of botanical extracts to control pests 6) increase of organic residues in soil 7) no use of synthetic fertilisers, pesticides and herbicides 8) biostimulants as catalysts for soil fertility, for example jivamrita (see Table 6), 9) minimal disturbance of soil, for example, limiting tillage (RySS, 2023a).

Over the years, the ZBNF practices of Palekar and the practices promoted by the RySS started to diverge. While original ZBNF principles, as shown in Table 6, are still a significant part of the promoted ZBNF in Andhra Pradesh, several other principles have been adopted. These contain principles from other disciplines which sometimes contradict the teachings of Palekar (Veluguri et al., 2021). This divergence of concepts led to the renaming of Andhra Pradesh ZBNF to Andhra Pradesh Community Natural Farming (APCNF), while Palekar renamed its agricultural approach 'Subhash Palekar Spiritual Farming' (Veluguri et al., 2021). Due to the overlap and conceptual reputation of ZBNF in scientific literature, I will use the term ZBNF.

Key within ZBNF in Andhra Pradesh is building a supportive network of actors such as other farmers, practitioners and farming trainers (Bharucha et al., 2020). The spread of ZBNF is arranged decentral, providing a pivotal role for farmer-to-farmer learning through practical training called farmer field schools and female self-help groups (Bharucha et al., 2020). The RySS utilises the women's self-help groups already present in Andhra Pradesh as a primary way of distributing knowledge of ZBNF in Andhra Pradesh.

The women's self-help groups in Andhra Pradesh result from earlier established development programmes of several NGOs and the state government. These programmes date back to the 1980s and were initially used for poverty alleviation through micro-credit schemes (Galab & Rao, 2003). Over time the aims of women's self-help groups diversified, taking up themes such as empowerment. The women's self-help groups have been part of the National Rural Livelihoods Mission, trying to 'improve livelihoods of poor rural people and boost the rural economy' (Kumar, 2021). In 2011, 90% of rural households in Andhra Pradesh were part of women's self-help groups of the National Rural Livelihoods Mission.

Chapter Three: theoretical framework

During this chapter, I will discuss the theoretical foundation of this research and link them to the available research. First, I will define agroecology and how it links with ZBNF. Second, I will discuss the sustainable livelihood framework (SLF) and its weaknesses. Third, the concept of intersectionality will be discussed and linked to the SLF. At last, the theoretical concepts will be placed into the existing literature discussing gender roles and livelihood outcomes of ZBNF.

A history of agroecology and its fields of influence

The concept of agroecology originated in the 1970s/80s when scholars of agriculture and ecology found that they shared similar interests. Two sidenotes must be placed by this statement: 1) agroecology as a concept is relatively new, and its practices are as old as agriculture itself (Hecht, 1995); 2) although the term came into existence around the 1970s/ 80s, some of the ideas date back to the 1930's (Francis et al., 2003).

The starting point for agroecology was the idea to link the studies of agriculture to the discipline of ecology. Scholars focused on the interrelatedness of organisms within an ecosystem viewing agriculture as an ecosystem (Hecht, 1995; Gliessman, 2018). This was a more ecological view of agroecology that tried to find natural ways to improve agricultural production. During this phase, it was often seen as a response, resistance or alternative to the changes caused by the green revolution, which was characterised, among others, by monocultures and industrialisation (Hecht, 1995; Gliessman, 2018).

Seeing agriculture as an ecosystem where all organisms are interrelated and dependent on each other also relates to sustainable agriculture. Sustainability within agroecology partly came from environmentalism's influence in the 1960s and 1970s (Hecht, 1995). Environmentalist scholars argued for the minimalisation of disruption within ecosystems. Hecht (1995) explains how this idea was later applied in agriculture, which was mainly concerned with the (in) direct of toxins such as pesticides and insecticides on the environment (also in the 1960s/1970s). The input of environmentalism knowledge contributed to the sustainable outlook of agroecology in defining the concept.

Another significant intellectual contribution to the concept came from the field of ecology. The ecologists of the 1960s were mainly occupied with three crucial areas related to agroecology: nutrient cycling, the relation of pests and plants and succession. For example, ecologists investigating nutrient cycles in tropical areas found that diverse species enabled each other to improve nutrient uptake. This principle was later applied in agriculture (Hecht, 1995). Although ecology did play an important role, the critique was that it was too technical, not addressing the social side of agroecology (Hecht, 1995; Francis et al., 2003).

The fourth contribution to agroecology came from the field of (rural) development studies. The scholars of this field focused on the impact of new agricultural technologies, market expansion, changing social relations and tenure/access rights on rural communities. These themes were mainly

researched in light of the green revolution causing inequalities among rural communities. By analysing the green revolution from different disciplines, the field provided the first holistic approach to analysing the rural context (Hecht, 1995). Development scholars placed the farmers and the rural community as a whole in a central place of research criticising the technology-driven developments in the rural area. This shows the broader notion of agriculture moving beyond the agricultural disciplines and introducing an interdisciplinary and holistic approach central to agroecology (Hecht, 1995).

Agroecology definition

These different disciplines all contributed to the concept. In this section, I will discuss several definitions which shaped agroecology, and last, I will describe the definition used in this research. I am aware that many definitions of agroecology exist, and in the following section, I try to assess several definitions leading up to the one used in this research. As mentioned before, agroecology came into existence when scholars of agriculture and ecology found out they had similar interests. Therefore agriculture was viewed through an ecological lens reflected in the definitions of agroecology. The early definition in the 1990s defined agroecology as follows (Gliessman, 1998, p. 13):

“agroecology is defined as the application of ecological concepts and principles to the design and management of sustainable agroecosystems.”

This definition underlines the link between the practice of ecology and agriculture. Francis et al. (2003) stated that this definition was mainly used to investigate ways to increase yields while managing agriculture for endurance and sustainability. However, quality of life was seen as a part of *sustainable agriculture systems*, thereby including a social factor in the definition. Francis et al. (2003) critiqued this definition for being too narrow, looking only at the impact of on-farm practices and neglecting the broader food systems (Gliessman, 2018). The concept of agroecology was broadened by including the entire food system, non-farmers and power structures.

Mendez et al. (2013) worked out the broadening of agroecology, which focused on the ‘transdisciplinary, participatory and action-oriented side of agroecology. Thereby including multiple disciplines and moving beyond using only scientific knowledge. These authors also introduced the term transformative agroecology, stating that it could transform the entire food system including more actors and disciplines in the field. Mendez et al. (2013) proposed to link agroecology to justice, food sovereignty, equal distribution and self-determination of marginalised groups. This way, agroecology is defined as a science and a social movement striving for change. Therefore, the definition evolved to the following definition by Gliessman (2018):

“Agroecology is the integration of research, education, action and change that brings sustainability to all parts of the food system: ecological, economic, and social. It’s transdisciplinary in that it values all forms of knowledge and experience in food system change. It’s participatory in that it requires the involvement of all stakeholders from the farm to the table and everyone in between. And it is action-

oriented because it confronts the economic and political power structures of the current industrial food system with alternative social structures and policy action. The approach is grounded in ecological thinking where a holistic, systems-level understanding of food system sustainability is required”

The definition of Gliessman (2018) underlines the importance of social change as a part of agroecology. This is the definition I will use in this research since it allows for impact beyond the farm level, which is relevant for investigating power relations embedded in the food system. I know many definitions of agroecology, but this definition is well-known and fitting for this research.

Sustainable livelihoods framework

To frame the impact of ZBNF, I opted to apply the SLF. This people-centred approach is beneficial to provide some structure to the fluidity of intersectionality, which is discussed later in this chapter. Furthermore, it applies to multiple levels of analyses, making it a good fit for the multi-levelled analysis (See methodology for further elaboration).

Origins of the Sustainable Livelihood Framework (SLF)

The Sustainable Livelihood Approach emerged from the increased attention towards sustainability and capabilities theory. It drew inspiration from the work of Amartya Sen (1981), focusing on how (available) resources translate into beneficial livelihood outcomes. Sen approached inequality from the perspective of ‘substantive freedom’, which described how people should have the freedom to lead a life they value. The capabilities describe if and how a person can achieve a life they value and depend on many aspects such as one’s characteristics, available resources, institutions and legal framework. Consequently, poverty is viewed from a broader perspective than the absence of monetary means or commodities but is defined as a lack of capabilities to realise a valued life. With this, he prioritises free choice of people to give value to their lives and steers clear from judging what values are more or less important (Stewart & Deneulin, 2002)

This is reflected in the SLF, which moves beyond only monetary assets to identify multiple livelihood assets which are inspired by the capabilities to realise a valued life. The ideas of Sen are also reflected in the livelihood outcomes, which offer a wide range of livelihood outcomes. This allows individuals to determine what beneficial livelihood outcomes are. Criticasters might mention that the SLF identifies some livelihood outcomes and judges what people value. Although this is a valid point, the SLF still introduced much more aspects of analysing development than the standard monetary indicators.

Mainstream development organisations of the time, such as the UNDP and WCED, had adopted these ideas implying that the SLA emerged from mainstream development thought present at the time (Natarajan et al., 2022). The concept ‘sustainable livelihoods approach’ emerged from these two concepts by Chambers (1995: 174) & Scoones (1998: 5):

“A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a living is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term.”

In the years after the first definition of the sustainable livelihoods approach, multiple large developmental organisations started to develop a framework based on its ideas. Scoones (1998) published a framework visualisation, revised a year later to form the SLF, which is still widely used (See Figure 1). Due to the quick adoption of the framework in its early years, it became an essential influence in development thinking, influencing major development institutions (Natarajan et al., 2022).

How does it work

A livelihood is deemed sustainable if ‘it can cope with and recover from stresses and shocks and maintain or enhance its capabilities, assets, and activities both now and in the future, while not undermining the natural resource base’ (Serrat, 2008, p.1). The SLF tries to connect people’s inherent potential and relate it to external processes and structures such as policies, institutions, seasonalities, shocks and critical trends. The model entails four major sections, utilising livelihood capitals and livelihood outcomes in this research. Although the ‘vulnerability context’ and ‘transforming structures and policies’ play critical roles in ZBNF farmer households, these trends are primarily on large scales. Since this research focuses on the (intra) household and individual levels, I will not address these themes of the SLF in depth. I am aware of the risk of underplaying the importance of macroeconomic trends, but it is beyond the scope of this research to adequately address these issues (Scoones, 2015; Natarajan et al., 2022).

The first section is capital assets which describes five different assets: human, natural, financial, physical and social. However, one must approach these categories cautiously since different capitals are interrelated and overlap. The livelihood assets have been the subject of a vibrant debate surrounding its meaning which is beyond the scope of this paper to discuss (read Scoones, 2015 p: 39-40 for an overview). It is essential to state that assets move beyond only quantifiable assets, as stated by Bebbington (1999, p: 2022):

“Assets, or what I call capitals in this framework are not simply resources that people use in building livelihoods: they are assets that give them the capability to be and to act. Assets should not be understood only as things that allow survival, adaptation and poverty eradication: they are also the basis of agents’ power to act and to reproduce, challenge or change the rules that govern the control, use and transformation of resources.”

The second theme analysed is the livelihood outcomes which describe the outputs of livelihood strategies. Livelihood outcomes comprise what degree intentional outputs are realised by the livelihood strategies. It is essential to realise that some of these outcomes compete (Serrat, 2008). Livelihood outputs include sustainable use of natural resources, increased income, improved well-being, food security and decreased vulnerability.

The two themes not explicitly utilised during this research are the vulnerability context and the livelihood strategies. The vulnerability context describes how changes external to the households or communities shape their well-being. It consists of two sides: the external side, which describes the changes, such as shocks and seasonalities, and the internal side discusses the ability to cope with these changes (Serrat, 2008; Scoones, 2015). Livelihood strategies describe how people try to achieve livelihood outcomes. Examples are outmigration, off-farm work, and agroecological practices. Since the vulnerability context relates to external trends often taking place over long periods. Since this research was performed within six months, it was beyond the scope of this research to adequately address this part of the SLF. Livelihood strategies are mentioned shortly in the form of adopted ZBNF practices but are not discussed in depth. This is done because the livelihood strategies related to ZBNF are more widely discussed (see RySS, 2023b), while livelihood outcomes require more research, especially from an intersectional perspective.

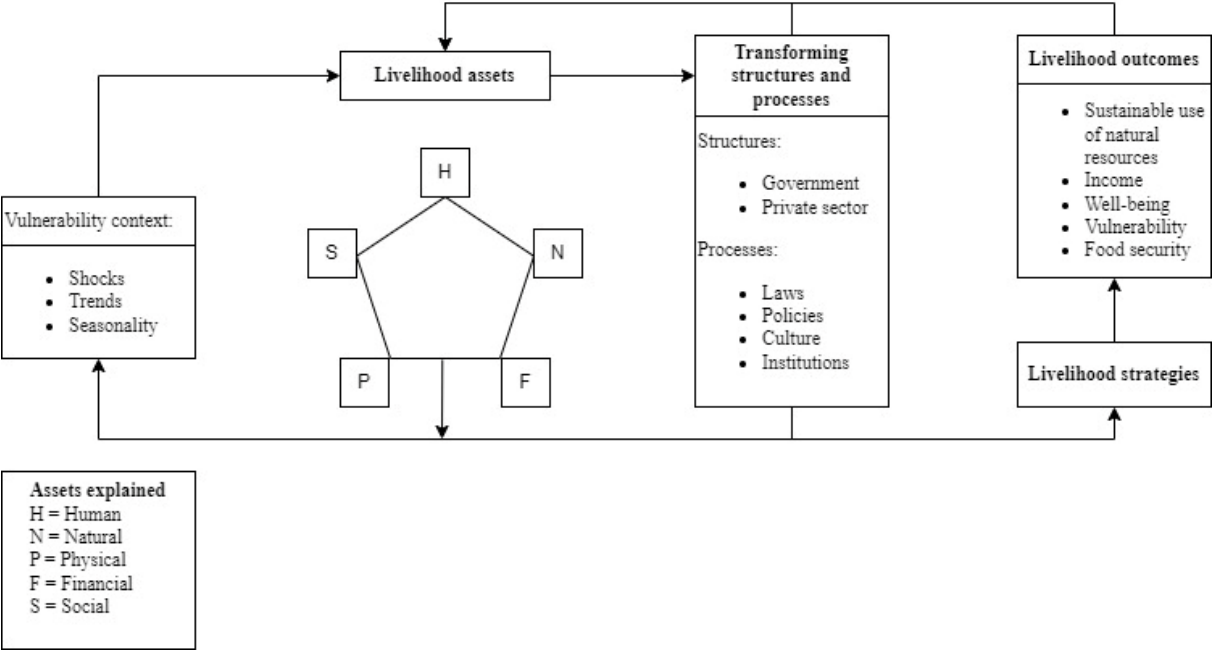


Figure 1: The SLF (redrawn from Serrat, 2008)

Critiques

Despite the immense popularity of the SLF academic critiques persist. Natarajan et al. (2022) identify five different areas of critique, which are all relevant. It is beyond the scope of this research to discuss them all, so the two most applicable themes of critique concerning this research will be

discussed.

First, the SLF has insufficient attention towards structural political dynamics and remains an extensive source of criticism (Scoones, 2015; van Dijk, 2011). While politics are present in the SLF ('transforming structures and processes'), its interpretation has mostly shifted to the analysis of policies instead of addressing structural factors like inequality, inclusion and social justice (Natarajan et al., 2022). As a result, communities are regarded as homogenous groups neglecting power relations within communities such as gender, caste and class (van Dijk, 2011). Multiple scholars have tried to overcome the bias by paying specific attention to women highlighting the underlying power structures (for example, Arun, 2012). In addition, de Haan (2012) explains how feminist theories also contributed to expanding the concept of capital. Capital can entail more than only material assets; non-material assets such as control of money and increased skills should be included.

A second critique of the SLF entails that it does not consider different scales. Through household-level analysis, relevant livelihood dynamics on different scales might be lost. An example of this loss are the gender dynamics taking place within households. Many scholars found that the different aspects of the SLF differed for men and women (see Arun, 2012; Pattnaik et al., 2018). A different way by which household scale analysis is prone to oversimplification is through the dispersed livelihoods where separate household members are not bound to one place but co-reside in different contexts. Translocality is one of the terms describing these dispersed livelihoods showing different dynamics, which would not be visible when investigating only the local household level (Schröder & Stephan-Emmrich, 2016; Schor et al., 2018).

Why SLF and intersectionality

Despite the critiques posed above, the SLF and intersectionality provide some complementary strengths. The lack, or underrepresentation, of political structures within the SLF makes it relevant to apply an intersectional lens which inherently tries to unravel power structures at play (Scoones, 2015; Else-Quest & Hyde, 2016). In turn, the vagueness or absence of intersectional methodology can profit from the structured outline and cadres offered by the SLF, providing a way to identify differences in intersectional identities. An additional advantage of utilising the SLF is that it approaches diverse livelihoods beyond economic and materialistic outlooks (Bebbington, 1999). It challenges 'expert' knowledge and values the local expertise of local knowledge. In addition, it requires a cross-disciplinary outlook considering the multi-faceted dynamics that make up a household.

Applying a multi-scale research design to incorporate both theoretical outlooks is vital. Therefore I will analyse several levels ((intra) household and individual). A multi-levelled analysis will detect different dynamics on different scales ((intra) household and individual. For example, I will investigate decision-making at the intra-household level intersecting both gender and economic class. By doing this, I hope to adequately address some of the structural power dimensions often neglected in SLF analyses.

Intersectionality

As mentioned above, I chose to include an intersectional outlook to address the weaknesses of the SLF by adding an intersectional outlook to the analysis of power relations and politics on the intra-household become visible. In addition, intersectionality requires moving beyond the household level to address the SLF's second critique.

Origins of intersectionality

The concept of intersectionality is rooted in black feminist theory distinguishing different effects of gender for different groups of women (read, for example, King, 1988; McDermott, 1998). However, the term 'intersectionality' has been coined by Crenshaw (1991), explaining how different identities such as race, gender, and class shaped the employment experiences of black women. These ideas are intricately linked with the dynamics of power, explaining how the agency is affected by different identities (Colfer et al., 2018). From here, other disciplines took the notion of intersectionality and started implementing the concept in fields beyond black feminism. This turn in intersectionality expanded the concept, including a wide range of categories of difference (Gopaldas, 2013; Davis, 2008).

Defining intersectionality

Although intersectionality has attracted significant attention from the academic world and beyond, a universally accepted consensus on its definition has not been reached (Nash, 2008). Because it is beyond the scope of this research to address the many different and sometimes murky definitions of intersectionality, I will discuss three broad agreed-upon principles (Else-Quest & Hyde, 2016). The first and foremost principle is that identity is shaped through many different and interacting social categories (Crenshaw, 1991; Al-Faham et al., 2019; Nash, 2008). These identities are entangled and cannot be seen separately (Ferree, 2008). While the initial definitions confined intersectionality to specific social categories, over the years, it expanded to different (academic) fields, leading to broadening the concept. In its current understanding, intersectionality can encompass many categories, such as physical ability, attractiveness and education (Gopaldas, 2013).

The second principle is that attached to intersectional identities, dimensions of power and inequality exist (Else-Quest & Hyde, 2016). The multi-faceted identities are rooted in structures of power and inequality; it is essential to identify and analyse them. These different power structures create and sustain privileged and underprivileged experiences (Al-Faham et al., 2019). It must be noted that the extent of focus of power structures differs. Some scholars interpret intersectionality as a way to seek diversity. Others argue that this approach depoliticises intersectionality neglecting its social inequality-remedying potential (Bilge, 2013).

The third principle is that multifaceted identities and their influence on human experiences are not only individual traits but also dependent on the different social contexts (Else-Quest & Hyde,

2016). Certain traits are beneficial in one social context while being negatively associated with other contexts. In addition, certain traits and identities might change over time, possibly resulting in different experiences. This shows the fluidity of intersectionality across contexts and time and how identities and intersectionality are social constructs (Else-Quest & Hyde, 2016).

Critiques

Since gaining popularity as a concept, intersectionality received critiques from different disciplines discussing different aspects of intersectionality. The first relevant critique is the absence of a transparent methodology investigating intersectionality (Nash, 2008). This appears to result from the lack of consensus regarding a definition of intersectionality (Rice et al., 2019). This flexibility leads to the analysis of constructed social groups, often criticised by poststructuralists as too simplistic and falsifiable (Nash, 2008). However, the lack of a transparent methodology does allow for flexibility when choosing methods. This makes the concept particularly interesting to investigate intersectional effects on different scales, which require different methods (Clarke & McCall, 2013).

The second critique relates to the gradual depoliticisation of intersectionality due to neglecting the influence of social contexts such as capitalism and neoliberalism. These grand social contexts shape and constitute how social categories are defined (Salem, 2018). For example, capitalism has shaped how racism could occur due to the transatlantic slave trade creating century-lasting adverse effects for specific social categories. When left unaddressed, the neglect of social context undermines the potential of intersectionality to advocate for 'justice advocated change' (Bilge, 2013).

Intersectionality in Indian agriculture

As described above, intersectionality has its roots in feminist theory which aims to identify the gender dynamics at play. In the following sections, I will establish several relevant gender dynamics in Indian agriculture, discussing women's self-help groups and perceived decision-making power in agriculture. Subsequently, the different social categories of women's intersectional identities will be discussed. At last, I will discuss how these themes relate to the wider discussion of gender and rural development.

Women play an essential role in agriculture, spending, on average, 32% of their time working on the farm, and this is increasing (FAO, 2011; Pattnaik et al., 2018). The term coined for this increase in women's involvement in agriculture is the 'feminization of agriculture'. Some research from other contexts suggests that women make more decisions due to higher involvement. However, this increased influence on decision-making appears to be coupled with more responsibilities, higher workload, poverty, and indebtedness (Haug et al., 2021; Srivastava & Srivastava, 2010). This has caused several scholars to rename this trend as the 'feminization of agricultural distress' (Pattnaik et al., 2018).

The second way gender plays a significant role in this research is through the importance of

women's self-help groups. Women's self-help groups play a key role within ZBNF in Andhra Pradesh, but research on its impact is, to my knowledge, non-existent. However, several scholars have investigated the impact of self-help groups in Andhra Pradesh. These scholars have primarily focused on the impact of the microcredit programme. The micro-credit programme of women's self-help groups increases access to financial and physical capital (Deininger & Liu, 2013; Raghunathan et al., 2023). However, the impact of this access to financial capital remains ambiguous. Some evidence suggests that microcredits empower women in decision-making and financial control (Kumar et al., 2021). In contrast, microcredit loans have been associated with beneficial outcomes for men who could allocate more work to self-employment, lowering the time they worked (un) paid (Basumatary et al., 2023). In addition, the empowerment of women has been identified as a cause of domestic violence (Bulte & Lensink, 2019). Meta-analyses of the effects of microcredit in women's self-help groups show that the effects are, at best ambiguous, showing no clear positive effect of microcredits (Vaessen et al., 2014; Duvendack et al., 2014).

The next step is to move beyond the aspects of gender alone and understand that women are not a homogenous group. Therefore effects of policies might differ between different groups of women. To my knowledge, no research exists investigating the role of women within ZBNF through an intersectional lens. However, some research has investigated various social categories intersecting with gender within Indian agriculture to create differentiated outcomes. The first social category which intersects with gender is male outmigration. Male outmigration is linked with increased female decision power. Females take over the agricultural tasks of the migrated male, gaining influence (Ravera et al., 2016; Pattnaik et al., 2018). In line with this, male outmigration has also been linked to adverse livelihood outcomes, including increased female labour. A second social category which intersectionality was caste. Although caste did not seem to affect intra-household decision power belonging to a higher caste reduced the presence of women in agricultural activities such as selling agricultural products on the market and engaging in fieldwork (Farnworth et al., 2022; Leder, 2022). The third social category was (economic) class, shaping women's role in farming. An important factor in economic class and wealth is the access and ownership of land. Middle-class women can access land; however, most land ownership is male-dominant amongst all classes, which appears to decrease the decision power regarding agricultural activities (Leder, 2022). Other research found that middle-class women with access to land increase their decision power over agricultural livelihood activities in some contexts (Ravera et al., 2016).

As the paragraphs above show, gender is an essential theme within rural development, receiving increased attention. Research from other contexts has linked gender dynamics to nutrition, control over assets, and leadership (Lastarria-Cornhiel et al., 2014; Dagdeviren & Oosterbaan, 2022). A central theme within rural development is the 'empowerment' of women which relates to the expansion of abilities to choose life strategies previously unavailable (Quisumbing et al., 2014). The effect of women's self-help groups on empowerment has been ambiguous (Vaessen et al., 2014;

Duvendack et al., 2014). Although agroecology aims to address unequal power relations in food systems, limited research is available on how its principles affect (different groups) of women (Bezner Kerr et al., 2022).

ZBNF Sustainable Livelihood framework

I chose to apply the SLF to structure how ZBNF practices affect farmers' livelihoods. Research investigating ZBNF all discuss topics related to livelihood outcomes. Research about ZBNF concerning intersectional identities, gender and women's livelihood capitals is, to my knowledge, non-existent. In the following paragraphs, I will synthesise the research discussing ZBNF.

The impact of ZBNF practices on income

The net income of ZBNF farmers is shaped through three different routes; the first is through the reduction of costs. This is done by eliminating all external inputs, such as synthetic chemical fertilisers and pesticides. First, farmers perceived cost reductions when switching to ZBNF, with 90.9% of the surveyed farmers reporting cost reductions, while in-depth interviews confirmed this view. In addition, all empirical evidence reports a reduction in costs ranging from 13% - 44.5%, while others report a cost reduction of 2817 rupees per hectare (31.76 euros). However, none of these studies included increased labour as a cost, while ZBNF is associated with increased labour (Laishram et al., 2020).

The second route to increased income is obtaining premium prices for chemical-free produce. Farmers across different contexts perceived receiving higher prices for their products was difficult compared to chemically farmed products (Laishram et al., 2020; Reddy et al., 2019). This is in line with the crop prices from Andhra Pradesh, showing no availability of premium prices. In contrast, 57.9% of Karnataka farmers report higher prices, while ZBNF products in west-Bengal received 1627 rupees more per hectare compared to conventional farmers (Khadse et al., 2018; Koner & Laha, 2020). The absence of specialised markets and proper infrastructure have been posed as an explanation for the different impacts (Galab et al., 2022; Laishram et al., 2020).

Third, increasing yields might raise farmers' income (Reddy et al., 2019). Alterations in yield might differ depending on the time of ZBNF practices adopted. Farmers reported that they experienced an initial yield drop in the first years after converting to ZBNF, which is in line with potential yields based on nitrogen availability in ZBNF-managed soils (Smith et al., 2020; Reddy et al., 2019; Koner & Laha, 2021). However, a crop-cutting experiment revealed no initial yield penalty when comparing vegetable yields produced chemically or through ZBNF practices. An explanation for these different results is that the research of Duddigan et al. (2022) did not include significant crops and only ran their experiment in the Kharif season (AP-DES, 2019).

ZBNF and sustainable use of natural resources

The second livelihood outcome relates to the sustainable use of natural resources by increasing soil health. ZBNF practices impact soil health through moisture content, earthworm abundance, nutrient availability and microbial activity. First, mulching positively affects the earthworm population, indicating healthy soil biology and increasing soil moisture content (Duddigan et al., 2023). The effects of ZBNF practices remain ambiguous. Smith et al. (2020) report a potential decrease in available nitrogen, contrasted with two other crop-cutting experiments (Duddigan et al., 2023; Saharan et al., 2023). Other nutrients, such as phosphorus and several micronutrients,³ were equally or more present when comparing ZBNF plots with chemically farmed plots (Duddigan et al., 2023; Saharan et al., 2023). Differences in results can be explained by the time an experimental site was under ZBNF conditions. While Saharan et al. (2023) use experimental sites already under ZBNF practices, Duddigan et al. (2022; 2023) do not specify this in their research. This might be a possible explanation when considering that soil needs to adapt to agroecological processes (Ponisio et al., 2015). At last, applying Jeevamrita is associated with an increase in the diversity of microbes and genetic material in the soil which in turn is associated with increased yields and plant growth (Bargaz et al., 2018).

The effect of ZBNF on well-being

Since ZBNF arose partially as a reaction to the high levels of farmers' suicides, it actively tries to enhance farmer well-being (Veluguri et al., 2021; Kannuri & Jadhav, 2018). The stress related to high degrees of indebtedness caused many suicides in India (Kennedy & King, 2014). ZBNF is supposed to lower stress levels by eliminating the need for costly external inputs and reducing debt associated with decreased farmer distress (Meek & Khadse, 2022). In line with this finding, 51-60% of ZBNF farmers reported increased happiness/stress reduction (depending on different seasons) (Galab et al., 2019). To my knowledge, little further research exists on the impact of ZBNF on the well-being of farmers (Weiler et al., 2015).

³ Zinc (Zn), iron (Fe), copper (Cu), manganese (Mn)

Chapter Four: Methodology

In the following chapter, I will elaborate on how I performed this research based on three main sections. The first is the introduction and explanation of the conceptual framework, which is linked to the five sub-questions. The second section will discuss the methods used, while the third section entails the limitations and positionality. These sections are all in place to describe how the following research question will be answered:

How are inequalities of gender and economic class embedded in the dissemination of ZBNF and its livelihood outcomes in Andhra Pradesh, India?

Conceptual model

To investigate the research question, I created a conceptual model to investigate the different aspects of this research. The conceptual model is split into three parts. The first is the household livelihood capitals and motivations that enable the adoption of ZBNF. The second stage discusses the livelihood capitals of women and their role in agricultural work and decision-making. The last stage is the effect of ZBNF practices on (intra) household livelihood outcomes (see Figure 2). Comparing the differences in study areas and intersectional identities is relevant during the entire course of the research. It is done systematically across all stages of the research, as depicted in Figure Two. Since the effects of and on ZBNF occur across multiple scales, it is essential to relate different sub-questions to their relevant scales (see Figure Three).

The first part of the model describes what factors enable/hamper the consideration or adoption of ZBNF by investigating the effects of household livelihood capitals. This analysis will be done on a household level to compare how households with a distinctive distribution of livelihood capitals adopt or neglect ZBNF. Sub-question two describes the motivations why households consider/adopt ZBNF. It is vital to understand how these livelihood capitals and motivations shape the (consideration of) adoption of ZBNF since women's self-help groups are just one factor of importance when analysing adoption of ZBNF.

SQ1: What household livelihood capitals enable the adoption and practice of ZBNF?

SQ2: What are the motivations of households to consider/adopt ZBNF practices?

The second part of the conceptual framework zooms into the specific role of women within ZBNF. The first step is to understand how women's self-help groups affect individual women's livelihood capitals, which are investigated by answering sub question three. Livelihood capitals shape the possible livelihood strategies, which include ZBNF. However, a change in livelihood capital might not translate into different livelihood strategies due to structural inequalities and power structures (Kumar et al., 2021). Intra-household power structures and inequalities are addressed by sub-question four, investigating the role of women within (ZBNF) agriculture households. Both sub-questions take

an intersectional approach to investigate how gender intersects with economic class and shapes the role of women within households.

SQ3: How have women’s self-help groups affected women’s livelihood assets concerning ZBNF?

SQ4: What is the role of women, intersected with socioeconomic class, regarding livelihood activities and decision-making within farmer households?

The last part of the research investigates how adopting ZBNF shapes livelihood outcomes across income, well-being, vulnerability, food security and sustainable use of natural resources (Serrat, 2008). The results are investigated primarily on the (intra) household level while also paying attention to gender and economic class intersectional differences in livelihood outcomes.

SQ5: How do ZBNF practices affect the household livelihood outcomes of ZBNF farmers?

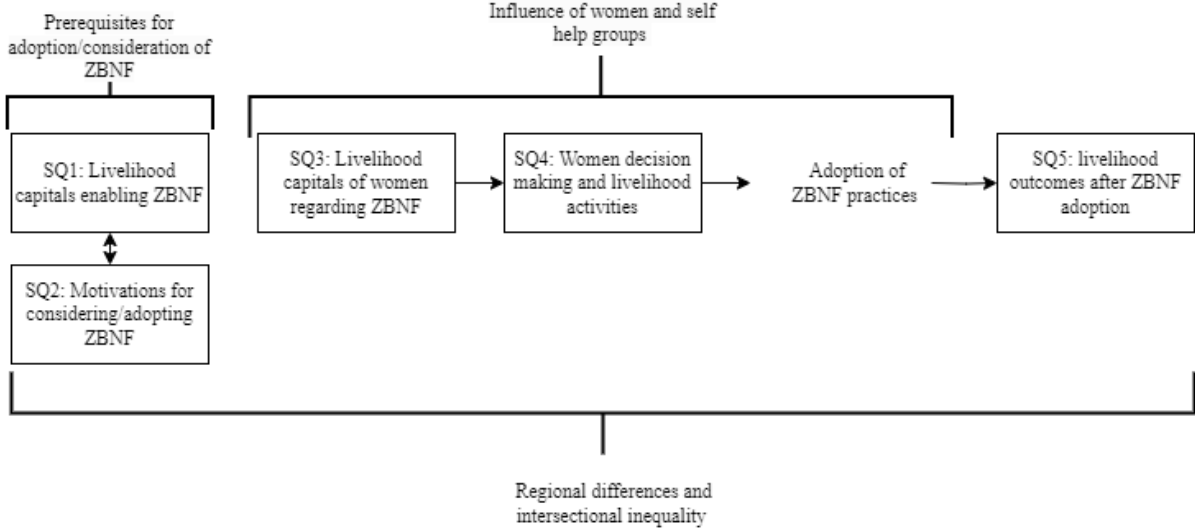


Figure 2: Conceptual Framework

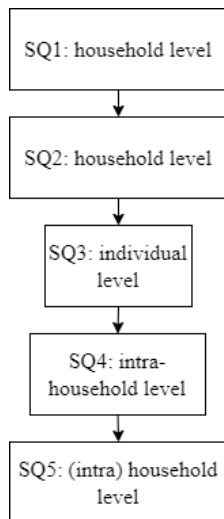


Figure 3: Different scales of analysis per sub-question

Operationalisation

The research question and additional sub-questions are analysed through two different analysis frameworks. Sub-questions one, three and five analyse the livelihood capitals and outcomes within the SLF, while sub-question four investigates the role of women and their perceived role in decision-making. In the following section, I will operationalise the utilised aspects of the SLF, intersectional social categories and perceived decision-making influence. Before operationalising, it is important to address that livelihood capitals and outcomes are highly fluid and interrelated (Natarajan et al., 2022). Moreover, data derived from semi-structured interviews are characterised by fluidity because there is no rigid answering form as is present in, for example, a survey. For example, a respondent mentions how women’s self-help groups enabled him to access credit for expanding his agricultural land while his wife also sells agricultural produce through the women’s network. The example shows how the social capital of the network of women’s self-help groups can increase physical capital and their livelihood outcomes. The livelihood capitals are operationalised in Table 1.

Livelihood capital	Operationalisation	Example	Reference
Human	When a respondent mentions one’s own (change in) skills, education, workforce, experience, knowledge, health, and nutrition.	If a participant describes how they learned to prepare ZBNF inputs.	Serrat, 2008; Glover et al., 2019
Natural	When a respondent mentions (a change) in yields, soil fertility, environmental services, water quality, cattle, water holding capacity of the soil, change in microbes in the soil, biodiversity, ecosystem services	If a participant mentions that they noticed that microbial activity went up.	Cohen et al., 2019; Serrat, 2008; Duddigan et al., 2022

Financial	When a respondent mentions (a change in) income, debt, (access to) credit, cost reductions, savings, wages, remittances, and premium prices.	If they mentioned how cultivation costs dropped.	Serrat, 2008; Bharucha et al., 2020
Physical	When a respondent mentions (a change) in infrastructure, such as roads, access to physical markets, agricultural tools, machinery, transport	If a participant mentions how agricultural-related machinery affects ZBNF practices.	Serrat, 2008;
Social	When a respondent mentions (a change in) a formal and informal social network as family relations, village relations such as neighbours, friends, village meetings, self-help groups, farmer fields schools, client networks, benefits of these relations.	When a participant describes how they communicate with other farmers in the village, such as village meetings or casual meetings with neighbours.	Caldas, & Christopoulos (2023)

Table 3: Operationalisations of livelihood capitals

Livelihood outcomes are operationalised as the result of altered livelihood strategies, which entail adopting ZBNF practices. The interpretation of livelihood outcomes varies but are all ultimately rooted in the ‘philosophical assumptions about the objectives of development’ (Scoones, 2015, p.18). Concerning this research, this will entail changes in livelihoods perceived by respondents after and because of adopting the practices of ZBNF (see Table 6). Therefore the outcomes will be, by definition, subjective. Based on the SLF, outcomes span the themes of well-being, income, sustainable use of natural resources, vulnerability and food security (Serrat, 2008).

Livelihood outcome	Operationalisation	Example	Reference
Income	This outcome described how ZBNF practices affect the income of farmers. Income is affected in three ways: change in cultivation costs, yields and making sales for premium prices.	If a participant describes how income has been changed due to lower cultivation costs.	Reddy et al. (2019)
Well being	Well-being has been considered to entail multiple aspects, but I chose to focus on <i>material</i> well-being, which describes people’s resources and if their needs are met. This includes good human and mental health and diet diversity.	If a participant describes how their diet diversity improved and consequently perceives fewer health issues.	Bezner Kerr et al., 2022
Sustainable use of natural resources	The effect of ZBNF practices on natural resources, such as water retention, soil health and fertility	If a participant mentions how water use went down after mulching.	Duddigan et al., 2023

Vulnerability	Vulnerability relates to the degree of resilience towards external shocks or trends. Examples are extreme weather, droughts, changing commodity prices,	If a participant mentions how they were less vulnerable to price shocks due to intercropping practices.	Holt-Gimenez et al., 2021
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Table 4: Operationalisation of livelihood outcomes

Intersectionality has, as mentioned in chapter three, a somewhat broad and murky definition hindering a clear operationalisation. The first step is to identify the relevant social categories within ZBNF (Tavener et al., 2022). This was done by conducting multiple key informant interviews. The informants mentioned the importance of gender as well as caste. However, caste was deemed somewhat sensitive for me to investigate as an outsider, and therefore economic class was more feasible to analyse in this research. However, caste is closely related to economic class and, therefore, relevant (Zacharias & Vakulabharanam, 2011). In addition, the RySS focused on the poorest of the poor in their programme, taking economic class into account. The poorest of the poor are defined as farmers who do not own any agricultural lands deemed an essential indicator of economic class (Galab Et al., 2022; Leder, 2022). Because this definition of the poorest of the poor is universal within the RySS, it was possible to create a similar sample in both study areas. During the semi-structured interviews, respondents without land were identified as people from low economic classes. Women’s self-help groups were also categorised as ‘poorest of the poor’ if more than 70% of participants possessed no land. The next step was to identify if and how results differed between interviewees of different economic statuses and gender and differences in results derived from women’s self-help groups. If differences occurred, data from key informant interviews and participant observations were used to check if these differences could be explained by economic status or gender.

The last step is to operationalise the perceived decision-making dynamics. Since it is beyond the scope of this research to go in-depth on decision-making, I decided to follow the example proposed by de Zeeuw & Wilbers (2004), drawing up several agriculture-related decisions based on earlier interviews with farmers and key informants as proposed by Tavener et al. (2022). Participants (only female self-help group members, see Table 4 for details) could choose if decisions were (fe) male-dominated or made together. Participating groups were categorised as middle and low economic class to implement intersectional outlook. I am aware of the risk of oversimplifying decision-making. However, this method does allow for gathering information quickly and reflecting on results with participants during group discussions.

Methods

To answer the research question, I utilised a mixed-method approach consisting of semi-structured interviews, participatory rural appraisal exercises and participant observations. Semi-structured interviews were utilised in two forms, the first being interviews with ZBNF farmers using a standardised interview guide covering the same topics in both geographical contexts (See appendix for

interview guide). The transcripts of the interviews were coded using deductive and inductive codes to groups and later categorise the answers (See appendix for codebook). The data gathered from the semi-structured interviews were used in every sub-question. The second way semi-structured interviews were used was by interviewing key informants. These were experts on specific topics such as health, self-help groups and gender or specific contexts such as the ZBNF representative in the Tenali and Madakasira regions (see ‘sample regions’ for an in-depth description of the regions). These interviews were used to contextualise results found by fieldwork and often functioned as a form of triangulation of results between different actors (Hennink et al., 2020).

Participatory rural appraisal methods comprised three exercises during women’s self-help group meetings. The methods used were daily activity mapping, a decision matrix and a gender role table (Tavener et al., 2022). These methods are fitting to discern how daily activities, performing of agricultural tasks and perceived decision-making are shaped by gender and economic class. The PRA methods were also applied to women’s self-help groups from different economic statuses to investigate how intersectional inequalities took shape. The results were collectively discussed, analysed, evaluated and checked during group discussions. The data gathered from these methods were mainly used when answering sub-question four (see Table 3). Moreover, several questions were asked during the women’s self-help group meetings to understand the perceived benefits of the meetings, contributing to the answer to sub-question three. I chose to apply PRA methods because they allow for the representation of results which might otherwise be neglected or ignored (Lilja et al., 2013). Since I focus on intersectional inequalities, an under-researched field, I chose to apply PRA to shine a light on these often hidden dynamics (Bezner Kerr et al., 2022).

At last, I used participant observations and informal conversations to deepen my knowledge of ZBNF in Andhra Pradesh. In Madakasira (two and a half weeks) and Tenali (over a month), I lived in the villages where I performed my research, allowing me to see how ZBNF worked in practice. It also enabled me to speak with many actors not fit for the interviews but related to ZBNF. These actors ranged from ZBNF produce buyers, food processing factory owners, chemical farmers and young people. Although some scholars argue that participant observation should be done for at least a year, this was impossible due to the limited time allocated for this research project (Shah, 2017). Other principles such as *intimacy and estrangement*, *holism* and *elevation of social relations of a group of people* were met to the best of my abilities by living in the homes of a family practising ZBNF while also attending multiple events not related to ZBNF such as weddings, religious festivals, sports events, school classes (Shah, 2017). Most of this ‘data’ was used to triangulate results while providing critical information guiding me to interesting (groups of) respondents.

Sub-questions	Methods used	Specific method applied
What household livelihood capitals enable the adoption and practice of ZBNF?	Semi-structured interviews	Key informants and farmers
	Participant observation	Informal conversation
What are the motivations of households to adopt ZBNF?	Semi-structured interviews	Key informants and farmers
	PRA methods	Group discussion
	Participant observation	Informal conversation
How have women’s self-help groups affected women’s livelihood assets concerning ZBNF?	Semi-structured interviews	Key informants and farmers
	PRA methods	Group discussion
	Participant observation	Informal conversation
What is the role of women, intersected with socioeconomic class, regarding livelihood activities and decision-making within farmer households?	Semi-structured interviews	Key informants
	PRA methods	Agricultural gender role mapping
		Daily activity mapping
		Decision matrix
	Participant observation	Informal conversation
How do ZBNF practices affect the household livelihood outcomes of ZBNF farmers?	Semi-structured interviews	Key informants and farmers
	Participant observation	Informal conversation

Table 5: Applied methods per sub-question

Study areas

The sample was derived from two distinct contexts to understand how agroclimatic conditions and economic factors might shape the role of women and the adoption of ZBNF (for sample specifics, see ‘Sample’ and Table 4). This was done to identify structural factors shaping livelihoods often neglected when performing livelihood analyses (Natarajan et al., 2022). In consultation with the RySS, two different regions were chosen: Madakasira and Tenali (a block of four to six villages). It is important to notice that both regions contained so-called ‘model villages’. Key informants stated that

these villages were characterised by a more extensive spread of ZBNF than the rest of the region (See limitations to understand the potential biases these region selections caused).

The first point of difference between both areas is the agroclimatic conditions. First, the average precipitation rates differ, with the Madakasira measuring an average rainfall of 714.1 mm and Tenali measuring 1078.2 mm. A second difference is that Tenali is an assured irrigated area due to the presence of various rivers, while the Madakasira district is rainfed. In addition, crops grown in Tenali (paddy, cotton, chilli maize) differed from Madakasira (Peanuts, Bengal gram) (AP-DES, 2019).

The second difference is socioeconomic, with Tenali (472.439 – 541.898 rupees) having a higher annual household income than Madakasira (374.415 – 396.411 rupees annually). In contrast, pure tenant farmers (the poorest of the poor) comprised 24.1% of the Tenali district, while Madakasira comprised only 4.7%.

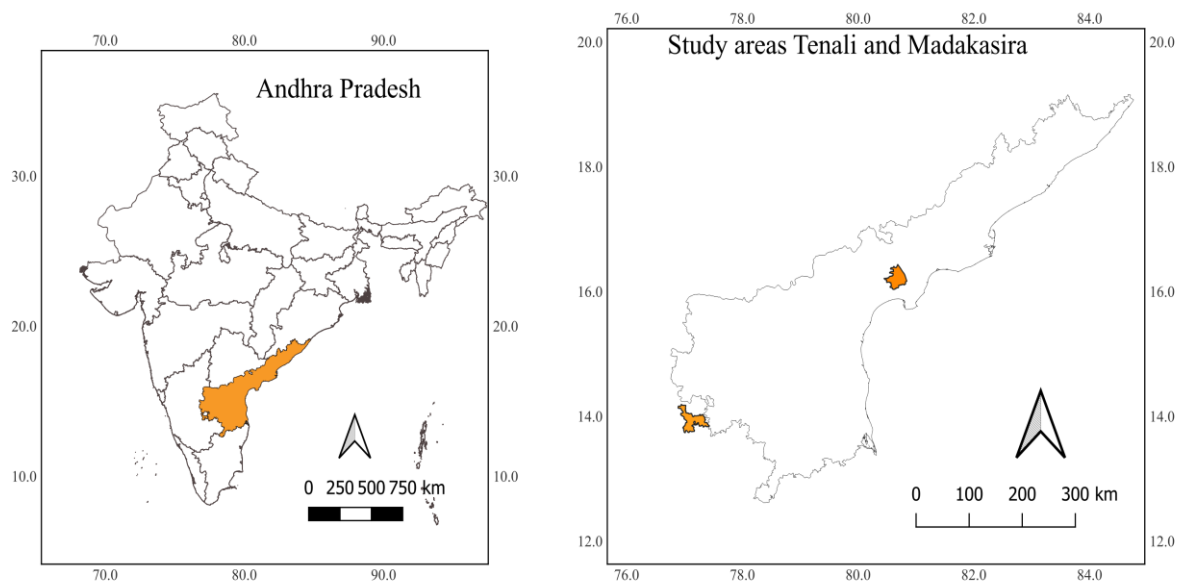


Figure 4: The study areas in Andhra Pradesh, India

Sample

To answer the research question and sub-questions, I used a network sample finding respondents who (previously) participated or were related to the RySS programme. A network sample is characterised by using already existing formal and informal networks. In both Tenali and Madakasira, a representative of the RySS helped me to get in touch with eligible respondents (see 'study areas' for specific information about both regions). The representatives used (in) formal networks such as women's self-help groups and farmer field schools while also using informal networks such as ZBNF neighbours, friends and family. Purposive sampling was applied to include respondents of different gender and economic status to be able to investigate intersectional inequalities.

A fundamental requirement to be eligible for participation in semi-structured interviews was that farmers did not use any synthetic chemical inputs like fertiliser, pesticides, herbicides or weedicides. A second criterion was that the respondent should work at least once a week at the farm to filter out non-farmers. The requirements for the women’s self-help groups were that at least 30% of the participants were engaged in ZBNF to compare answers of ZBNF with chemical farming participants. Women’s self-help groups, with approximately 70% poorest of the poor participants, were considered a self-help group from low economic status. For an overview of the sample, see Table 3.

These requirements resulted in a sample of fifteen farmer interviewees while also interviewing eleven key informants. Furthermore, it resulted in the attendance of four women self-help groups the in both Tenali and Madakasira, three being middle class and one being low economic class (Tenali) self-help group. Due to a lack of time and availability, some exercises in Madakasira had to be split across two different self-help groups with similar characteristics. Both groups were middle class with the same crop plantings while living in the same village.

Research method	Gender	Location	Economic class	POP	
Interviews	Females: 6 (coded: 2)	Tenali: 7	Marginal (<1ha):	5	3
		Madakasira: 8	Small (1-1.9 ha):	3	
		Medium (2-3.9 ha):	3		
		Semi-medium: (4-9.9 ha):	2		
		Large (<10 ha):	1		
		Unknown:	1		
SHG pra	10-15 female participants per SHG	Tenali: 2	Middle class: 3		-
		Madakasira: 2	Poorest of the poor: 1		
Key informants	-	Guntur: 7	-		-
		Tenali: 2			
		Madakasira: 2			

Table 6: Distribution of the sample

Limitations

The limitations surrounding this research are threefold. The first limitation is rooted in the purposive network sample and attendance of RySS personnel. Using existing networks of the RySS employees, my access to respondents was limited to people (previously) known to the RySS employee. It is possible that this way of sampling led to a bias underrepresenting certain groups which are less involved with the RySS but still engage in ZBNF. I want to stress that this bias might not be on purpose since the employees used their network of ZBNF farmers. These farmers often had more contact with the employees, explaining their presence in the sample. In addition, translators and RySS employees knew some of the respondents limiting the anonymity of respondents. This might have

limited the freedom of respondents to express sensitive or critical information. However, the fact that some respondents knew the translators and RySS employees also helped to build rapport much quicker, providing me with more in-depth knowledge not always available to outsiders. At last, my translators and accompanying RySS representatives were all male, potentially shaping results.

A second source of bias could be that both study areas contained model villages characterised as frontrunners of ZBNF in the surrounding region. The downside of using these regions for the sample is that they might provide a flawed and overly optimistic view of ZBNF. However, these regions also made it possible to find exciting insights due to the higher prevalence of ZBNF farmers.

At last, it is essential to discuss the influence of my positionality as a researcher. I am a white male with university-level education, unable to speak Telugu, making me an outsider in both study areas. Being a male might have influenced the answers given by some respondents and self-help groups. Another aspect was that due to my white skin and education level, I was often perceived as an expert, which on the one hand, opened many doors but, on the other hand, shied people away from participating to prevent giving 'wrong answers'. In addition, my positionality sometimes appeared somewhat of a status symbol, placing me more than once on the same level as RySS officials, possibly creating distance to respondents and eventually shaping results. This could result from the racial division during colonial times, which created a racial hierarchy. However, I did not experience this dynamic and attributed the attention primarily to me being a very unusual guest in both study areas.

Chapter Five: How livelihood assets shape the adoption of ZBNF

During this chapter, I will discuss how household livelihood capitals shape the ability to adopt ZBNF practices. In a later stage (chapter seven), the livelihood capitals identified here can be compared to individual women's livelihood capitals gained from self-help groups. This will provide insight into how women's livelihood capitals might offer different problems or opportunities for adopting ZBNF practices overlooked by household-level analyses. The results of this chapter are often based on the answers to the interview questions: 'What are the main difficulties for the adoption of ZBNF?' and 'What do you need for ZBNF?'. This allowed participants to mention several topics which they deemed most important freely. However, why people did not mention certain aspects has not been discussed. For example, if a respondent did not mention the importance of indigenous cows, I did not bring that topic up to steer the conversation as least as possible. During this chapter, I try to answer sub-question one, namely:

What household livelihood capitals enable the adoption and practice of ZBNF?

ZBNF and land ownership

The first theme relevant to the adoption of ZBNF was the ownership of land. Approximately half of the respondents described how land ownership shaped the farming decisions made by farmers. They discussed three interlinked themes: the influence of land size, tenancy and inheritance. In addition, I will discuss the different regional characteristics related to land ownership.

Land size is the first theme mentioned by approximately one-fifth of the interviewees, explaining how large landowners face difficulties with gathering and preparing the appropriate amount of ZBNF input. When doing ZBNF, farmers have to prepare their inputs, while chemical farming practices do not require input production since inputs can be bought. Land size is therefore (indirectly) related to the availability of labour since agricultural inputs are generally not purchased anymore but self-made. Larger land sizes require more labour limiting the uptake of ZBNF amongst larger landowners. Bhartesh⁴, a male farmer with five hectares of ZBNF-managed land for the (inter) national market, explained:

“yes, manpower is simply not available. It is too costly [...] Sometimes in monsoon time the weeds grow too much and we need manpower”

However, labour availability is not equally distributed across the entire state of Andhra Pradesh. Two key informants explained how Tenali was generally a region with higher wages and alternative job options limiting cheap labour availability. Two key informants and a large-scale farmer in Madakasira explained that labour was more readily available due to lower wages. One large-scale ZBNF Tenali-based farmer explained that the government has a scheme where the poorest people get

⁴ These are not the real names but pseudonyms to ensure anonymity.

260 rupees per hour. In contrast, he paid that amount for six hours of work.

As a result, most large-scale landowners give up their land for tenancy, shaping the adoption of ZBNF for farmers from a lower economic status. According to two key informants, regional differences exist between the Madakasira and Tenali districts resulting in different tenancy structures. Large landowners in Madakasira primarily rent out their land to farmers of the lower economic class. Contrary to Madakasira, Tenali large landowners rent out their land to the economic middle class. The Tenali-based key informant explained that the Tenali region attracts more factories, resulting in higher land prices. Additionally, the soil in Tenali was deemed very fertile and fit to grow commercial crops. Therefore only the middle class can afford to rent large areas.

The second theme is the effect of tenancy on the adoption of ZBNF. Tenancy farming is associated with the economic lower and middle class. Almost half of the farmers leased agricultural land. A quarter leased land in addition to their lands, while a fifth of farmers were entirely dependent on leased lands. All farmers who leased land in addition to their own lands were based in Tenali and were middle-class farmers. Of the farmers who only had access to leased lands, two were based in Madakasira and one in Tenali. A quarter of the interviewees mentioned tenancy as a significant influence stating that (short-term) rents make it difficult to transform to ZBNF for two reasons. A strong minority of interviewees mentioned that farmers fear losing yields and income, which they need to pay the rent. Some farmers stated that converting agricultural land from chemical farming to ZBNF takes up to three years. Tenant farmers are not sure if they can rent the land for multiple years, thereby not wanting to take the risk of initial yield drops during the first years of conversion. Javesh, a middle-class partial tenant farmer based in the Tenali region, explained:

“mostly lease farmers here, own land farmers not cultivating land, mostly lease farmers. Lease farmers are thinking about most income and most yielding, that's why they use chemicals. When you are own farmer you don't need to worry about paying back [the] landlord”

The role of indigenous cows

The second livelihood asset which shapes the adoption of ZBNF is the availability of indigenous cows. As seen in Table 6, ZBNF inputs are prepared using cow dung and urine. One-third of the interviewees (all Madakasira farmers) mention cattle as an essential asset for adopting ZBNF practices. In contrast, all interviewees adopted practices in which cow dung and urine were necessary. Cows are an important physical capital, but the regional context shapes their availability. During one Tenali self-help group meeting, the participants mentioned the lack of livestock as a significant constraint to adopting ZBNF practices. Madesh, a farmer in Tenali who started applying ZBNF practices a couple of years ago, identified why cows were difficult to obtain:

“[in the] olden days cows were used for ploughing fields and other [agricultural] activities, nowadays technology developed [and] they are [using] tractors”

However, Madaksira faced different issues regarding their cows. Farming technologies such as tractors are not as widespread as in Tenali resulting in a higher availability of indigenous cows. The Madakasira region is rainfed and experiences hot and dry summers as opposed to the river-irrigated Tenali region. One Madakasira-based key informant explained how these agroclimatic conditions and the availability of bore wells shaped the availability of cows:

“There are enough desi (indigenous) cows here. But sometimes people can’t feed them in summer because the grass is not there. If people can grow their own grass they can feed their cows. [Otherwise] they will sell [them] at the beginning of summer for low prices and buy cows back before monsoon for high prices. [...] When people have bore wells they can grow grass to feed their cows [through] summer.”

The availability of bore wells and, consequently, the ability to maintain cattle is shaped by economic status. One Madakasira farmer mentioned that the poorest tenants could rent rainfed lands but would have more difficulty renting land with water facilities. A farmer from the lowest economic class based in Madakasira explained how he had to give 25% of his maize yield to pay for the water used at his leased farm.

The role of social capital

The social capital of the farmer household is the last substantial capital affecting the adoption of ZBNF. Most interviewees mentioned social networks as affecting multiple aspects of ZBNF. Several interviewees mentioned regular village meetings as opportunities to sell their produce. About a third of the interviewees explained how farmer field schools and female self-help groups discuss pests and ZBNF inputs. One interviewee explained that he would talk to his neighbour farmers to convince them to start with ZBNF. During participant observation, I saw that cow urine and dung were shared among families and friends. The Tenali-based farmer Madesh explained how social capital, established through farmer field schools, shaped his knowledge about ZBNF:

“[during farmer field schools] we go to the field, we observe the pests and then we do the remedy. Through natural farming. I get more knowledge. It is every Tuesday. [...] Together we learn and make [ZBNF inputs] [...] Packing 20-25 bags and selling [to] relatives and who knows and who wants. [we create a] direct farmer connection. Through word of mouth marketing.”

Social capital was also important during the marketing of ZBNF produce and was mentioned by a third of the interviewees. Farmers could get a (slightly) higher price for their ZBNF produce through self-marketing and a good reputation. An essential aspect of self-marketing was that people were aware and convinced that the farmer practised ZBNF. One way to build trust was through taste. Anandi, a female farmer, explained how they advertised their products through taste on the local market:

“We get 10% higher prices, they [customers] check the taste, the first time they will buy. They pay more money for good taste”

Farmers who produced for the (inter) national market lacked this option and depended on buyers. This made it very difficult to reap higher prices for ZBNF produce.

Conclusion

This chapter has shown how different household capitals enable the inclusion of farmers in ZBNF practices. The land size appeared to be a major influence on adopting ZBNF practices due to the higher workload, which was not always available, mainly in the Tenali region. It showed how large landowners struggled with high labour costs, specifically in the Tenali region. This led to large landowners subletting their land to farmers from the low (Madakasira) and middle (Tenali) classes. Tenant farmers faced difficulties in adopting ZBNF practices due to initial yield drops and feared they might be unable to rent the same land again, thereby losing the effort to transform the land towards ZBNF.

The availability of indigenous cows also played a major role in adopting ZBNF practices due to their importance in preparing ZBNF inputs (see Table Two). Respondents in both regions stated how the availability of indigenous cows was subject to other factors, such as bore-well availability and the degree of industrialised agriculture. At last, social capital was important because it allowed respondents to gain knowledge, marketing opportunities and access to cow dung and urine.

This chapter shows how various household capitals can allow people to be in/excluded in ZBNF practices. By establishing what household capitals enable/hamper the adoption of ZBNF practices, it is possible to see how women's livelihood capitals, derived from self-help groups, might overcome a lack of livelihood capital on a household level. However, establishing the necessary livelihood capital is insufficient to understand which people engage in ZBNF. It is essential to understand why people adopt ZBNF, as discussed in the following chapter.

Chapter Six: Why do households choose to adopt ZBNF

After establishing what livelihood capitals enable the adoption of ZBNF, it is essential to understand why people adopt ZBNF practices. In the following chapter, motivations for adopting ZBNF will be discussed. The results are based on the interview question: ‘Why did you start with ZBNF?’. This way, people could freely indicate their motivation to start with ZBNF. Identifying why people adopt ZBNF will later be related to the individual livelihood capitals of women to analyse if and how motivations are changed through self-help groups (chapter seven). Five major themes arose from the data: health, cost reductions, soil improvement, increasing yields and helping society. This chapter tries to answer sub-question two:

What are the household’s motivations for adopting ZBNF?

Expectations of a better health

The most mentioned reason to adopt ZBNF was to improve health, with a large majority of interviewees mentioning this as the (primary) motivation to adopt ZBNF. Within the broader theme of health, four major sub-themes arise. The first is the relationship between chemical usage and health. The second is improved nutrition and diet diversity. Third, the impact of the covid-19 pandemic. Fourth, the influence of ZBNF on mental health. Interestingly no differences were found between participants from various economic statuses or regions, hinting at the universal importance of this motivation to adopt ZBNF. Gender did appear to influence motivations for adoptions, with one women’s self-help group stating that health was a way to convince husbands to engage in ZBNF.

About a third of the interviewees mentioned how using chemicals during farming created diseases such as cancer, dementia, and gastric problems. This group clearly stated that using chemicals caused these diseases. Interestingly, most of these interviewees were based in Tenali. One key informant explained how Tenali had been a chemically intensive agricultural zone for decades, making its adverse effects more visible. Multiple interviewees mentioned explicitly that they converted to ZBNF to cure the diseases they, or people around them, had. The cured diseases ranged from ulcers and gastric problems to cancer and diabetes. Panchavaktra, a Tenali-based farmer in his fifties, explained how he and his wife had produced sorghum for the (inter) national market by applying chemical inputs for many years. This has caused health problems which they tried to solve by adopting ZBNF practices four years ago:

‘My wife suffered from health problems when we used chemicals. Now her health has improved. [...] Our doctor said we could try ZBNF to cure it [brain tumour]. Her brain tumour went away after we started to do ZBNF.’

The second sub-theme within health showed how interviewees wanted to improve their health by eating more healthy and nutritional food which nine interviewees mentioned. Several interviewees

mentioned how they would eat a greater variety of fruits and vegetables, while half mentioned that they expected that ZBNF-produced food was healthier or better than chemical foods. One key informant specialised in health explained how ZBNF, primarily through nutrition gardens, enabled farmers to eat a wider diversity of food. This view was confirmed, with a majority of the interviewees stating that they ate their own ZBNF products. Of these interviewees, more than half indicate that they consume their food first and only sell the remaining food.

The third sub-theme within health was the impact of covid-19 pandemic. A couple interviewees, key informants and informal conversations confirmed that the covid-19 pandemic influenced people's thinking about their health. The effects of the pandemic were twofold: creating an incentive to consume healthy food (through ZBNF practices) and increasing consumer interest in ZBNF produce. A couple of farmers and customers linked the consumption of ZBNF produce with increased immunity. Bhartesh explained how he had read several reports on the impact of chemical farming and health. He explained:

“Mainly health concerns, corona has been a learning lesson. By eating natural (ZBNF produced) food we create a higher immunisation”

The last theme within health was the effects of ZBNF on mental health. Although mental health improvements are supposed to answer the high levels of farmer suicides, none of the farmers mentioned improving mental health as a motivation to adopt ZBNF practices (Veluguri et al., 2021). When explicitly asked, one key informant explained how mental health improved through improved nutrition. The general reasoning is that farmers are less likely to end up in debt by drastically reducing input costs and improving mental health. However, no evidence was found to support this reasoning during the interviews. However, reducing cultivation costs was deemed a vital motivation to adopt ZBNF and might indirectly relate to mental health.

A cheaper way of producing food

The second motivation for adopting ZBNF was the reduction of cultivation costs which was mentioned by almost half of the interviewees. However, all interviewees expected cultivation costs to decrease by replacing expensive chemicals with cheap homemade inputs. The large majority of interviewees mentioning cost reduction as a motivation to adopt ZBNF were based in Madakasira. A key informant explained how the need for lower cultivation costs was more pressing in Madakasira due to the region's lower income than Tenali. Interestingly, premium prices for ZBNF produce were not mentioned by any of the interviewees as a motivation to adopt ZBNF practices while being identified as a way to increase income (Reddy et al., 2019).

Preparing inputs

As described in chapter four, preparing natural inputs is key within ZBNF replacing the need for synthetic chemical inputs. The inputs are created manually, and different recipes exist for different problems in the agricultural fields. For example, *Ghana Jivamrita*. This input comprises cow dung, soil, pulse flour and jaggery. These products are mixed and dried in the sun. Farmers dissolve it in water when completely dried out



Figure 5: The manual preparation of Ghana Jivamrita

and spray it onto the fields. Several participants indicated they had to spray every two weeks, while others stopped using the mixture after two years of applying it. The advantage of these products is that they are very cheap compared to synthetic chemical inputs. Ishani, a female farmer managing one acre of land, explained how the cultivation costs went down:

'In chemical farming cultivation costs for one acre are 1 lakh, for natural farming we need only 20000 to 25000 per acre, we save 75% of costs'

Although these positive outcomes are known to many people, input preparation is perceived as hard work. This forms a major obstacle to adopting ZBNF. One key informant working in the Tenali region explained:

'They [the farmers] do not feel like doing the thing [input preparation] because it needs time and hard work. And they will go on and do the chemical'

A healthier soil and more fertility

The third motivation to adopt ZBNF was to increase soil health and fertility mentioned by a third of the respondents. The expectations of ZBNF regarding soil health ranged from general improvements of soil health, reducing saline soil and better pest management. Multiple informal conversations showed that the reduction of water use was an important motivation for applying ZBNF methods, especially mulching. Mulching was practised by a large majority of the Madakasira-based farmers, while only one of the Tenali farmers applied mulch extensively. One Madakasira-based informant explained that mulching was an essential retention strategy, often applied in the early phases of adopting ZBNF. In the agroclimatic conditions of Madakasira (dry and rainfed), water retention plays a more crucial role. Tenali farmers related their soil health more to the extensive use of chemicals killing beneficial pest-eating organisms and salination of their soil.

Alternative motivations

In the following paragraphs, I will discuss *increasing yields* and *doing something back for society* as two motivations for adopting ZBNF. A couple of interviewees mentioned increasing yields as a motivation to adopt ZBNF. Although mentioned by the APNCF (2019) as a strategy to increase income, increasing yields through ZBNF was not a prevalent motivation for ZBNF adoption. The Tenali-based farmer did not specify how she thought yields would increase. A Madakasira-based farmer named Laxmidevi explained how she usually would not get any crops during the summer period (pre-monsoon). When she adopted the pre-monsoon dry sowing, her yields increased:

“Normally we wouldn’t grow anything during the pre-monsoon time. With PMDS everything we grow is extra”

The last motivation for adopting ZBNF was observed during multiple informal conversations where several men indicated they (considered to) return to farming to perform ZBNF. These people were mostly highly educated and mentioned doing something for society as the main reason (consider) to adopt ZBNF. This is also supported by a report of Galab et al. (2022) which shows that a small group of young, highly educated people are adopting ZBNF.

Theme	Mentioned	Sub-theme	Mentioned
Health	80% (twelve of fifteen)	Solving chemical-related health issues	33% (five out of fifteen)
		Increasing nutrition and diet diversity	60% (nine out of fifteen)
		Response to the Covid-19 pandemic	20% (three out of fifteen)
		Mental health	0% (zero out of fifteen)
Cost reduction	40% (six out of fifteen)	Cost reduction through replacing costly chemical inputs	40% (six out of fifteen)
Increasing soil health and fertility	33% (five out of fifteen)	Overall improvements in soil health	20% (three out of fifteen)
		Decreasing salinity in soil	7% (one out of fifteen)
		Better pest management	7% (one out of fifteen)

Table 7: The distribution of motivations to adopt ZBNF practices

Conclusion

This chapter has shown that households choose to adopt ZBNF practices for different reasons expecting different beneficial outcomes. The most important reason to adopt ZBNF practices was that respondents expected their health to improve by eliminating chemical usage (mostly Tenali-based farmers), consuming nutrient-dense food, and increasing diet diversity. The second reason households chose to adopt ZBNF practices was to reduce cultivation costs boosting income, which Madakasira-based farmers primarily voiced. A third of the participants expected that ZBNF practices would

improve soil health, fertility and water reduction (especially important in Madakasira). At last, a few farmers mentioned how they wanted to improve yields or do something for society.

This chapter gave insight into factors beyond household livelihood capitals that shape adopting ZBNF practices. It is essential to understand why people adopt ZBNF because it involves expectations about ZBNF before adopting the practices. One of the sources of these specific expectations could be the women's self-help groups investigated in the following chapter.

Chapter Seven: The livelihood capitals of women in self-help groups

This chapter will describe how the activities of self-help groups shape the livelihood assets of the women participating. The RySS have used self-help groups for multiple years to distribute their ideas, while programmes such as cheap loans go back to the 1980s. This implies that women's self-help groups have had impact on livelihood capital for at least a few years. Understanding what livelihood capitals are specifically available for women highlights how women can obtain different livelihood capitals compared to other household members. This will provide insight into how livelihood capitals can be gender specific, potentially influencing the role of women in the household. Moreover, analysing individual women's livelihood capitals allows for comparing household capital important for adopting ZBNF. In addition, women's self-help groups form the primary strategy for disseminating the principles of ZBNF in Andhra Pradesh.

I will explain how social capital is acquired by discussing the structure of women's self-help groups. Second, I will discuss how women's self-help groups affect access to financial capital. Third, human capital in the form of knowledge creation will be discussed. At last, access to physical capital will be discussed. It is important to notice that these capitals are highly interrelated. This is done to answer sub-question three:

How have self-help groups affected women's livelihood assets concerning ZBNF practices?

The social capital of women's self-help groups

Social capital is generated through regular meetings of women's self-help groups, which occur once a week, two weeks or a month depending on the group. The groups consist of ten to fifteen members who live in the same neighbourhood and come from similar socioeconomic backgrounds (Sato et al., 2022). Women can perform different roles within a self-help group, such as (vice) president, administration and accountant. Some of the groups I spoke to handed in some money each month to create little savings which could be used as a loan or emergency. Furthermore, a majority of the attended self-help groups mentioned how they discuss social and financial topics such as 'domestic violence' and 'financial problems'. Other advantages of self-help groups concerning ZBNF include produce trading and mass preparation of ZBNF inputs.

In the sustainability of self-help groups, gender plays a quintessential part for two reasons. According to a key informant, women's self-help groups could sustain themselves. In contrast, male self-help groups fell apart a few years after due to lower social bondage and political games within the group. Another key informant explained how gender influenced Tenali-based self-help groups, stating that women of the middle class had to spend fewer hours working in the fields, having more time to engage in these meetings.

Access to financial assets through loans

Financial livelihood capital is directly affected by participating in self-help groups, most

prominently by increased access to loans with low-interest rates. Most interviewees who reported being involved in or with self-help groups mentioned access to finances as a pivotal aspect of self-help groups. In addition, all attended self-help groups and the key informant who specialised in self-help groups all confirmed this role. Loans are distributed to the group, and participants can divide the loans amongst their members as they see fit. The repayments of these loans have been consistently successful, with women's self-help groups maintaining a sustainable financial structure (Sato et al., 2022). One banker providing the loans confirmed this view:

“women's self-help groups are extremely reliable. They always pay back on time with repayment rates of 99.9%. Most groups even repay money before the deadline, we say: ‘Keep the money for a while, you don't have to pay back now,’ but they will still repay us.”

Although these loans are an initiative separate from the RySS, ZBNF loans are an essential way to increase the adoption of ZBNF. A majority of the interviewees mentioned the importance of loan activities, of which about half directly linked it to ZBNF-specific aspects. They describe how loans are provided to acquire the necessary physical assets for ZBNF, such as (indigenous) cows, leasing land and constructing bore wells. Nishant, a male interviewee who had worked for RySS and had attended many women's self-help groups to teach women about ZBNF, explained:

“[women] Self-help groups are very important for natural farming, if farmers want to do ZBNF, they need cow, so for that they need money and that money they get from [women] self-help groups”

Knowledge creation

A second key aspect of women's self-help groups concerning ZBNF is knowledge creation, a form of human capital. All attended self-help groups, and almost half of the interviewees and almost all key informants underlined the importance of knowledge creation. Knowledge creation concerning ZBNF occurs during meetings where a proportion of the time is spent discussing several aspects of ZBNF. RySS employees attend these meetings to discuss and explain ZBNF practices. Two key informants mentioned how explaining the advantages is the first step to creating awareness of ZBNF's existence. The advantages discussed during the meetings were health benefits and cutting cultivation costs related to ZBNF. One trainer explained that the benefits and basic ideas had to be established before going more in-depth since ZBNF was sometimes approached with caution.

Once the benefits of ZBNF are introduced, its specific practices will be taught to the participants. Participants mentioned two specific sets of knowledge creation. A third of the interviewees explained how they had learned to prepare ZBNF inputs. A third of the interviewees also discussed different cropping schemes during different seasons. Two key informants stated that self-help groups were primarily theoretical in nature. However, women could apply their theoretical knowledge through multiple channels besides the women's self-help groups. Although these forms of bringing knowledge into practice are not directly a form of women's self-help groups, they are

interrelated. Most of the women's self-help groups indicated they discussed the application of ZBNF in practice during their meetings. Additionally, this application of theoretical knowledge highlights the intersectional identities at play.

First, theoretical knowledge from the women's self-help groups is applied to practice through nutrition gardens promoted during the meetings. Nutrition gardens are small plots of land near the house where different vegetables and fruits are cultivated. First, nutrition gardens were seen as female controlled by all self-help groups as opposed to the household's agricultural fields, which males generally managed. One key informant explained how this allows women to bring their knowledge into practice and develop their skills surrounding ZBNF. Second, nutrition gardens are viable options for poor households to start with ZBNF. One key informant and a couple of self-help groups explained that nutrition gardens could be started on the ground around the house already in their possession. When zooming in on women with low economic status, the ZBNF plays a different role. During one self-help group consisting of only low-economic-status women, nutrition gardens were the only way to apply this knowledge for several women since most of them did paid labour, not owning any land themselves.

The second way to apply theoretical knowledge into practice is through farmer field schools. These meetings are separate from women's self-help groups and freely accessible for men and women. During these meetings, RySS employees and participants choose a specific agricultural plot to discuss what is happening, such as improving the soil and fighting pests. Notably, women from the middle class in the Tenali region stated that attending farmer field schools was deemed a male dominant agricultural activity. In contrast, women from the low class in Tenali and middle class in Madakasira indicated that both men and women attended farmer field schools. A key informant working in Tenali later explained that this group was not as involved in the agricultural fields because of a higher standard of living and mechanisation of agriculture. Technology has replaced some of the jobs formerly performed by women.

At last, more informal forms of knowledge application were observed. Sometimes women from the self-help groups organised the mass preparation of ZBNF inputs with a RySS representative. During an informal conversation one female farmer explained how she and other participants of women's self-help groups visited each others farms to learn from the differences.

Physical assets

As mentioned above, access to financial capital is used to acquire ZBNF-related physical capital, such as leasing agricultural land, (indigenous) cows and bore wells. Understanding how economic status influences which physical capital is acquired is necessary. First, women from lower economic classes had low access to agricultural lands limited due to high prices. One key informant explained how women's self-help groups provide the necessary loans to pay for the rent of these agricultural lands. Regional differences occur between Tenali and Madakasira districts since the loans

provided to women with a low economic status in Madakasira are sufficient to lease land. Women in the Tenali region often can not due to higher land prices. A second dynamic is that Madakasira-based farmers generally require a bore well or open well to provide their agricultural lands with water year-round. A couple of Madakasira-based interviewees explained how low-economic-status farmers often were limited to leasing rainfed lands. One key informant said self-help group loans were available in Madakasira for bore wells. However, none of the low economic class farmers would invest in bore wells since they did not own the lands, according to one key informant.

The livelihood capitals people not included in women-self help groups

At last, it is essential to understand how people not included in women's self-help groups acquire livelihood capital. About half of the males derived social capital related to ZBNF from the earlier described farmer field schools. A couple of male farmers explained that they discussed ZBNF practices with neighbouring farmers during village meetings. When looking at access to financial capital, a minority of the respondents stated they had indirect access to loans via their husband participation in a women's self-help group. Male farmers had access to knowledge through the farmer field school. However, a majority also mentioned training by Subhash Palekar, who is often regarded as the founder of ZBNF (see Chapter Two for more information about Subhash Palekar). Access to land was generally perceived to be higher for males because multiple interviewees indicated that they inherited their land from their fathers and indicated that they also stated that only very few women lease agricultural lands themselves.

Conclusion

This chapter set out to investigate if and how women's self-help groups shaped the livelihoods capitals of women. It showed how women can access unique livelihood capitals compared to men not in women's self-help groups. Women have access to financial capital through loans with low-interest rates. Human capital is expanded through education about multiple aspects of ZBNF taught by RySS representatives. Nutrition gardens serve as a way to apply the theoretical knowledge into practice and allow women from a low economic class to practice ZBNF while not requiring possessing or leasing land. At last, women have appeared to have indirect access to physical capital by investing money from loans from the women's self-help groups.

This chapter shows how women acquire multiple livelihood capitals beneficial for ZBNF adoption. When comparing the household livelihood capitals, one can observe that women have acquired some livelihood capital which could be used to overcome problems in adopting ZBNF practices. An example is that women have access to financial capital, which can be used to obtain or maintain indigenous cows enabling the adoption of ZBNF on a household level. However, it is important to understand that women's livelihood capitals are analysed individually. Since women do not form a household by themselves, it is important to understand how women interact with other

household members. To investigate if the livelihood capitals of women translate into adopting ZBNF practices, it is important to investigate the intra-household dynamics in the following chapter.

Chapter Eight: The role of women in agricultural tasks and decision-making

After establishing how self-help groups affect the livelihood capitals of women concerning ZBNF-related livelihood capitals, it is crucial to investigate if and how these capitals translate into adopting ZBNF practices. To investigate this, I will discuss women's tasks at farms and within households. Investigating women's roles within agriculture illustrates the potential fields of influence on farming practices. The second part will describe women's perceived intra-household decision power to illustrate if and how women can influence or make decisions regarding adopting (certain) ZBNF practices. Both sections will highlight how the intersectional identity of gender and economic status shape the role of women within ZBNF and agricultural households in general. During this chapter, I try to answer sub-question four:

What is the role of women, intersected with economic status, regarding livelihood activities and decision-making within farmer households?

The labour of women and the double time burden

Women in the sample performed several forms of labour on and off the farm. Participants of all self-help groups which discussed this topic mentioned they spent time in the fields for agricultural work. The time spent at the agricultural fields ranged from a minimum of 19% (approximately three hours) to a maximum of 50% (approximately eight hours) of their sixteen-hour day. Working in the agricultural fields was perceived as separate work from maintaining nutrition gardens which were, in general, considered domestic or household tasks. Time spent at the farm is not consistent year-round and changes with seasons. All participants of the self-help groups indicated that during the Monsoon season, the workload was the highest increasing workload with one or two hours a day. Within seasons harvest time was perceived to be the busiest compared to other phases of agriculture, such as seeding and weeding.

Aside from agricultural work in the fields, women performed several other tasks, including household and domestic work. Three self-help groups which discussed different labour mentioned how preparing and eating three meals took approximately 33% of their time, resulting in approximately five hours and fifteen minutes of work. This percentage was the same for members of different economic classes (members of four self-help groups). In addition, food preparation was not perceived as a job for males, with twenty-six female participants unanimously considering this a typical task for women. Based on data from three self-help groups, housework such as cleaning, taking care of the children and caring for cattle took 13% up to 25% of women waking hours.

In contrast to household work, time spent on agricultural work appeared to be influenced by economic class. Members of two middle-class self-help groups from Tenali stated that they spend around three to six hours at the agricultural fields, depending on the season. Middle-class women from

Madakasira mentioned they spent about eight hours on agricultural work. In contrast, the lower-class women in Tenali mentioned working seven to eight hours in the fields. One key informant explained that a lower economic status would increase the involvement of women in agriculture for two reasons. The first is that with increased income, agricultural involvement is less necessary due to sufficient means to maintain the family. The second reason is that wealthier families in the Tenali region had access to machinery to reduce or replace women's labour. One key informant explained that families in the Tenali region were wealthier than those in the Madakasira region. Therefore Tenali households were able to purchase machinery.

Two self-help groups mentioned how ZBNF was (a little) more time-consuming compared to chemical farming. However, participants indicated that the increase in workload was relatively incidental during the preparation of inputs while not requiring more work daily. One participant estimated that the time spent on agriculture increased by ten to twenty per cent. The other two self-help groups indicated that ZBNF did not considerably alter their daily time spent on agriculture.

These results hint at a double time burden for women who are not only engaged in agricultural activities but also solely responsible for domestic and household work. It is important to understand that women indicated that household and domestic work was perceived as solely women's tasks, not affecting men. However, during informal conversations, men indicated working longer hours on the farm than women. It is important to understand that the weight of the double time burden might differ for women from different economic classes. The Tenali middle class stated they spent the least time at the farm compared to the Madakasira middle class and Tenali low class. Due to the perceived higher workload adopting ZBNF practices might increase the double time burden for women who are already most involved in agriculture, such as the low-class women in the Tenali region.

Women's tasks within ZBNF practices

The second step of this chapter is to identify what specific tasks women perform at farms to see where acquired knowledge of ZBNF can be applied. Three self-help groups engaged in an exercise where a discussion was started to establish gender-specific roles, and across all three self-help groups, women agreed that sowing, weeding and transplanting crops were tasks for women only. In contrast, selling and marketing products and ploughing the land were unanimously deemed male jobs. In addition, some tasks were unanimously considered for both, such as input preparation, cattle care, off-farm paid labour, and food processing after harvest. During an informal conversation, one ZBNF Madakasira-based farmer explained how men and women had distinctive jobs due to their perceived gender-related qualities:

“Look here [showing a picture of him ploughing with a bull]. See, I am handling the bull [which] my wife can't do. She is behind me seeding. Men can't do seeding so the wives do it”

In contrast to the abovementioned tasks, some were not perceived as typically male or female. While the Madaksira middle-class self-help group considered harvesting a job for both males and females, the middle-class Tenali women's self-help group considered it a men's job as long as machines were used. When machines were not available, Tenali middle-class women did the harvesting. This aligns with the low-class self-help group from Tenali, which mentioned harvesting was a women's job. Middle-class Madakasira women perceived mulching as a task for women, while Tenali middle class perceived it as a task for men. Tenali low economic class women mentioned mulching was not an adopted practice. A possible explanation could be that mulching plays a minor role in the Tenali region; only one out of seven Tenali interviewees practices mulching, compared to the Madakasira region (six out of eight interviewees practised mulching). Because mulching is a minor task, men could perform this task more easily in Tenali without help.

A third field of difference was job outmigration which was only mentioned by the Madakasira middle-class women's self-help group. One Madakasira key informant estimated job-related outmigration at 10% of the population and only present in the low economic class. The Madakasira-based women's self-help group considered job-related outmigration a task for both men and women. In contrast, women from the low and middle classes in Tenali stated that job outmigration did not happen on a big scale. One key informant explained that the irrigated lands in the Tenali region made it possible to grow commercial crops year-round. This created job opportunities for the poorest people all year.

Agricultural activity	Male			Both			Female		
Weeding							TM	TP	MM
Input preparation ZBNF and chemical				TM	TP	MM			
Harvesting	TM (with machines)					MM	TM	TP	
Spraying	TM	TP	MM					TP	
Sowing							TM	TP	MM
Transplanting							TM	TP	MM
Selling	TM	TP	MM						
Marketing	TM	TP	MM						
Ploughing	TM	TP	MM						
Mulching	TM								MM
Cattle care				TM	TP	MM			
On-farm paid labour					TP	MM			
Off-farm paid labour				TM	TP	MM			
Migration for labour						MM			
Processing of food				TM	TP	MM			

Attending farmer field schools	TM	TP	MM
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Table 8: How women perceive the gendered task of agricultural tasks. TM stands for Tenali middle class, TP stands for Tenali poorest of the poor (low economic class), and MM stands for Madakasira middle class.

Perceived decision power of women in agricultural households

The last step in this chapter is to investigate what women perceive to be decisions made by men, women or together. In the following paragraphs, I hope to bridge the gap from ZBNF-related livelihood capitals to adopting ZBNF practices as livelihood strategies.

When examining seven decisions surrounding ZBNF and its practices, males dominate 44% of the decisions, 43% are taken together, and women take the other 13%. When zooming in on the decision when to prepare and apply (ZBNF), input was the most female-dominated decision with 28% while also having the highest rate of participants who indicate it is a shared decision. Interestingly, the preparation of inputs is taught during the women’s self-help groups. Nishant, a former RySS representative in Madakasira, explains how the knowledge about ZBNF changed their role in decision-making:

“women go home and make suggestions to husband, they discuss. [...] Here women are all participating. [...] In chemical farming women didn’t know what to do, you go to the shop [chemical input shop] and you get what he [chemical input salesperson] says”

However, only women of the Madakasira indicated this to be women’s dominant decision (78%), while all Tenali-based participants indicated this to be a decision made by males or together. Within Tenali women of the middle class, 89% of the participants indicated that when to prepare and use inputs was a male-dominated decision. In comparison, 100% of the lower-class participants in Tenali indicated it was a shared decision. The difference between the groups is interesting because all indicated that learning to prepare and use inputs was one of the lessons from self-help groups.

The decision of when to prepare inputs sharply contrasts with who decides what work needs to be done on the farm. 60% of participants indicated this is a male-dominated decision, while 40% named it a shared decision. A few male farmers suggested they thought they owned the land because they inherited it from their father. Govindaraj, a male farmer whose wife participates in self-help groups, confirmed that his wife had learned about ZBNF and spent the most time at the farm but considered his father as the boss of the fields:

“Me, my father and my wife do the farming. [...] Every day we come to the field, if any diseases are there we will prepare these things [NF inputs] [...] My wife is spending the most time at the farm. Me and my wife do the work, my father is manager.”

Multiple decisions reflected how intersectional inequalities shaped the perceived decision-making roles. Overall, women in the low class from the Tenali region measured the lowest percentage of male-dominated decision-making while having the highest shared decision-making rates. In contrast, women from the Tenali middle have the highest rate of male-dominated and lowest rate of women-dominated decisions. A Tenali-based key informant explained that the middle class in Tenali is relatively wealthy compared to the middle class in Madakasira and could afford machinery. These machines replaced some of the jobs women used to do. This view aligns with the agricultural tasks and time spent performing agricultural tasks as discussed earlier in this chapter (see Table 8). Women from the middle class in Tenali stated that they would do the harvesting if no machines were available. If harvesting machines were available, men would do this work. Women from the low class in Tenali and the middle class never mentioned any use of machinery during farming.

Two specific agricultural decisions are worth singling out because they relate to the earlier mentioned women's livelihood capitals derived from self-help groups. The decisions are 'who decides what crops are planted' and 'who decides to make new investments'. These decisions relate to access to physical capital (through taking loans and purchasing land) and human capital (knowledge about cropping patterns). Interestingly, intersectional inequalities appeared between the different groups, with the women from the Tenali low class stating that the decision about what crops to grow was female-dominated or a shared decision. None of the women from the low class perceived it to be a male-dominated decision which contrasts with the middle-class women from Tenali and Madakasira.

Second, women from the Madakasira middle class stated that making new investments was primarily a male-dominated decision. In contrast, women from Tenali (both middle and low class) perceived it more as a shared decision. Interestingly women from the low class in Tenali indicated most often that decisions about making new investments were female-dominated. Kausthuba, a female farmer from a low economic class who manages agricultural land owned by her husband (inherited through his father), describes the process of shared decision-making:

“On my own farm husband and wife [she and her husband] decide both. Both will discuss and then make decision together [...] [if one is away on work] they still both decide.”

At last, it is important to compare how the transition from chemical farming to ZBNF practices affected decision-making. All participating self-help groups indicated that adopting ZBNF did not change the decision-making process. Participants practising chemical farming did not report any differences in decision power compared to participants practising ZBNF. All participating groups indicated that tradition is the reason behind this distribution in decisions which one key informant confirmed. Several other research has found that inequalities were indeed reinforced by social norms and familial traditions (Vishwanath & Palakonda, 2011; Littrell. & Bertsch, 2013). It is essential that tradition is not static and changes over time under influence of many factors. Anthropologists found that culture change is amongst many other factors influenced by world view (Ji et al., 2001), economic

situation (Castree, 2004), and population growth (Shennan, 2000). A second explanation for which only limited evidence was found was that land was owned and inherited through the male lines in the family. During the group discussion, several women stated that their husbands were the boss on the farm because they owned the land. At last, due to the short research period, potential changes might not have been detected.

Decision	Man	Together	Women
Who decides what work needs to be done at the farm?	Total: 60% (15 of 25) MM: 66% (6 of 9) AM: 22% (2 of 9) AL: 100% (7 of 7)	Total: 40% (10 of 25) MM: 33% (3 of 9) AM: 78% (7 of 9) AL: 0% (0 of 7)	Total: 0% (0 of 25) MM: 0% (0 of 9) AM: 0% (0 of 9) AL: 0% (0 of 7)
When to use/prepare inputs?	Total: 40% (10 of 25) MM: 22% (2 of 9) AM: 89% (8 of 9) AL: 0% (0 of 7)	Total: 32% (12 of 25) MM: 33% (3 of 9) AM: 33% (3 of 9) AL: 100% (7 of 7)	Total: 28% (7 of 25) MM: 78% (7 of 9) AM: 0% (0 of 9) AL: 0% (0 of 7)
Who decides which crops are planted?	Total: 46% (11 of 24) MM: 63% (5 of 8) AM: 66% (6 of 9) AL: 0% (0 of 7)	Total: 50% (12 of 24) MM: 37% (3 of 8) AM: 33% (3 of 9) AL: 86% (6 of 7)	Total: 4% (1 of 24) MM: 0% (0 of 8) AM: 22% (2 of 9) AL: 14% (1 of 7)
Who decides when to harvest?	Total: 48% (12 of 25) MM: 44% (4 of 9) AM: 88% (8 of 9) AL: 0% (0 of 7)	Total: 32% (8 of 25) MM: 22% (2 of 9) AM: 11% (1 of 9) AL: 71% (5 of 7)	Total: 20% (5 of 25) MM: 33% (3 of 9) AM: 0% (0 of 9) AL: 29% (2 of 7)
Who decides what products are sold?	Total: 52% (13 of 25) MM: 22% (2 of 9) AM: 55% (5 of 9) AL: 86% (6 of 7)	Total: 32% (8 of 25) MM: 55% (5 of 9) AM: 33% (3 of 9) AL: 0% (0 of 7)	Total: 16% (4 of 25) MM: 22% (2 of 9) AM: 11% (1 of 9) AL: 14% (1 of 7)
Who decides on investments such as new land?	Total: 36% (9 of 25) MM: 66% (6 of 9) AM: 22% (2 of 9) AL: 14% (1 of 7)	Total: 52% (13 of 25) MM: 22% (2 of 9) AM: 78% (7 of 9) AL: 57% (4 of 7)	Total: 12% (3 of 25) MM: 11% (1 of 9) AM: 0% (0 of 9) AL: 29% (2 of 7)
Who decides to convert to ZBNF?	Total: 28% (7 of 25) MM: 33% (3 of 9) AM: 22% (2 of 9) AL: 29% (2 of 7)	Total: 64% (16 of 25) MM: 66% (6 of 9) AM: 78% (7 of 9) AL: 42% (3 of 7)	Total: 8% (2 of 25) MM: 0% (0 of 9) AM: 0% (0 of 9) AL: 29% (2 of 7)
Cumulative:	Total: 44% Total MM: 45%	Total: 43% Total MM: 38%	Total: 13% Total MM: 21%

Total AM: 52%	Total AM: 49%	Total AM: 5%
Total AL: 32%	Total AL: 49%	Total AL: 16%

Table 9: The perceived division of agricultural-related decisions between men and women. Based on the answers of twenty-five respondents on a decision matrix

Conclusion

This chapter tried to address several aspects that could explain how individual women's livelihood capital translated into adopting ZBNF practices. The first step was to identify to what degree women were involved in agriculture. Women appeared to spend significant time on agricultural activities while being responsible for all the domestic/household labour resulting in a double time burden. Evidence suggests that women from a low economic class spend more time on agricultural tasks. The second step was to see what tasks women performed and showed that specific tasks were deemed gendered while some were shaped by intersectional inequality. At last, I investigated if women can take certain decisions surrounding ZBNF practices which appeared to confirm that women who spend the most time (Tenali low-class women) had the most balanced perceived decision power.

Based on these results, one can conclude that several aspects shape if women can translate their livelihood capitals into adopting ZBNF practices. First, women were all involved in farming, but women from the low economic class were more involved. This would suggest that women spend time in agriculture, enabling them to apply their individual livelihood capital. However, women were not as involved in every aspect of agriculture, potentially limiting the possibility of applying their livelihood capital. At last, women were not always entitled to make decisions which might eventually limit the adoption of ZBNF practices. The next chapter will investigate how livelihood outcomes are investigated if households adopt ZBNF practices.

Chapter Nine: Improved livelihood outcomes? The impact of ZBNF

While previous chapters explored what factors influenced the adoption of ZBNF practices, this chapter will focus on how livelihood outcomes are affected after adopting ZBNF. None of the interviewees wanted to go back from ZBNF to chemical practices. The following paragraphs will explain why by discussing the livelihood outcomes of income, well-being, vulnerability, and sustainable use of natural resources. The results are based on answers to specific livelihood outcome questions such as ‘How did ZBNF practices affect your health?’. This allowed me to discuss several outcomes while allowing participants to freely state in what way livelihood outcomes were related to ZBNF. The chapter will be split into parts, each discussing one of the livelihood outcomes. As in other aspects of the SLF, some aspects are interlinked and influence each other. In addition, intra-household dynamics will be approached from the intersectional inequalities perspective to discern different livelihood outcomes for household men and women. Through this approach, I hope to answer sub-question five:

How do ZBNF practices affect the household livelihood outcomes of ZBNF farmers?

How the adoption of ZBNF practices affected income

The first theme is income and will be discussed according to the earlier proposed ways to increase income, of which increasing yields is the first. Participants explained how yields were affected in the short and long term. It is important to notice that participants defined short-term yield alterations differently, ranging from one to six years. Approximately a third of the respondents indicated they had faced initial yield drops. However, the duration and severity of these yield drops varied amongst participants. A couple of participants insisted it took one year, while others explained it took six years to generate higher yields. The explanations for the yield drops varied among participants. Multiple respondents explained how the soil needed to adjust to the new situation without any chemical inputs, and another explained how farmers needed to gain the appropriate experience to overcome the yield drops. At last, one farmer mentioned that starting an intercropping farm with trees took six years to get good yields because of the slow growth rate of trees.

However, regional differences in the occurrence of an initial yield drop exist. Of the various respondents who reported an initial yield drop, more than half came from the Tenali region. In addition, all Tenali-based participants mentioned an initial yield drop duration of two to three years, and one mentioned it took six years to get over the initial yield drop. In contrast, A couple of Madakasira-based farmers indicated that the yield drop lasted one-year maximum. Another interesting result was that several Madakasira-based participants mentioned an immediate yield increase.

In the long term, perceived yields showed variability between participants, with a third of the participants stating their yields increased and almost half stating that yields decreased. Several respondents mentioned that it remains comparable to chemical farming practices. Again regional

differences occur since all the participants who reported an increase in yield were Madakasira based, while all who reported a drop in yields were based in Tenali. Decreases in yields were estimated from five to twenty per cent. Increases in yields were estimated by one participant at ten per cent, while others stated that comparison was difficult due to different crop use. One key informant explained the regional difference in the importance of pre-monsoon dry sowing. This farming technique allows farmers to grow vegetables during the summer. This season was usually neglected as a growing season. Since rivers irrigate Tenali well, water shortage is no issue, while the Madakasira is rainfed, hampering the growing of vegetables all year round.

The second way income could be boosted was through obtaining a premium price for ZBNF produce. A large majority of the participants indicated they could get a slightly higher price for their products. A third of the participants mention they do not get a higher product price. Participants' differences are based on where they can sell their produce. Larger-scale farmers (five and ten hectares) state how (inter) national buyers do not care about ZBNF produce and do not give higher prices for ZBNF produce. The other participants who stated that they do not receive a higher price stated that people were not interested in ZBNF products. About half of the participants mentioned they could get (slightly) higher prices indicating this was only possible through self-marketing their products. Self-marketing appeared to depend on the amount of social capital since consumers had to know the farmers, and their ZBNF practices, to pay a higher price. When participants would go to (local) markets, consumers were generally not inclined to pay higher prices due to cheaper, chemically farmed alternatives.

The marketing of products has a vital gender component: all women's self-help groups indicated this was primarily a male task (see Table 8). Other research has found that the marketing and selling of products by males increases women's dependency on their husbands (Sylvester & Little, 2021; Trevilla Espinal et al., 2021). Interestingly, some women did report they traded or sold their products during women's self-help groups, partially overcoming the gendered division of marketing and selling.

The last way to improve income is through the reduction of cultivation costs. Almost all respondents stated that their cultivation costs were (drastically) reduced, while the rest did not know if costs were reduced. Cost reductions were achieved by eliminating the need for expensive chemical fertilisers, pests, herbs, and fungicides. A couple of participants estimated their cost reductions at 75%, while one estimated it to be around 50%. Madesh, a Tenali-based farmer explained how he only sold his products through self-marketing. He explained how he had a good reputation in the village, which enabled him to do so:

'We get more money through self-marketing. If we go to market we get normal price[...]. I only do self-marketing and making [making is selling] by-products. [...] We get better price than chemical'

The effect of ZBNF practices on well-being

The second livelihood outcome is well-being and consists of three sub-themes. The first is health. Almost all participants related ZBNF practices to improved health. In line with the motivations behind adopting ZBNF participants (see chapter six), people reported improvements in health for two reasons. The first was an improvement in health by not using chemicals, while the second identified cause was the improvement of nutrient-rich diverse food. A third theme discussed here is the influence on labour which affects women of different economic classes differently. It is essential to understand that these results reflect the perceived influence of ZBNF on health. Careful interpretation is therefore required.

First, a minority of the participants stated that they perceived increased health by eliminating chemical inputs. All mentioned specific health issues which went away or were evaded in the long run. Half of these participants stated that health issues disappeared after they stopped using chemicals. The cured issues included a brain tumour, gastric problems and ulcers. The other half of the participants who mentioned chemicals as a cause of health issues stated that not using chemicals lowered the chance of getting diseases later in life. The health issues identified were disabilities in children, cancer, heart problems and skin diseases. Yadurai, a highly educated male farmer in his end twenties, explained that chemical inputs affect health:

'When we were spraying chemicals it will go through eyes, nose and mouth, and stomach. Something will happen, skin diseases. Sometimes men will die in chemical farming.'

Interestingly only male participants mentioned how eliminating chemical inputs could improve health. One explanation could be that spraying of inputs is a male job, and women do not experience pesticide problems. However, women prepare chemical inputs deemed equally toxic (see Table 8) (Mancini et al., 2005). The authors found that people from low economic are very much at risk because they engage in on-farm paid labour (often on large-scale farms) being involved with many harmful pesticides. Although this research did not find evidence to support this stance, it did find that women from a low class were more involved in agriculture and on-farm paid labour, potentially being exposed to pesticides more than middle-class women.

The second theme related to health is a result of improved nutrition and is mentioned by a quarter of the participants. Interviewees linked improved nutrition to increased immunity, more energy, lower blood pressure, lower chance of sugar disease, and not having to go to the hospital. Another way increased nutrition value was associated with ZBNF products is through portion control. One participant and one key informant mentioned that people require less food due to the proposed higher nutrient density of ZBNF products than chemical-farmed products. Ishani, a female farmer, explained that she and her husband converted their half-hectare nutrition garden to ZBNF practices. The family itself consumed most foods:

“We eat more different fruits we grow ourselves. [...] We give milk and turmeric to children for more immunity power. [...] We notice that the children are more active, normally their health would change when the climate changes, but now diseases won't come. They develop immunity.”

The last theme concerning well-being is increased labour associated with ZBNF practices which were mentioned by approximately a third of the participants. In addition, one key informant (farmer trainer) and two women self-help groups identified increased labour as a problem for further adoption of ZBNF. The effect of the increased labour is twofold. The first effect is that specific groups of women might experience a higher workload. As mentioned in Chapter Eight, women from lower economic class appear to spend more time on farm-related tasks. Due to the higher workload of ZBNF practices, women potentially increase farm-related work. This might become challenging since women of all economic classes are also, to a similar extent, engaged in other gendered activities such as cleaning, cooking and taking care of the children. It might be the case that women from lower economic classes might be more heavily burdened with the increased labour related to ZBNF. One key informant explained that increased knowledge of ZBNF practices might result in a higher workload because they know how to prepare inputs. She emphasised the need to discuss gender roles to divide the work equally.

In contrast, increased workload is not always perceived as negatively influencing well-being. A couple of interviewees and one key informant stated that the increased workload of ZBNF positively affected physical fitness. The respondents stated that they had more energy and strength. Tirthayaad, a farmer of almost eighty years old managing a food forest with fifteen different crops, explained how he would climb the six-meter-high coconut trees himself without any climbing gear:

“I am nearly eighty years [old] and very healthable (healthy) and fit. I climb the coconut tree and cut the coconut myself. [...] Other people [of my age] cannot do that anymore.”

Sustainable use of natural resources

The third theme of livelihood outcomes is related to the sustainable use of natural resources. When asked about the consequences of ZBNF on using natural resources, interviewees mentioned two different natural resources influenced by ZBNF practices. The first is using soil, which roughly a third of the interviewees mentioned. They explain how the soil, due to ZBNF practices, became less saline, increasingly biodiverse, less warm, disease-free, decreased pest activity or improved in general terms. There was no regional difference between Tenali and Madakasira; in both regions, three interviewees mentioned sustainable use of soil (by improving soil).

The second theme related to using natural resources was water retention which was also mentioned by a third of the respondents. Regional differences occurred since all participants mentioning water reduction were Madakasira-based farmers. Madakasira is a drier area that relies only on rain and groundwater, while Tenali is river irrigated with more accessible water access year-round.

One key informant explained that water retention was more important in the Madakasira region because of the intense dry seasons. During field observations, one Madakasira-based farmer trainer explained how mulching helped to retain water. Kausthuba, a female farmer who had managed her farm with ZBNF practices for five years, explained how the soil transformed and was able to retain more water:

“[chemical farming requires] water maintenance is every week, ZBNF only every eleven to twenty days. [...] If rain does not come for a month crops are good because [of] mulching. [...] ZBNF soil becomes like a sponge, chemical is very smooth.”

The changes in vulnerabilities for ZBNF households

The fourth theme regarding livelihood outcomes is the vulnerabilities of a household. This theme is highly interlinked with the sustainable use of natural resources. They differ because this category discusses how external factors interact with households who converted to ZBNF. More than a third of the interviewees mentioned that their vulnerabilities changed in two ways after converting to ZBNF. The first theme was the increased resilience of their farm to extreme weather events such as droughts. A couple of the participants explained how intercropping created higher resilience, stating that they could lose one crop and still have several others to sell. Other interviewees explained how the increased water retention of soils associated with ZBNF increased their resilience to droughts. Although other interviewees did mention that they needed less water compared to chemical farming practices, they are not included in this section because they did not relate it to external factors of extreme weather.

The second form of decreased vulnerability to external factors was related to the variability of (inter) national market prices for produce. A couple of interviewees indicated that ZBNF produce has a longer shelf life than chemically farmed products. This allows them to store their product and wait longer for a favourable price. This might be very useful when farmers sell their produce since prices on the national market are highly volatile. For example, the price of sorghum can vary widely between months and price fluctuations of eight per cent are not uncommon (Index Mundi, 2023). Javesh, a farmer who produced inedible sorghum mainly for international liquor production, explained how the longer shelf life of his sorghum made him less vulnerable to low prices:

“Any time price goes down, we took product in our home, storeroom, waiting for price increase. If price increases I will sell. Now possible because ZBNF creates better crops to store.”

Theme	Number of participants	Sub-theme	Number of participants
Health	14	Benefits from nutrition	4
		Benefits of not working with chemical inputs	6
		Labour	6
Income	14	Premium price	9
		Yields (long term)	Higher: 5 Similar: 3 Lower: 7
		Lower cultivation costs	14
Sustainable use of natural resources	10	Water	5
		Soil health/fertility	6
Vulnerability for shocks	6	Less vulnerable to extreme weather	4
		Less vulnerable to low (inter) national price shocks	2

Table 10: Number of participants who mentioned specific livelihood outcomes. In total, fifteen participants participated in the semi-structured interviews used for the results.

Conclusion

This chapter tried to capture how the livelihood outcomes of farmers had changed after adopting ZBNF practices. Respondents indicated that their income had changed in several ways. First, only farmers in the Madakasira reported higher yields, while Tenali-based farmers experienced a (small) drop in yields. Second, obtaining premium prices for ZBNF farmers appeared challenging, primarily for farmers producing for the (inter) national market. One way to obtain (slightly) higher prices was by performing self-marketing. At last, income was affected by a sharp decrease in cultivation costs due to substituting expensive synthetical inputs. Participants stated they experienced improved health from eliminating chemical inputs and higher diet diversity. This research found no evidence for improved mental health. Farmers also indicated they used natural resources more sustainably because ZBNF practices increased soil health and water retention capacity. At last, some participants indicated they were less vulnerable to external shocks such as price fluctuation and extreme weather.

These results show that ZBNF farmers perceive ZBNF as a positive change which establishes

itself on various outcomes. However, it is essential to understand that intersectional inequality also establishes itself in livelihood outcomes. The increased workload might affect the well-being of women of low economic class. Marketing and selling were perceived as a male job, while some evidence suggested that women have found ways to sell products through women's self-help groups. The various perceived positive livelihood outcomes show that farmers recognise ZBNF as a viable alternative to the industrialised food system.

Chapter Ten: Discussion

This chapter aims to relate the results found during this research with the already existing research surrounding agroecology. The first section discusses how the findings in this research relate to the literature discussing health and agroecology. Second, I will discuss what aspects of ZBNF transform or challenge the current food systems. Third, the role of intersectionality will be placed in the context of agroecology. Fourth, I will explain how these results relate to the broader field of international development. At last, I will discuss how biases, positionality and methodology shaped results and conclusions

Agroecology and health

As seen in chapters five and nine, health is one of the drivers and pillars of ZBNF. Besides being the most mentioned motivation to adopt ZBNF practice, almost every respondent stated that their health improved after adopting ZBNF. Both chapters show that farmers expect that ZBNF is better for health and perceive health improvements. As the results have shown, perceived health benefits were divided into two themes: benefits due to eliminating chemical inputs and increased nutrition due to nutrient-dense food and diet diversity. Farmer household health improvements are one of the ways agroecology claims to be a viable alternative for farmers (Frison & Clément, 2020). It is essential to understand that this research cannot claim that farmers' health has changed due to ZBNF. However, it can highlight if and how farmers perceive health benefits. Further research is required to understand if ZBNF indeed causes actual health improvement.

The first theme is the perceived health benefits of eradicating (toxic) inputs from the farm. Other research linked pesticides with serious health issues in the short term, such as acute pesticide poisoning, and in the long term, such as higher cancer rates and neurological diseases (Frison & Clément, 2020; Mancini et al., 2005). Despite the severe health conditions associated with pesticide use, scientific literature on the effects of agroecological practices on health benefits related to abstinence from pesticides does not yet exist (Bezner Kerr et al., 2022). However, participants reported both long and short-term effects of chemical pesticide use. Long-term effects such as cancers and tumours were mentioned several times. Short-term effects such as acute pesticide poisoning were also perceived as a consequence of chemical farming practices.

Health relates to agroecology through increased nutrition and diet diversity (Frison & Clément, 2020). In contrast to the health benefits of eliminating chemical input usage, this topic is more widely researched. First, organic produce appears, amongst others, to be higher in antioxidants (Baranski et al., 2014), vitamin C (El-Hage, 2013) and micronutrients (Hattab et al., 2019). It is important to notice that the results reflect organic produce and not agroecological produce due to a lack of data availability (Frison & Clément, 2020). However, these results are consistent with the evidence found in this research, with approximately one-third of the participants stating that ZBNF products were higher in nutrient density. A second route for improving health is to increase diet

diversity which can be achieved by consuming self produced agricultural products (Carletto et al., 2015). An essential aspect of own consumption is that the household cultivates various crops (Kumar et al., 2015). This research has shown that a majority of the respondents stated that they used their agricultural products for their food consumption. While also growing multiple crops through intercropping.

Third, this research showed that gender is related to health. In chapter seven, women indicated they learned about the (health) benefits during women's self-help groups. Women indicated health as their primary motivation to adopt ZBNF and used this argument to convince their husbands to adopt ZBNF. Furthermore, health is important in light of the intersectional identity of women from low economic classes. Chapter Eight showed how women perform several tasks next to their agricultural work, such as cooking, caring for the children and cleaning. Since women from lower economic classes are more involved in agriculture tasks, health could be affected in two ways. The first is that women reap the benefits of a more active lifestyle which was supported by a key informant on health and two interviewees. The second way the health of lower-class women could be affected is that ZBNF practices require, in general, more labour which increases the already heavy workload on low-class women, potentially adversely affecting health. It is crucial to notice that there was limited evidence for this statement since it was mentioned only by a key informant discussing gender.

Transformative nature of ZBNF

The critical aspect of agroecology is its transformative nature confronting the current industrial food system Gliessman (2018). This research found two ways in which ZBNF challenges the international food system. First, multiple farmers self-marketed, relying on local markets and social relations instead of (inter) national markets. Direct farmer-to-consumer sales allowed them to cut out the 'middlemen', reaping higher profits identified as a sign of confronting industrial (inter) national food systems (Bellamy & Ioris, 2017). Premium prices were difficult for farmers to obtain when operating within the (inter) national market. This aligns with evidence from other contexts, such as Europe and America (Bezner Kerr et al., 2022). In addition, agroecological practices, specifically intercropping, often conflict with the food system based on industrial-scale monocropping (Kremen et al., 2012). In accordance, marketing of ZBNF products was seen as a major issue due to the lack of interest of (inter) national buyers and local consumers. Two main barriers to transforming the food system were that some people were not interested in ZBNF products, while others stated that it was difficult to prove their produce was ZBNF. This shows how simply adopting ZBNF practices at the farm level cannot transform the food system as a whole (Bellamy & Ioris, 2017).

The second way ZBNF practices challenge the status quo of the industrialised nature of (inter)national food regimes is by eliminating the need for chemical inputs (Holt-Giménez & Altieri, 2013). This status quo relies heavily on external inputs replaced by ZBNF inputs. The results of this research showed that the motivation for cutting out chemical inputs is the related cost reduction which

was almost unanimously mentioned by the participants, which is in line with earlier findings (Khadse et al., 2018; Koner & Laha, 2021). The cost reductions achieved by cutting out chemical inputs are associated with reduced debts. Consequently, they might address farmer suicides linked to farmer indebtedness (Kennedy & King, 2014).

Intersectionality and agroecology

A central theme within agroecology is creating a just food system and addressing power differences (Gliessmann, 2018; Bezner Kerr et al., 2022). One field of power differences is related to gender inequality and can establish itself on different levels. Women participants indicated they were solely engaged in household and domestic tasks while performing agricultural tasks. However, due to the increase in workload associated with ZBNF, women, especially those from the low economic class, could face a heavier double time burden. Because women from a low economic status were more involved in agriculture (own land or on-farm paid labour) than women from the economic middle class, the double time burden could potentially increase the most for the low economic class. One key informant explained how this limited the adoption of ZBNF practices. Women spend a significant amount of time on farming but already face high workloads due to the double time burden. Since ZBNF is often associated with a higher workload, women might hesitate to adopt ZBNF practices.

In addition, gender-specific agricultural tasks potentially create a heavier time burden for women, although evidence is limited. Weeding, sowing, and transplanting were perceived to be typical female jobs. It is important to notice that two participants indicated that by adopting ZBNF practices, weeding was increasingly necessary. This could indicate that women face increased workloads because of this gendered task. Similarly, input preparation was perceived as a job for both men and women and was recognised as a primary driver for increased agricultural work. Considering the already heavy burden of domestic work, input preparation might affect women differently than men (Trevilla Espinal et al., 2021).

These results aligned with research from Costa Rica and Mexico, which found that the triple time burden for women hindered the adoption of agroecological practices (Lyon et al., 2017; Sylvester & Little, 2021). Women faced social and reproductive next to agricultural responsibilities creating a lack of time. The authors describe how women stated they wanted to share the responsibilities for household work so they could spend more time on the farm.

Another way this research approached intersectionality was through agricultural-related decision-making within households. The results showed that most decisions were shared, while male-dominant decisions were more prevalent than female-dominated decisions. However, women from lower economic classes reported lower rates of male-dominated decisions and higher rates of decisions taken together. Multiple participants and self-help groups indicated that these decision-making divisions resulted from tradition and culture. Since the data did not elaborate on what participants meant by 'culture' and 'tradition', it is essential to understand that tradition and culture are constantly

changing and very broad concepts. Caution is required when interpreting these results since it is unclear what the participants described by mentioning ‘culture’ and ‘tradition’. Other research has linked traditional systems of inheritance to land access which appeared to explain a difference in the decision-making of women with access to land (Dagdeviren & Oosterbaan, 2022; Larrauri et al., 2016; Trevilla Espinal et al., 2021). Some evidence of this research supported these findings.

The last step is to investigate if the perceived roles of women in agricultural tasks and decision-making have changed due to the adoption of ZBNF practices. Except for increased knowledge surrounding ZBNF, this research did not find any results that point to a change in women's agricultural activity or decision-making. This lines up with other research from India who also did not find an effect of increased involvement in agriculture on decision-making (Pattnaik & Lahiri-Dutt, 2022). Limited evidence from other research indicates that agroecology can change intra-household labour division and decision-making if participatory learning discussing these issues is in place (Bezner Kerr et al., 2019). One gender expert underlined the importance of educating men and women about equal labour division and intra-household decision-making to change its long-standing division.

Agroecology and its implications for development

Agroecology has been posed as an answer to the many problems present in today's food system. While some reports linked it to addressing SDG2 (end world hunger), others state it could be important in mitigating climate change (Caron et al., 2018; IPCC, 2019). Furthermore, agroecology strives for a more just food system addressing issues such as farmer indebtedness, health and income (Gliessman, 2018). Consequently, agroecology is closely linked to development on many different scales. Therefore key drivers for ‘scaling’ have been identified. Scaling has been defined as a process including more farmer households and acreage devoted to agroecology, which engages more people in processing, distribution and consumption (Mier y Terán et al., 2018). The key drivers are characteristics which are related to agroecological projects around the world. I will discuss the following themes based on critical drivers pushing agroecology to scale: 1) co-creation and knowledge sharing, 2) advocating for human and social values, 3) the creation of favourable markets, 4) the presence of a crisis (Barrios et al., 2020; Mier y Terán et al., 2018).

The first way ZBNF relates to scaling agroecology is through ‘constructivist learning and co-creation of knowledge’ (Mier y Terán et al., 2018). This driver describes how farmers should learn together, share knowledge and co-create knowledge surrounding agroecological practices. This research has found several examples of co-creation of knowledge in the form of women's self-help groups, farmer-fields schools, collective ZBNF input preparation and informal gatherings to compare farms. Notably, women from the Tenali middle class perceived attending farmer field schools as a male task excluding women from acquiring more practical knowledge. Women from the low class in Tenali and middle class in Madakasira did not think this was a male task and claimed to be engaged in

this form of co-creation. Therefore middle-class women might be excluded from applying theoretical knowledge in practice through farmer fields schools.

A second driver for successfully scaling agroecology is that the programme or promoted principles emphasise human and social values such as dignity, inclusion, equity and justice (Barrios et al., 2020). The authors state that agroecology programmes or principles should address power imbalances, such as women's inequality, to realise an extensive adoption because these values improve multiple livelihood outcomes for many people. This research did not find strong evidence that ZBNF changed role patterns or women's decision-making in ZBNF. Some evidence hinted that ZBNF practices might even negatively affect women due to the increased workload associated with ZBNF. Due to the double time burden of women, increased workload might have a negative effect. Women from the low economic class might face the most substantial consequences of the increased workload because they are already most engaged in agricultural tasks next to their household and domestic work.

The third key driver to scale agroecology is the availability of a favourable market for agroecological products. ZBNF showed how the lack of a favourable market could be overcome to contribute to a more local, direct farmer-to-consumer economy (Barrios et al., 2020; Mier y Terán et al., 2018). Most farmers who reported that they could receive higher prices for their ZBNF produce stated they did perform self-marketing. They depended upon people who came to visit their farms to purchase their products. Creating favourable markets also has an important gender component since men sell and market agricultural products (see Table 8). The markets should also be created to provide opportunities for women to sell products. The exclusion of women from food markets has been associated with increasing dependence on male family members, negatively affecting the autonomy of women (Sylvester & Little, 2021; Trevilla Espinal et al., 2021). However, this research found some evidence stating that sometimes women could sell products through women's self-help groups. It is essential to understand that the local structure of selling products through self-marketing might be affected by the introduction of (inter) national markets. These connections to international players might limit the food sold through these local networks and thereby (unwillingly) diminish the already limited control of women over agricultural produce sales (Khadse & Rosset, 2019).

A fourth driver that enabled the mass adoption of ZBNF was the presence of multiple (agricultural-related) crises (Mier y Terán et al., 2018). Farmers in Andhra Pradesh faced several aspects of the agrarian crisis, such as farmer indebtedness, suicides, health problems and groundwater loss (Veluguri et al., 2021). The results provided insight into how ZBNF addressed health problems and indebtedness by substituting chemical inputs for own produced inputs. At the same time, mulching and increased soil health were perceived to address the lack of water availability, especially in the Madakasira region. By addressing the issues associated with industrial agriculture, ZBNF might have attained scale. Due to the beneficial livelihood outcomes associated with agroecology, diversified farms might expand, as is the case in countries and regions with lower rates of industrial agriculture

(Kremen et al., 2012). This theory is supported by findings from this research which showed that the industrialised agriculture in the Tenali region had a far lower adoption of ZBNF practices compared to the more traditional agriculture in Madakasira.

Biases and limitations

Caution must be applied when interpreting these results due to their potential bias towards positive and active ZBNF farmers. The sample consisted of people known to RySS employees, and the study areas contained ‘model villages’ (See limitations in chapter Four for further elaboration). I felt like these characteristics shaped my results by interviewing people who favoured ZBNF practices and strategy. For example, I only found positive effects of women’s self-help groups, while other research found some adverse effects (Vaessen et al., 2014; Duvendack et al., 2014). This could suggest that hidden adverse effects of the programme exist but were not captured during this research. Additionally, my positionality and low availability of low-economic-status respondents and women’s self-help groups have limited the presence of low-economic-class respondents. When interpreting results, it is essential to understand that they are based on a small purposive sample aimed to extract as much information as possible from different viewpoints instead of creating a representative sample of the state of Andhra Pradesh. Therefore one must be very careful with generalising the results of this research to other contexts or Andhra Pradesh as a whole. At last, due to the relatively short period of research (three months), trends taking place on longer time scales might not be captured. An example could be that this research found no evidence of changing gendered or intersectional role patterns, which might take place on a larger time scale.

Chapter Eleven: Conclusion

This research set out to investigate how gender and economic class are embedded in the spread of ZBNF practices and their livelihood outcomes in Andhra Pradesh. To do this, intersectional inequalities were identified comprising gender and economic class. The analysis was done on different scales, revealing some interesting (power) dynamics.

The first part of the research has shown that the availability of household livelihood capitals can enable the adoption of ZBNF practices. These capitals consisted of land size, tenancy, availability of indigenous cows and physical capital such as bore wells. The availability of household livelihood capital was shaped by intersectional inequality showing that the low economic class possessed no land and had limited access to lease lands.

When zooming in to the livelihood capitals of women who participate in women's self-help groups differ from the reported household livelihood capitals. The self-help groups created social capital allowing women to sell and trade products while indirectly affecting other livelihood capitals. The participants of women's self-help groups indicated that women had access to finances and gained knowledge about ZBNF increasing their human capital. The access to financial capital also increased the availability of physical capital. In this way, women's livelihood capitals of women could, in theory, help to adopt ZBNF.

However, women did not appear to be able to transfer all these individual livelihood capitals into adopting ZBNF practices. First, women were faced with a double time burden of being responsible for household and domestic work while performing agricultural tasks. Second, women were only involved in specific agricultural tasks. Additionally, women perceived they had little influence on specific agriculture-related decisions, potentially limiting the translation of individual livelihood capitals into adopting ZBNF.

At last, this research zoomed out again to investigate how ZBNF practices affect the livelihood outcomes of households. Furthermore, intra-household differences in livelihood outcomes have been investigated. The research showed that on a household level, people perceived that health improved, cultivation costs went down, vulnerability for external shocks decreased, and natural resources were managed more sustainably. When zooming in, differences occurred between household members. Women from low economic classes who adopted ZBNF might face a higher workload than the middle class due to their higher involvement in agriculture and double time burden. Women indicated that they did not sell agricultural products, potentially increasing their dependency on their husbands. At last, women might benefit from eliminating chemical inputs since they are involved in mixing chemical inputs which can be highly toxic (Mancini et al., 2005).

This research has shown how analyses on different scales unravel dynamics otherwise hidden. Looking beyond the household level by zooming in, differences in livelihood capitals and intra-

household power dynamics became clear. It showed that women from different economic classes connected differently to ZBNF practices and livelihood outcomes.

Policy implications

My first policy implication is that the RySS or aligned organisations should analyse the local social networks of women's self-help groups that differ amongst economic classes and regions. However, more social categories such as caste, religion and age could play an important role. Although practices are somewhat rooted in the local context, extra attention should be given to the intra-household dynamics. This is necessary to divide the labour between men and women equally so the burden of the extra work is shared equally. Since the RySS relies heavily on women's self-help groups to spread knowledge, it is crucial to understand how groups differ to understand what each group needs.

A second policy implication would be to focus on supporting tenant farmers financially. In the current situation, tenant farmers are afraid to change their farming practices due to the (perceived) initial yield loss and transition time. It is essential to understand that the tenancy structure is highly complex and challenging to change. A suggestion could be that the RySS, or other organisations, function as a bridge between the large landowners and the low or middle class to ensure lease periods for multiple years so farmers can transition to ZBNF.

To ease the transition period further, I would offer an insurance policy to compensate farmers trying to transition towards ZBNF. This would cover the losses in yields of the initial years, giving the farmers more time to get experienced with the practices. Another way could be through certification of ZBNF products, which is currently in its beginning stages. I want to stress that certification should not compromise the ability of people to sell their products through self-marketing. I have two notes of caution. One, through certification, ZBNF products might become more attractive for (inter) national buyers. Although it could result in higher prices, it could also decrease the opportunity for women to sell agriculture through their social network since selling produce to buyers or at markets is perceived as a man's job. My second note of caution relates to the potential that people will notice the value increase in their products and potentially limit their intake. Other contexts have shown how commercial farmers in Uganda would limit their food uptake because of the market production (Ntakyo & van den Berg, 2019). Since health is a pillar of this programme, it is essential to consider this dimension when designing certification programmes.

Further research

My first proposal for further research is to investigate the role of intersectional identities within agroecology to understand which people benefit from the transition to agroecology. The first step is to go beyond the categories of gender and economic class to gain a more complete picture. My second proposal in this field would be to see if and how agroecology relates to the empowerment of certain groups. Since agroecology tries to address power inequalities in the food system, it is essential

if it empowers groups of specific intersectional identities in their current forms worldwide. This would add to an emerging but, in my opinion, somewhat under-researched field of intersectionality and agroecology.

My second suggestion would be to investigate the role of the youth in ZBNF. During this research, I spoke to many young people and their parents, who stated they were unwilling to engage in agriculture. This might seriously threaten the gains made by agroecology over the past years. Research should focus on why young people do not want to engage in agriculture. This theme has not received the attention it deserves (Bezner Kerr et al., 2022).

A third recommendation of research should focus on the impact of agroecology on people with low access to food. Agroecological produce has been associated with higher prices which might affect access to food for the poorest people. In many places in the world, people depend on imported cheap food, and attention should be given to the impact of large-scale agroecology on these groups of people.

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Appendix

Interview guide

Introduction

This interview is conducted to understand how the ZBNF programme influenced your livelihoods. I am especially interested in how your life has changed after adopting the ZBNF practices. In addition, I am interested in the role of SHGs and women's decision-making related to ZBNF. Everything you tell me won't be shared with others and will be anonymous. Your name will not be used and I will make sure that no one can relate your answers to you. Is it okay if I record the interview to re-listen to your answers? Do you have any questions? If you have any questions regarding my research you can always contact me at [my telephone number] or contact my person of reference [translator phone number].

Background information

No. interview:

Age:

Land acreage:

Opening questions

1. What do you do on a day?

Probe: workload, social network

2. Who is the head of the farm?

Probe: emancipation, empowerment, woman empowerment

3. What are the main crops you grow?

Probe: farm structure, important crops

4. What do you do with your grown food?

Probe: own consumption, livelihood strategy

5. Why did you adopt ZBNF practices?

Probe: Motivations for ZBNF, earlier agricultural challenges

6. What practices did you adopt?

Probe: Intensity of ZBNF, scale of adoption, animal husbandry, indigenous seeds

Questions about expectations and reality

7. What were the most important factors enabling the transition to ZBNF?

Probe: crucial programme characteristics, social capital, knowledge, communication

8. What was the biggest change in your life after adopting ZBNF methods?

Probe: most important capital change,

9. What were the challenges when adopting ZBNF?

Probe: challenges, problems,

Questions about specific livelihood capitals

SHG and livelihoods

10. What are the activities of SHGs?

Probe: perceived activities of SHG, livelihood assets

11. What do you [or your wife] learn from SHG meetings?

Probe: female livelihood assets,

Intra-household decision making

12. What are the on-farm tasks for different family members?

Probe: on-farm family roles,

13. How do you make decisions regarding your farm?

Probe: role of women decision making,

Impact of ZBNF on household livelihoods

Social capital

14. Where do you learn new practices surrounding ZBNF?

Probe: knowledge co-creation, presence of farmer to farmer networks

Natural capital

15. How did ZBNF practices affect your yields?

Probe: Natural capital, production

16. How does ZBNF relate to climate change?

Probe: environmental services, farm resilience

Financial capital

17. How did ZBNF practices affect your operational costs?

Probe: external input cost reduction,

18. How did ZBNF practices affect your labour time?

Probe: work hours, labour costs, capacity to work

19. How did ZBNF practices affect the prices for your products?

Probe: premium price for organic produce, income

20. How did ZBNF practices affect your net income?

Probe: net profitability, financial capital,

Human capital

21. How did ZBNF practices affect your health? If yes what advantages in health?

Probe: Human health, sickness, mental health

22. How did ZBNF affect your meals, are you becoming more food secure?

Probe: Meals a day, nutrition density, varied diet

Physical capital

23. How did the availability of physical assets affect the adoption of ZBNF?

Probe: need for machines, need for cattle,

Closing questions

24. How did ZBNF influence your future?

Probe: Resilience, sustainability,

25. Would you recommend ZBNF practices to other farmers?

Probe: Satisfaction with the programme

Characteristics of interviewees

Interviewee number	Pseudonym	Gender interviewee	Crops	Size HA	Lease/ownership	Region	NF how long
1	Tirthayaad	M	Intercrop	0.5 hectare	Own land	Tenali	35 years
2	Javesh	M	Sorghum	4 acre	Lease + own land	Tenali	6 years
3	Panchavakra	M	Edible sorghum	10 hectare	Lease + own land	Tenali	4 years
4	Ishani	V	Intercrop	0.5 ha	Own land	Tenali	2 years
5	-	V	Intercrop	4 ha	Lease	Tenali	3 years
6	Madesh	M	-	-	Own land	Tenali	4 years
7	Bhartesh	M	Intercrop	5 hectare	Own land	Tenali	4 years
8	Laxmidevi	V	Intercrop	4 acre	Own land	Tenali	2 years
9	Yaduraj	M	Intercrop + flowers	6 acre	Own land	Madakasira	1 year
10	-	V	Intercrop	1.5 acre	Own land	Madakasira	2 years
11	Nishant	M	Intercrop	7.5 acre	Own land	Madakasira	5 Years
12	Govindraaj	M	Intercrop	0.8 acre	Own land	Madakasira	3 years
13	-	M	Maise	1.5 acre	lease	Madakasira	5 Years
14	Anandi	V	Intercrop	4 acre	lease	Madakasira	5 Years
15	Kausthuba	V	Intercrop	5 acre	Lease + own land	Madakasira	5 years

Table 11: Interviewee characteristics

Codebook

Code	In/deductive	Description	Example	Not an example	Reference
1. SLF: financial capital	Deductive	Impact of ZBNF practices on financial assets such as production cost reduction, premium price for produce, net income changes.	'in chemical farming cultivation costs for one acre are 1 lakh, for natural farming we need only 20000 to 25000 per acre, we save 75% of costs' (Interviewee 4)	'we get higher yields from natural farming compared to chemical farming' (Interviewee 14) <i>This code is related to financial assets but are by the natural capital.</i>	Reddy et al., 2019; Bharucha et al. 2020; Serrat, 2008
2. SLF: Human capital	Deductive	Impact of ZBNF practices on the relation with one's body and skill set such as health, mental well-being, increased knowledge.	'we do the work more freely and energetically, more energy will come. We are more strengthly, and we get no health issues' (interviewee 7)	'health is the most important reason to convert to ZBNF' (interviewee 9) <i>Although discussing health issues it describes motivations and expectations of ZBNF and not their own perceived impact of ZBNF on health.</i>	Serrat, 2008
3. SLF: Social capital	Deductive	The role of social networks within enabling different aspects of ZBNF. Examples are the use of family network for marketing, neighbouring farmers.	'We talk regularly to other farmers, we ask what they need. If they need anything we will give. If I don't have anything I will get it from them' (interviewee 7)	'In self help groups we discuss different cropping [schemes], financial problems and social issues' (interviewee 4) <i>Although this quote relates to social capital it discusses social capital in the light of SHGs for which a separate code is developed.</i>	Khadse & Rosset, 2019; Kumar et al., 2021
4. SLF: Natural capital	Deductive	Natural capital entails the natural assets of a farmer explaining different topics such as yields, soil fertility, environmental services.	'Sometimes rains are not coming perfectly. At that time NF is better for the crops. Crops will be healthy and good. ' (interviewee 12)	'we get more money for intercropping because if one crop is damaged we still have more other crops' (Interviewee 4) <i>This is not an example because the financial consequences are described of crop damage and not the natural resilience such as yields.</i>	Duddigan et al. 2022; Smith et al., 2020

5. Reason for adopting ZBNF practices	Inductive	The main reason(s) why participants adopt ZBNF practices. This code describes the motivations and expectations driving ZBNF adoption. Examples are increased health, cost reduction, soil fertility, helping society.	‘this soil became salty, to improve the salty soil ... it becomes difficult to grow so that’s we converted’ (Interviewee 3) ‘the [chemical farming] costs were too high’	‘we get more money for intercropping because if one crop is damaged we still have more other crops’ (interviewee 4) <i>This is not an example because it does not describe the reason why people adopted ZBNF. It mentions a benefit but not the motivation to convert.</i>	-
8. Adopted practices	Deductive	This describes the nine different principles and practices posed by the RySS and Palekar four wheels. Examples are Ghana Jivamrutham, Botanical extracts, mulching, intercropping, PMDS.	‘firstly, I adopted Jivamrita after 15 DJ, when we find a pest I will use botanical extract’ (Interviewee 3)	‘When I participate in FFS, we discuss pests and diseases, and inputs’ (Interviewee 12) <i>Although practices are discussed they do not mention specific practices. The focus here is on FFS not on adopted practices</i>	Palekar, 2005; RySS, 2023
9. Division of labour	Inductive	Description of the work and labour women perform on and off farm. These can be specific activities such as weeding and harvesting or more general in the form of fieldwork. Aims to capture the distinct livelihood activities of (wo)men within farmer households.	‘Hard works like ploughing are men jobs while planting, weed removing and harvesting the women will do’ (Interviewee 14)	‘due to increased weeds we need more manpower to this is the most difficult’ (interviewee 4) <i>Although labour is discussed no division of labour is discussed here.</i>	
10. Intra-household decision making	Deductive	Description on what decisions are made by women regarding the practices performed on the farm. Relates to the topics and differences in decision power. Examples are descriptions of who takes the decision, how households reach decisions.	‘[if] my mother works in the field and find a pest or disease she will make a suggestion to me, me and my father decide to do it or not ’ (interviewee 10)	-	Goudappa et al., 2012;
12. SHG impact on female farmer livelihood assets	Deductive	Description on how SHGs affect the livelihood capitals of participating women. Examples are knowledge creation and access to financial loans, marketing through network.	‘It is now Kharif season, so we will decide what we are going to do, the preparation of inputs, seed treatments’ (interviewee 14)	‘I am part of an SHG and I learned from the SHG leader’ (interviewee 4) <i>Human capital in the form of knowledge is discussed however this question was an answer to where</i>	Sato et al., 2022;

				<i>their knowledge originated and is covered by code 15.</i>	
13. Destination of the food	Inductive	How is the produced food used. This can relate to selling and self consumption	'We eat the most food ourselves but if we have anything left we sell it to other in the village' (interviewee 3)	-	
14. Main constraints:	Deductive	This code describes the main difficulties related to ZBNF. These can include difficulties before, during and after adopting ZBNF practices. Examples are an increased workload, lack of cattle, marketing difficulties.	'due to increased weeds we need more manpower to this is the most difficult' (Interviewee 4)	'Sometimes rains are not coming perfectly' <i>Although this is a problem, it is not related to the adoption of ZBNF practices</i>	Laischram et al., 2022
15: Origin of ZBNF knowledge	Inductive	Where did the participant learn initially about ZBNF. Examples are SHG meetings, neighbour farmers, family members, Palekar trainings.	'I went to a Palekar training and ICRP explained how to do NF' (Interviewee 12)	'They discuss during the season which crop needs to be sowed and which pest present in our area' (interviewee 3) <i>This quote is discussing knowledge creation, however this is not the origin of their ZBNF knowledge and therefore not covered by this code.</i>	
16.Future of ZBNF	inductive	This code describes what interviewees think are the future challenges and opportunities of ZBNF. These challenges and opportunities lie ahead in the future and are not immediately felt right now.	'if youth is not coming to agriculture will die in the near future' (Interviewee 3)	'Some marketing problems are there, it is difficult without certification' (interviewee 4) <i>This quote is describing a problem but it is a current one and does not relate to the future prospects of ZBNF.</i>	
17. Land ownership	Inductive	This code describes how landownership is divided. In addition it will cover land ownership dynamics such as explanations impact of farming practices. Examples are the impact of male inheritance, tenancy, marriage.	'there are too many farmers and less land, if someone will not pay somebody else will pay. There is too much competition' (Interviewee 7)	-	

