Upscaling agroecology in Sweden:

A participatory-backcasting approach to investigate top-down measures for promoting an agroecological transition of the Swedish agricultural system

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Uppskalning av agroekologi i Sverige: En deltagande-backcasting-strategi för att undersöka top-down-åtgärder för att främja en agroekologisk omställning av det svenska jordbrukssystemet.

Pablo Ratti

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Abstract

Alongside its important contribution to the increase of yields, industrial agriculture has also generated environmental, social and economical negative side effects. Moreover, the forecasted growth of the world's population puts more pressure for solutions on how to increase food supply while reducing the negative effects of the current agricultural system. Despite having one of the most sustainable agricultural systems, Sweden presents unsustainable features such as: biodiversity loss, eutrophication, soil wear, and water pollution, high production costs, profitability challenges, low competitiveness in comparison to imported food, unsecure working conditions, rural exodus, and low societal understanding about agriculture.

Under the light of these problems, agroecology has been pointed out by researchers, grassroot movements and FAO as a key framework to achieve a food system that is socially, economically, and environmentally sustainable.

Therefore, this thesis is motivated by the challenge of feeding a growing population while increasing the sustainability and resilience of the agricultural system as well as the lack of scientific literature on how to promote agroecology through top-down approaches. Thus, the aim of this research is fourfold: (i) advance the discussion on how to facilitate an agroecological transition of the swedish agrifood system through top down measures, (ii) design an agroecological Swedish Agrifood System scenario, (iii) identify main changes between the current SAS and the idealised scenario and (iv) recommend participatory policies that address the necessary changes. So as to achieve these goals, a partly new methodology was adopted. The methodology is developed through semi-structured interviews - with farmers, researchers and a grassroot organisation - thematic analysis and backcasting.

The thematic analysis identified seven themes and eleven sub themes related to the characteristics of an agroecological Swedish agrifood system and the necessary changes to achieve it. Furthermore, five themes and seven sub themes were identified regarding the government's actions in order to promote an agroecological transition of the Swedish agrifood system.

The main features of the agroecological scenario are the focus on resilience, self-supply, developing a new food culture, application of agroecological practices, strong urban agriculture, sharing of information among farmers and decentralised marketing of food. The identified key changes so as to facilitate the emergence of this scenario are: political focus, subsidies orientation, increased communication among farmers, adoption of agroecological principles and the marketing system. By last, the recommended policies to address such changes are i) subsidise smallholders committed to local production and marketing, ii) regulate the adoption of unsustainable agricultural practices, iii) act as the main

buyer, in the municipal and regional level, or one of the main buyers of local produced food in order to supply public schools, elderly houses and public institutions, iv) establish a new labelling system that benefits the producers who adopt sustainable practices and v) creates a national platform where farmers can exchange information and look for reliable data.

The results of this research contribute to the advance of the discussion on agroecological transitions by I) putting the farmers' opinions in the centre of the decision making process of elucidating a possible pathway on how to upscale agroecology in Sweden through the designing of an agroecological scenario as well as the policies that could address the necessary changes and hence facilitate/promote the upscaling of such a scenario, ii) reinforce the multiscale approach for the transformation of agrifood systems and iii) envision an agrifood system in Sweden that is environmental, social and economical sustainable, identify key changes, and design policies that address such changes.

Preface

You are about to read the master thesis “Upscaling agroecology in Sweden: A participatory-backcasting approach to investigate top-down measures for promoting an agroecological transition of the Swedish agricultural system”. This study has been written so as to conclude the Agricultural Sciences graduation program at the Swedish University of Agricultural Sciences. I have been engaged with the research and the writing of this thesis since March 2022.

Since an early age, while growing up in Brazil, I have been bothered by the environmental, social and economical problems that affected my country. Along the years my discontentment became global and the urge to act in pro for a better world got stronger. Thus, the idea of researching agroecological transition through participatory policies comes from my desire for change combined with the will of including the farmers in the policy making process.

This study is the peak of my academic journey and represents different skills that I have acquired during my master studies. During the second year, when the students of the program had the opportunity of choosing which courses to attend, I made the happy choice of attending the “Future studies techniques course”. In this course I have learned, among other methods, the backcasting approach. From the moment I got in touch with it, I started thinking about the possibility of developing a participatory-backcasting approach so as to put the farmers in the centre of the research and blend together the collective visions and desires of farmers, scenario planning and participatory top-down measures. Despite applying a partly new methodology, the overall process of data collection and analysis as well as the design of an agroecological scenario and design of policies proved to be satisfactory from a personal and scientific point of view.

By last, I would like to thank my supervisors, Dr. Magnus Ljung and Dr. Jenny Höckert, family and friends for their support. For you my reader, I hope you enjoy reading this study.

Pablo Ratti

Malmö, March 10, 2022

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Abbreviations

GR	Green Revolution
IA	Industrial Agriculture
GHG	GreenHouse Gases
SI	Sustainable Intensification
EI	Ecological Intensification
FAO	Food and Agriculture Organization
SAS	Swedish Agricultural System
AFS	Agroecological Farming Systems
IFS	Industrial Farming Systems
CAP	Common Agricultural Policies
AES	Agri-environmental schemes
PRA	Participatory Rural Appraisal
SAAS	Swedish Agroecological Agrifood System

1. Introduction

1.1 General Introduction

The Green Revolution (GR) techniques, implemented around a decade after the second world war, were responsible for a fast increase of the yields of certain grains (such as rice and wheat), decreasing food prices and hunger diminishment (Gliessman, 2015; Altieri, 2002). The pack of techniques which characterises GR includes: intensive tillage, monoculture, use of synthetic fertilisers, heavy irrigation, chemical pest and weed control, manipulation of plant and animal genomes, heavy use of antibiotics and factory farming of animals (Gliessman, 2015). Despite its current capacity of mass production of food, modern-day Industrial agriculture (IA) cannot maintain the same productivity level for a long period of time. Gliessman (2015:03) argues that the unsustainability of IA arises from the deterioration of "the basic foundations of agriculture - fertile soil, available moisture, amenable climate, nutrient recycling, genetic diversity, and the ecosystem services of natural systems".

After about six decades of the implementation of these techniques, the social, economical and environmental negative effects - hunger, obesity, waste, rural exodus, food insecurity, water pollution, greenhouse gas emission, soil degradation, biodiversity loss, etc. - of our food system have been increasingly recognised (MISTRA, 2019). Going more in depth, it is estimated that the food system is responsible for between 21-37% of greenhouse gases emission (Mbow et al. in press). More specifically, the food system is responsible for half of the methane and 45% of nitrous oxide emitted by anthropogenic production (Lynch et al. 2021; Mbow et al. in press). When narrowing down to activities done within the farm gate - excluding associated land use activities, such as deforestation and drainages - agriculture answers for 10% of the total greenhouse gas (GHG) emission mainly correlated to livestock production and application of chemical fertilisers (Tubiello, 2022). Therefore, agriculture represents one of the most polluting human activities contributing to climate change. An important factor for the participation of agriculture in GHG emissions is the heavy dependence of fossil resources in IA. Woods et al (2010) argue that while the agrarian system keeps dependent on non renewable resources - for crop management, fertilisers, pesticides and machinery production - the food prices will fluctuate correlated to fossil energy prices and agriculture will remain a major contributor of GHG emissions. Such correlation is easily verified nowadays due to the events of the

unfortunate war between Russia - the biggest producer of mineral fertiliser in the world - and Ukraine.

Despite being pointed out as one of the countries with the lowest chemical pesticides and fertilisers use, the Swedish agricultural sector was responsible for 6.8 million tonnes of carbon dioxide equivalents, or 13% of Sweden's total greenhouse gas emissions in 2019 (SME, 2020). The predominance of the so-called "cost-effective" farms normally built around a monocultural linear system brings up other environmental problems such as biodiversity loss, eutrophication, soil wear, and water pollution. Furthermore, the current Swedish agrarian system also presents unsustainable social and economical characteristics, such as high production costs, profitability challenges, low competitiveness in comparison to imported food, unsecure working conditions, rural exodus, and low societal understanding about agriculture.

Due to the associated problems of industrial agriculture, there is an increasing consensus about the need for a paradigm transformation of the agrifood system (Altieri & Rosset, 2017; Gliessman, 2015; HLPE, 2019; Hebinck *et al,* 2021; Parmentier, 2014; Weber *et al,* 2020; Wezel *et al,* 2020; Sachet *et al,* 2021; Duru *et al,* 2015; Gonzalez *et al,* 2018; Lopez-Garcia *et al,* 2021; Lopez-Garcia & Molina, 2021). As a result of the debate around the negative side effects of industrial agriculture and the necessity of feeding a growing population within the world limits, two different discourses have emerged: (i) sustainable intensification (SI) and (ii) ecological intensification (EI).

SI does not have a precise definition, however, it is widely perceived that SI aims at increasing production while minimising environmental damage (Xie, *et al*. 2019; Petersen, *et al*. 2015). Given the lack of definition, there are many practices that are considered part of SI: precision agriculture, use of genetic modified crops, conservation tillage, crop rotation, use of biofuels, specialisation (monocropping or reduced number of crops), cultivation of flex crops, integrated pest management, and generation of ecosystem services (Xie, *et al*. 2019; Petersen, *et al*. 2015; Tittonel, 2014; Struik & Kuyper, 2014; Struik & Kuyper, 2017; Loos, *et al*.2014).

On the other hand, in general terms, EI is characterised by: the use of traditional knowledge to reduce production gaps while reducing external dependence through an ecological design in such a way that a semi-closed system endowed of feedback loops is created, enhancing stability and productivity as well as resource use efficiency and ecosystem services and increase resilience through bigger tolerance to abiotic and biotic stresses (Struik & Kuyper, 2017; Altieri *et al*, 2013). There are several different models of EI: agroecology, organic agriculture,

diversified farming systems, nature mimicry, and some forms of conservation agriculture (Tittonel, 2014).

The agroecological model of intensification is used as a departure point for this research. Agroecology represents a paradigm shift of the agrifood system. Agroecology is a practice, social movement and scientific approach that aims to provide social, economic, and environmental resilience and sustainability through the re-integration of the ecosystem in the agricultural system. Agroecological principles and practices have been pointed out by international institutions (FAO, 2015), researchers (Gliessman, 2015; Altieri, 2002), and social movements (La Via Campesina, Rural landless workers in Brazil, Nordbruk) as a key framework to achieve a food system that is social, economic, and environmental sustainable. It is important to highlight the social aspect of agroecology to understand what it means, since it can be easily incorporated into the SI discourse when taken into consideration merely as a set of practices or as a scientific approach (Wezel *et al,* 2020; Sachet *et al,* 2021). The inclusion of the social aspect to agroecology is translated into the transformation of the farmers from a "research object to a research actor" (Sachet *et al,* 2021:03).

In accordance with the change of farmers' role, there is an increasing concordance - between researchers - about addressing agroecological research through participatory methods (Parmentier, 2014; Weber *et al,* 2020; Wezel *et al,* 2020; HLPE, 2019; Sachet *et al,* 2021; Duru *et al,* 2015; Gonzalez *et al,* 2018; Lopez-Garcia *et al,* 2021; Lopez-Garcia & Molina, 2021). It is argued that participatory methods are essential for enhancing human capital, community empowerment, farmers' self determination and autonomy (Parmentier, 2014; Sachet *et al,* 2021; Duru *et al,* 2015) which are essential features for a real agroecological transition of the food system. Therefore, this thesis will address the agroecological transition of the Swedish agrifood system (SAS) through a participatory approach that aims to collectively envision an agroecological scenario, identify the main steps of the transition and recommend policies that can promote its agroecological transformation.

1.2 Description of the Swedish Agricultural System (SAS)

In terms of territory, Sweden is one of the largest countries in Europe. About 80% of its area is covered by forests (mainly planted), mountains and lakes, while the arable land corresponds to 6.5 percent of Sweden's total area - 2.7 million hectares (Jordbruksverket, 2008). Regarding the climate, agriculture faces very different conditions across the country. In comparison, the growing season in Skåne (southern county in Sweden) is around 100 days longer than in Norrland -

northern county in Sweden (Jordbruksverket, 2008). As a consequence the crop distribution is different throughout the country. In the north, the production is mostly built around forage leys and coarse grains. Cereals such as barley, oats and wheat - which dominate Swedish crop production - are grown in the south and central parts of the country. While potatoes are produced in all of Sweden and sugar beets are only grown in the southern region.

Table 1. Division of Swedish arable land by crop, 1000 hectares. Adapted from Jordbruksverket, 2020: 28.

	1990	1999	2010
Total Arable Land	2845	2747	2552
Wheat	350	275	472
Rye	73	25	33
Barley	..	482	300
Oats	388	306	148
Mixed Grains	33*	33	11
Triticale	..	33	29
Potatoes	36	33	24
Sugar Beet	50	60	27
Leys, other fodder	918	1006	1164
Oilseed	..	110	108
Other Crops	..	81	104
Fallow, untilled arable land	193	304	132

**) Include Triticale*

Table 2: Swedish crop production in 2019. Adapted from Jordbruksverket, 2020: 29.

Crops	**Total production, 1000 tons**	**Yield, kg/ha**
Winter wheat	3263	7730
Spring wheat	214	4520
Winter barley	140	6830
Winter Rye	221	6760
Spring barley	1406	5180
Oats	671	4760
Winter triticale	175	6440
Mixed grain	42	3440
Grain maize	11	6960
Peas	69	3380
Field beans	60	3310
Potatoes	847	35811
Sugar Beet	2029	74000
Rape and turnip rape	382	3614

Regarding livestock production, cattle, sheeps, pigs and hens are the most common animals raised in Sweden as shown in table 3. Table 3 three also shows that the industrial production of livestock is predominant in Sweden. Jordbruksverket[1] (2021) highlights that the number of animals has decreased in each of these groups. The main products of livestock production are meat, dairy products and eggs. In comparison with other countries, Swedish livestock production makes low use of antibiotics.

[1] Swedish government institution for agriculture.

Table 3: Number of animals in June 2020 and agricultural holdings with animals, broken down by species and organic production. Source: Jordbruksverket, 2021.

Animal species	Number of animals	Organically produced livestock	Business	Organically administered business
Cattle	1 452 982	331 735	15 426	3 017
Dairy cattle	303 390	57 187	3 087	559
Meat cattle	206 950	74 103	10 063	2 291
sheeps	501 153	110 113	7 956	828
Pigs	1 367 755	35 564	1 146	61
Laying Hens	8 403 424	1 222 543	2 451	98
Broilers	10 779 686	148 860	186	18

The rise of industrial agriculture (IA) through green revolution techniques resulted in a structural change of the SAS. As indicated by a Jordbruksverket's (2008) report, during the last fifty years the number of farms decreased sharply while, on the other hand, the size of the farms increased significantly (See Table 4) - a common process of fusion and acquisition typical in IA. The growth of large scale farms can also be verified through the number of agricultural holdings by sizes as displayed on table 5.

Table 4 : Decrease of farms' number between 1961-2007. Adapted from Jordbruksverket, 2008:04

Hectares	1961	1970	1980	1990	2000	2002	2007
2.1-10	141 652	73 539	44 722	36 352	25 894	23 575	23 100
10.1-50	83 672	71 354	59 874	47 546	34 794	31 298	30 691
50.1-	7 596	10 471	13 286	15 361	16 110	16 077	18 006
Total	**232 920**	**155 364**	**177 882**	**99 259**	**76 798**	**70 950**	**71 797**

Table 5 : Agriculturals' holdings by size. Adapted from Jordbruksverket, 2020:28

	1990	**1999**	**2016**
Holdings' size in ha	96 560	80 119	62 937
0 - 2	…	…	4 156
2.1 - 5	14 957	11 344	9 080
5.1 - 10	19 020	15 229	13 482
10.1 - 20	20 832	16 656	11 408
20.1 - 30	12 177	9 295	5 413
30.1 - 50	14 223	11 445	5 901
50.1 - 100	11 348	10 969	6 807
100.1 - 200	…	4 073	4 266
200.1 - 300	…	708	1 368
300.1 - 400	…	203	500
400.1- 500	…	83	227
500.1 -	…	114	329

Delving into the sustainability performance of the SAS, it is exposed here through its three dimensions: economical, social and environmental. In terms of economic performance, the SAS presents "alarmingly low" profitability margins (MISTRA, 2019:20). Between 2000 and 2017 the average profit margin has been minus three percent (See Figure 1). According to a report by MISTRA (2019), the low profitability is due to a combination of high production costs for modern production facilities, new machinery as well as high taxes on common external inputs - fertilisers, pesticides. These low profitability margins are a determinant contributor to the aforementioned process of land concentration.

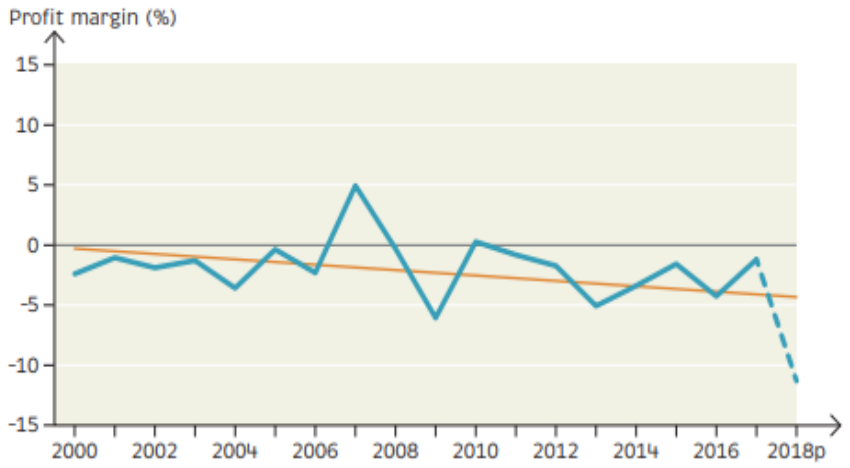

Figure 1: Declining rate of profitability margins of Swedish farms from 2000 to 2018 (Mistra, 2019:20)

Regarding social performance, the number of workers engaged in agriculture is steadily decreasing and ageing (Jordbruksverket, 2019) (See Figure 2). The decrease of rural workers can be seen as a result of the land concentration phenomena. The sharp decline of farms also raises broader questions about the farming's role in agriculture and the future of family farming (Waldenström, 2018). The participation of women - after their exit from the agrarian sector between 1960 and 19680 - is experiencing an "incipient feminization" (Knus, 2021:39). Nevertheless, substantial differences prevail when male-managed and female-managed farms are compared, such as: average size of operated arable land - 15 for female-managed and 36 for male-managed; the proportion of male managing farms with oilseeds or cereal is 5.9 or 3 times bigger than female-managed farms with these same crops; 72% of female-managed farms requires an outside source of income to remain in operation, while it happens for 56% of the male-managed farms (Knus, 2021). The review of literature done by Knus (2021) indicates that the differences are examples of the hindrances faced by women when becoming farmers. In respect of that, the most challenging obstacle is equal access to land. Since most of the farm lands are not acquired but inherited, it is argued that the main cause of gender inequality in Europe is the non-inheritance of land by women (Knus, 2021).

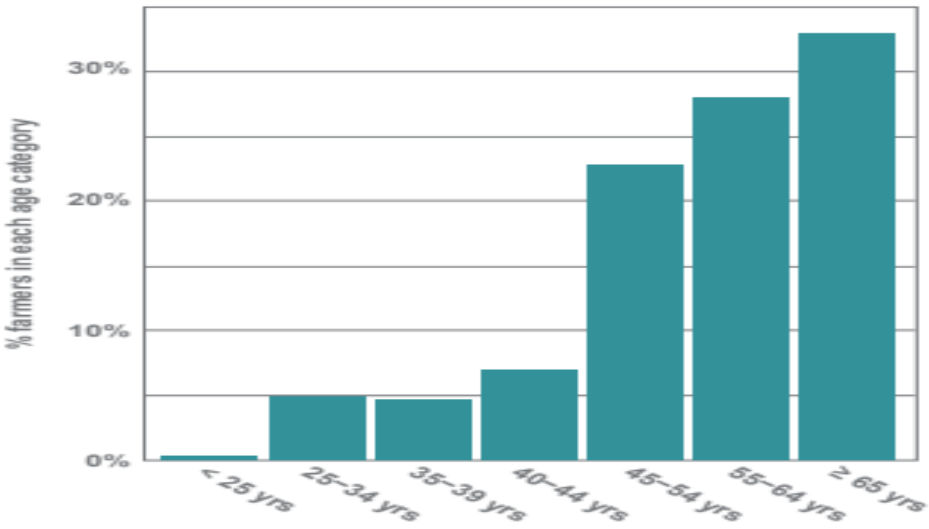

Figure 2: Percent of Swedish farmers divided into age groups, 2016. (Kuns, 2021:38)

When it comes to labour, special attention is paid to the high number of accidents in dairy farms - around 70% of farm accidents occur in dairy farms (Knus, 2021). Lindahl *et al* (2015) argues that practices which reduce animal stress and fear should be adopted as a measure to decrease the number of accidents on this type of farm. Furthermore, the dependence of migrant rural workers is flagrant in the SAS. It got evidenced during the first outbreak of the coronavirus in the spring of 2020 when the Swedish Federation of Farmers (Lantbrukarnas Riksförbund, 2020) argued that the harvest would be on risk if some eight thousand migrant workers were not permitted to ingress in the country.

So as to finish the description of the social sustainability of the SAS, two other topics need to be described: access to natural resources and food security. Regarding the first point, the Swedish government (Ministry of Enterprise and Innovation, 2017) considers that farmers have access to high-quality natural resources. In terms of food security, it exists, according to the FAO (Fraanje & Lee-Gammage, 2018:02) "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life". Sweden has a good availability of all sorts of food and the Swedish population has a good and stable power of purchase. On the other hand, the number of people overweight and obese is increasing and corresponds to more than half of the adult population (Molarius *et al*, 2016). Another important point in relation to food security is self-sufficiency. The level of self-sufficiency in Sweden is around 50% (Civilförsvarsförbundet, 2017), as stated by the Minister for Rural Affairs Anna-Caren Sätherberg "we are not self-sufficient in food. Sweden depends on trade, and EU cooperation is an important tool to ensure that our supply chains work" (Ministry of Enterprise and Innovation, 2022). It decreases the resilience of food availability under the light of unexpected events that might affect

international trade, such as the global coronavirus pandemic and the war between Russia and Ukraine.

By last, Sweden is recognized to have one of the most environmentally friendly agricultural systems. In 1999 the swedish parliament adopted fifteen national environmental quality objectives in which three are particular important for agriculture: varied agricultural landscape - biodiversity created by management is to be preserved, zero eutrophication - small biotope are to be preserved and also created in flat areas, and a non-toxic environment - nutrient leaching and use of chemical plant protection are to be reduced (Jordbruksverket, 2008). However, agriculture still stands out as one of the greatest contributors of GHG emissions in Sweden (See Figure 2) mainly due to animal husbandry, dependence of fossil fuels derivatives and for the use of heavy machinery and mineral fertilisers. The use of nitrogen fertiliser increased by eighteen percent between 2019 and 2020, which translates into an increase of fourteen kg per hectare. The pesticide use in Swedish agriculture is lower than in other countries, but still significant (MISTRA, 2019).

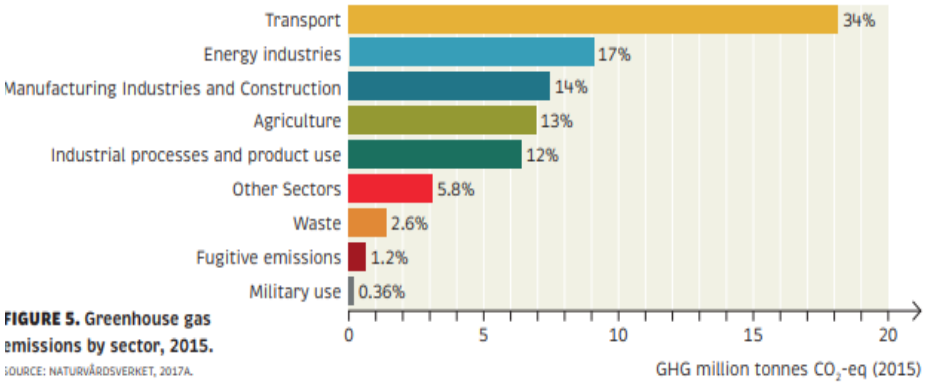

Figure 3: GHG emissions by economic sector (Mistra, pp. 32)

Furthermore, a report by The European Red List (2013) points out the SAS as one of the major threats to biodiversity loss due land use change and water pollution. Adding to that, the SAS is a contributor agent for the eutrophication of lakes, seas and watercourses. The baltic sea, for example, is specially affected by algal bloom and oxygen depletion resulting from the use of nitrogen and phosphorus in the SAS (Jordbruksverket, 2013). Therefore, the SAS shares, although on a smaller scale, common environmental risks as any other agricultural system based on industrial practices.

1.3 Motivation, Purpose and Research Questions

This study is motivated by three main factors. Starting from the big picture, as pointed out by FAO (2009), feeding a growing population while reducing the

negative socio-environmental effects of food production under the associated effects of climate change poses one of the biggest challenges for humanity in the twenty-first century. Narrowing down the problem, agroecology represents a great approach for this challenge. The question of how to upscale agroecological farming systems (AFS) has been addressed by relevant literature in which conceptual (Lopez-Garcia et al, 2021; Lopez-Garcia & Molina, 2021; Duru, 2015; Sachet et al, 2021; Collin et al, 2019; Wezel *et al,* 2020; Hebinck *et al,* 2021) frameworks and practical difficulties (Parmentier, 2014; HLPE, 2019; Niggli *et al*, 2021; Gonzalez *et al,* 2018; Duru, 2015) of this process have been identified. Moreover, in spite of the current consensus about the potential of agroecology, it has not been integrated into current agricultural public policy agendas and the efforts to develop agrarian policies in benefit of AFS are still rare (Migliorini and Wezel, 2017; LVC, 2018). In terms of scientific literature, despite being highlighted as a domain of transformation, policies or top-down approaches for agroecological transitions are still a blind spot.

Therefore, the aim of this research is fourfold: (i) advance the discussion on how to sustainably/agro ecologically transform (or influence the transformation) the swedish agrifood system through top down measures, (ii) design an agroecological SAS scenario, (iii) identify main changes between the current SAS and the idealised scenario and (iv) recommend participatory policies that address the necessary changes.

Hence, the research is going to be developed around the following questions:

1) What Would an agroecological agrifood system look like in Sweden?
2) What are the key changes necessary to upscale agroecology in Sweden?
3) Which policies can promote an agroecological transition of the Swedish agrifood system?

1.4 Limitations

Due to its exploratory nature and specific objectives, this study is limited to investigate participatory policies that can facilitate the upscaling of agroecology in Sweden without delving into their resonance with the current common agricultural policies (CAP) nor its divergences. Besides that, the evaluation of long term consequences of proposed policies to facilitate the transition of the SAS is out of scope for this work and, therefore, is not be evaluated.

In relation to the first point, during the interviews it was asked to the interviewees to think/brainstorm freely about characteristics of an agroecological agrifood system in Sweden, necessary changes and policies to tackle these problems. Thus, it is not an objective of this study to investigate the applicability of the suggested policies. For example, policies related to financial instruments and regulations

might not be authorised by the European Commission - responsible for changes to the CAP. Besides that, protective policies could also raise sanctions from the World Trade Organization (WTO) that would affect Swedish trade. Regarding the second point, it is necessary further investigation so as to check whether the suggested policies can facilitate an agroecological transition in Sweden and their potential risks on Swedish agricultural production.

Moreover, the limitation of generalizability is another important point in this study. As pointed out by Linton (2020), it is often more problematic to call for generalisation in social sciences studies due to the challenges of including all relevant stakeholders in the research process. This is an important problem when designing policies suitable for all the different groups of farmers. In this study, such a challenge is reflected on the impossibility of including industrial farmers - all of the contacted industrial farmers either rejected the invitation or never answered. Due to the existing cultural and political differences between industrial farmers and alternative farmers as well as the risk aversion of industrial farmers related to their uncertainty regarding agroecological practices (Duru *et al*, 2015; Weber *et al,* 2020; Parmentier, 2014), it is likely that the suggested policies of the present study would have been different.

2. Focus: Top-down coordinated Agroecological transition; Review of Literature

This chapter, divided into six sections, aims to present the theoretical background of the thesis while highlighting its focus in the top-down agroecological transition of the SAS. In the first section, a brief differentiation between transition, transformation and incremental change is done. In the second section, the three spheres of agroecology - set of practices, science and social movement - are briefly described as well as the agroecological principles. While the third section focuses on the added value of agroecology in comparison with SI. Finally, the fourth section explores how agroecological transformations have been approached within the scientific literature. It is expected that after going through this section, the reader can clearly understand the type of agroecology defended in this thesis as well as what is meant by transition/transformation and the reasons for investigating a top-down approach.

2.1 Transition, Transformation and Deep Change

Due to the wide use of terms like ‘transition’, ‘transformation’, ‘deep change’, and ‘incremental change’ in specialised scientific literature, it is necessary to clarify what transition means in this study by briefly defining and differentiating it from the other terms.

Deep change is referred to by Weber *et al* (2020:02) as “systemic societal change” in institutions, social norms and values, technologies and practices. The authors also highlight that deep change is recurrently coined as ‘transformation’ or ‘transition’. Transformations translate into drastic changes of essential social-ecological systems (SES) that disrupt the current state (Weber *et al*, 2020). According to O´Brien & Sygna (2013), transformations to sustainability encompass significant changes in personal, practical and political dimension of man-nature interactions. Transformations are less likely to be managed, they rather emerge in a bottom-up way through involvement of grassroot organisations and exogenous shocks (Stirling, 2015 in Weber *et al*, 2020). Although transitions are also described as long-term significant changes in SES, they are normally conceived from a multi-level perspective consisting on three levels: a) micro-level of niches, b) meso-level of socio-technical regimes, and c) macro-level of socio-technical landscape (Geels & Kemp, 2000). A key difference between the two terms is how the change emerges. While transformations have a bottom-up nature, transitions are usually managed/governed processes following a specific goal (Rotmans et al, 2001). A purposive transition is a “deliberately

intended and pursued" process that "reflect an explicit set of societal expectations or interest" (Geels & Schot, 2007:402).

Since agricultural systems, in a general way, are locked-in in different domains, the chances of upscaling agroecology relying merely on bottom-up approaches are minimal (Duru *et al,* 2015). Thus, the change approach chosen for this research is transition management. It is understood as a participatory policy-making strategy based on complex systems thinking (Foxon *et al*, 2009 in Duru *et al,* 2015). In these terms, Kemp & Rotmans (2005 in Duru *et al,* 2015:1242) highlight the importance of "mutual understanding and collective development of shared goals and visions of the expected future and potential pathways to reach it are particularly at stake". In relation to agriculture, the term 'transition' is often employed to suggest a restructuring of in-farm activities as well as 'deep change' in agriculture at local, regional, national, and global levels (Duru *et al,* 2015).

2.2 The three dimensions of Agroecology and its principles

Given the different definitions and uses of agroecology, it is necessary to elucidate what agroecology is in this research by going through its component aspects. It can be said that farming systems developed by traditional communities in different parts of the world could be considered agroecological since these communities were applying, to a certain extent, what nowadays is considered as agroecological principles. Rosset and Altieri (2017) argue that these traditional farming systems are the starting point, for agroecologists, when developing new agricultural systems. The combination of this traditional/indigenous knowledge with disciplines of agriculture and ecology results in agroecological practices. However, as pointed out by Wezel (2007), a caveat needs to be done when describing agroecological practices since there are no consensual boundaries that define what is agroecological and what is not. Thus, the processes present in agroecological practices are exposed here rather than the set of practices itself. According to HLPE (2019), Gliessman(2015), Altieri(2002) and Wezel (2017), these practices involve a wide group of processes such as: species diversification, intercropping; biological pest control and natural regulation of diseases; waste management as well as reuse and recycle of materials as input to the production process; water management; biological nitrogen fixation; improvement of soil structure and health; biodiversity conservation; and carbon sequestration.

The researchers responsible for the HLPE (2017:36) report also indicate that agricultural practices can be considered as more or less "agroecological" depending on the degree which: "(i) they rely on ecological processes as opposed to the use of agrochemical inputs; (ii) they are equitable, environmentally friendly, locally adapted and controlled; and (iii) they adopt a systemic approach, rather

than focusing only on specific technical measures". Thus, the goal of applying agroecological practices is to improve farming systems by making use of ecosystemic processes (mimicking nature), through the creation of beneficial interaction and synergies between their constituent parts (Gliessman, 2015; Wezel, 2017).

As a science, agroecology has roots that date back in the 1920s. The term was first used by the Russian agronomist Basil M. Bensin[2] who was concerned with the increasing dependence of external inputs by the farmers (Gliessman, 2015; HLPE, 2019). In the 1970s the concept of agroecosystem was formalised. According to Gliessman (2015:21), it "provides a framework with which to analyse food production systems as wholes, including their complex sets of inputs and outputs and the interconnections of their component parts". Departing from this concept, it can be noted the biggest difference between the science behind industrial agriculture and agroecology. Industrial agriculture is based on reductionist thinking which aims at eliminating/externalising the uncertainties involved in the farming system through the use of external inputs. Therefore, this view delivers a rather statical farming system as "a unit with well defined boundaries and a well-defined goal that consists of interdependent parts that transforms inputs into output ' (Schiere *et al,* 2004). On the other hand, agroecology science is based in systems thinking which aims to understand farming systems as whole that is more than the sum of its component parts. Thus, the focus is in the analysis of emergent phenomena resulting from the interactions between the biotic and abiotic components of any farming system.

Following this systems thinking approach, agroecology science is increasingly understood as transdisciplinary, participatory and action oriented (Gliessman, 2015; HLPE, 2017). Dalgaard *et al* (2003) defined agroecological science as "an integrated discipline that includes elements from agronomy, ecology, sociology and economics". HLPE (2017:39) report describes three features agroecology as a science: "(i) the integrative study of the ecology of the entire food system, encompassing ecological, economic and social dimensions or, in brief, the ecology of the food system; (ii) the application of ecological concepts and principles to the design and management of sustainable food systems; and, more recently, (iii) the integration of research, education, action and change that brings sustainability to all parts of the food system: ecological, economic and social."

By last, the increasing struggle of traditional, small and mid scale farmers with the downsides of industrial agriculture led to the inclusion of agroecology as a constituent of social movements that advocate for a sustainable transformation of the food systems. Hence, as a social movement, agroecology represents a solution

[2] See Bensin, B. (1930) "Possibilities for international cooperation in agroecological investigation" and "Agroecology: Basic Science of Agriculture".

or a pack of solutions to the ongoing problems caused by industrial farming. The main objective is to transform food systems in a way in which they become economical, socially and environmentally sustainable, locally relevant, and provide fair and safe food. La Via Campesina (LVC) is the main peasant movement that advocates for agroecology worldwide, composed of over two hundred million peasants represented by 182 organisations spread in eighty one countries. LVC was responsible for developing the concept of food sovereignty (nowadays incorporated into agroecology itself) during the World Food Summit in 1996. This concept includes: prioritisation of local food production; right of farmers to produce food as well as of consumers to be able to decide what to consume; right of countries to protect themselves against dumping; food prices linked to production costs; popular participation regarding agricultural policy choices and; recognition of women farmers' right. So as to summarise the social movement dimension of agroecology a declaration from LVC at the end of the International Forum on Agroecology held in Nyéléni, Mali, 2014, is transcribed here: "Agroecology is political; it requires us to challenge and transform structures of power in society. We need to put the control of seeds, biodiversity, land and territories, waters, knowledge, culture and the commons in the hands of the peoples who feed the world" (Altieri & Rosset, 2017).

Once having described the three dimensions of agroecology, it is now possible to go through its principles. Since agroecology does not have specific recipes but rather it has principles that can be applied within the natural conditions of the farm localization, FAO designed ten elements so as to guide countries to transform their agricultural systems. The elements were created through a multi-stakeholder consultation process as well as debates held during the First International Symposium on Agroecology for Food Security and Nutrition which intended to guide countries and organisations to transform their food and agrarian systems so as to upscale sustainable agriculture, achieve zero hunger and others SDG's (FAO, 2015). The ten elements established by FAO (2015) (see Figure 1) are: (i) diversity: key principle to agroecological transformations in order to guarantee food security while securing environmental sustainability; (ii) co-creation and sharing of knowledge: agricultural innovation created through participatory approach to better respond to local challenges; (iii) synergies: increase key functions across food systems; (iv) efficiency: agroecological intensification to reduce the dependence on external inputs; (v) recycling: transformation of waste into agricultural input results in lower agricultural and environmental costs; (vi) resilience: increased social, environmental and economic resilience is key to sustainable food and agrarian systems; (vii) human and social values: protect and improve rural livelihoods; (viii) culture and food traditions: healthy, diversified and culturally appropriate diets, contributes to food security and nutrition while maintaining environmental sustainability; (ix)

responsible governance: sustainable food systems require responsible governance from local to global scale; (x) circular and solidarity economy: an economic framework that reconnects consumers to producers and provides solutions for living within planetary boundaries.

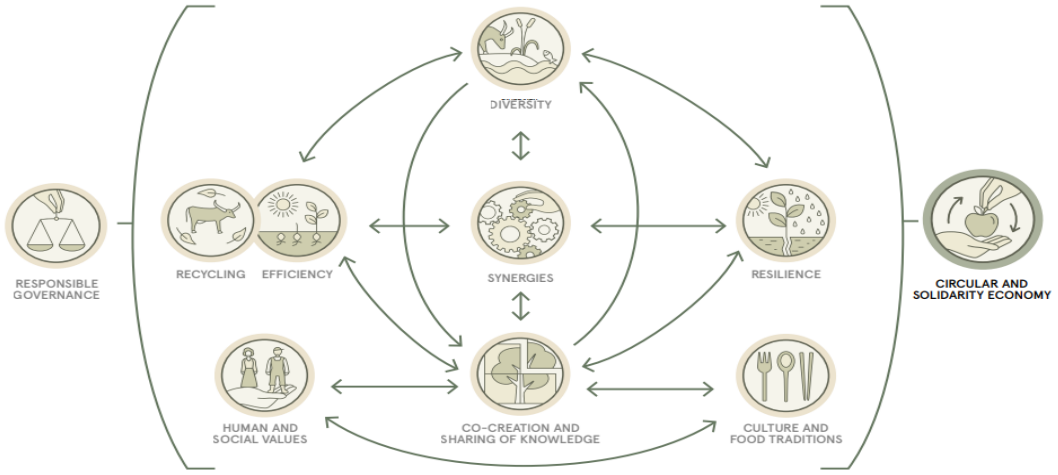

Figure 4: The 10 elements of agroecology (FAO, 2015:12)

In a study about agroecological principles and their implications for transitioning to sustainable food systems, Wezel *et al* (2020) define and consolidate thirteen principles that are well aligned and complementary to the elements developed by FAO (See Table 2): (i) recycling; (ii) input reduction; (iii) soil health; (iv) animal health; (v) biodiversity; (vi) synergy; (vii) economic diversification; (viii) co-creation of knowledge; (ix) social values and diets; (x) fairness; (xi) connectivity; (xii) land and natural resource governance; (xiii) participation. The main difference between these principles and the ten elements is the articulation for more explicit requirements for animal and soil health and the distinction between biodiversity and economic diversification.

Table 8: Set of 13 agroecological principles, their correspondence to FAO principles and their scale of application. . FI, field; FA, farm; agroecosystem; FS, food system. Source: Adapted from Wezel et al, 2020:07.

Principle	**Scale of application**	**Correspondence to FAO elements**
1. Recycling: preferentially use local renewable resources and close as far as possible resource cycles of nutrients and biomass	FI, FA	Recycling
2. Input reduction: reduce or eliminate external dependency.	FA, FS	Efficiency
3. Soil Health: secure and enhance soil health and functioning for improved plant growth	FI	Diversity, synergies and resilience
4. Animal health: Ensure animal health and welfare	FI, FA	Resilience
5. Biodiversity: Maintain and enhance diversity of species, functional diversity and genetic resources and maintain agroecossystem biodiversity in time and space at field	FI, FA	Diversity
6. Synergy: enhance positive ecological interactions, synergy, integration and complementarity	FI, FA	Synergies
7. Economic diversification: Diversify on-farm incomes by ensuring that small-scale farmers have greater financial independence.	FA, FS	Diversity as well as circular and solidarity economy

8. Co-creation of knowledge : Enhance co-creation and horizontal sharing of knowledge including local and scientific innovation	FA, FS	Co-creation and sharing of knowledge
9. Social values and diets: Build food systems based on the culture, identity, tradition, social and gender equity.	FA, FS	Human and social values, culture and food traditions
10. Fairness: Support dignified and robust livelihoods for all actors engaged in food systems, especially small-scale food producers	FA, FS	Part of human and social values
11. Connectivity: ensure proximity and confidence between producers and consumers through promotion of fair and short distribution	FA	Circular and solidarity economy
12. Land and natural resource governance: Strengthen institutional arrangements to improve, including the recognition and support of family farmers.	FA, FS	Responsible governance
13. Participation: Encourage social organisation and greater participation in decision-making by food producers and consumers to support decentralised governance.	FS	Part of human and social values

2.3 The added value of agroecology

How to convert degraded, monoculture production systems into multi-functional, resilient and low carbon agroecosystems maintaining or increasing the productivity level? The agroecological approach stands to play a crucial role in transforming agri-food systems due its capacity of reducing trade-offs between productivity and ecological degradation by connecting environmental sustainability with social justice in the production as well as the consumption spheres (Niggle *et al*, 2021). This section aims to explore the added value of agroecology in comparison with other approaches for achieving an economic, social and environmental sustainable agri-food system.

Regarding the economic sphere, agroecology is recognized for reducing the costs and risks associated with the production through the reduction of external dependence, diversification and alternative - decentralised - market channels (Parmentier, 2014; Altieri, 2002; Altieri & Rosset, 2017; HLPE, 2019). A report published by FAO (2018) shows that these strategies improved the income of farmers by thirty per cent. Adding to that, studies performed in different socioeconomic and environmental regions demonstrate that agroecological intensification methods could reduce the total pesticide use by forty-two per cent without compromising both productivity and profitability in sixty per cent of the farms under study in France (Lechenet et al., 2017) while in Malawi the agroecological practices were responsible for significantly improving the output hence increasing food security and nutritional diversity (Bezner Kerr et al, 2019). Furthermore, agroecological farming systems (AFS) can have a better or comparable economic performance in comparison to industrial farming systems (IFS) (D'Annolfo *et al*., 2017; Rosset, 1999) which leads to the increase of net income, and also ensures a greater capacity of forecasting and adaptation to changes for farmers (Chappell & LaValle, 2011).

In terms of social sustainability, the main contributions of agroecology are the reduction of poverty, inequality and hunger by promoting decent work and increasing food security. Parmentier (2014) points out that agroecological approaches play a significant part in food security in four main ways: 1) by substantially enhancing yields (increase of availability); 2) through the boost of urban agriculture; 3) reducing poverty (accessibility), and 4) ensuring the adequate character of food (adequacy). In addition to the above, the increase of net income of farmers as well as rural workers can guide the decrease of rural-metropole migration flux (Chappel, 2018) hence hindering the process of land concentration. It is also important to mention the diversification of diet provided by AFS and the correlated increase of health (Altieri & Rosset, 2017).

Going beyond the aforementioned, AFS have the distinctive characteristics of social capital creation and women empowerment. Kansanga *et al,* 2020 demonstrated the pivotal role of agroecology, when compared to IFS, in generating social capital through the emergence and/or strengthening of farmers networks and increased access to productive resources and knowledge sharing. It is also recognized that AFS can give rise to new norms, social rules and institutions (Pretty & Smith, 2004) as well as innovation processes in the production and marketing spheres (Rover *et al,* 2017). Niggle *et al*. (2021) defend that AFS can provide better chances for women through the integration of different work tasks and specific knowledge, creating a more significant role in the farm economy. While the HLPE (2019) report argued that the use of knowledge intensive technologies and the low investment costs of AFS stimulate women's economic opportunities and autonomy.

Closing the sustainability triad, the environmental performance of AFS is, perhaps, the most well known characteristic of agroecology. It is recognised that agroecological practices can bring up multiple ecological benefits, such as: increase of soil health and recover degraded areas (Berthe, 2012; Wilson, 2016); increase of biodiversity and resilience to climate change and disruptive social events (Altieri & Rosset, 2017; Gliessman, 2015; Parmentier, 2014); improve water management (Rosset, 1999; Parmentier, 2014); independence of fossil fuels resources (HLPE, 2019; Gliessman, 2015; Parmentier, 2014); contribution to mitigation challenge through carbon sequestration and generation of other ecosystem services (Parmentier, 2014; Altieri & Rosset, 2017). Furthermore, the independence of fossil fuels in AFS can generate a reduction of GHG emissions. According to the work developed by GRAIN[3] (Parmentier, 2014), upscaling agroecological practices could lead to the reduction of one-half to three-fourths of the current GHG emissions.

It is necessary to highlight the distinctive regenerative potential of agroecological practices for what the former executive secretary of UN's Convention to Combat Desertification (UNCCD) classified as "the greatest environmental challenge of our time" and "a threat to global wellbeing" (Carrington, 2010). According to UNCCD (1994), in order to combat desertification, the activities must be part of the integrated sustainable development of target areas which are aimed at: (i) prevention and/or reduction of land degradation; (ii) rehabilitation of degraded land; (iii) reclamation of desertified land. Within the spectrum of agroecological practices, agroforestry has been pointed out by FAO (Berthe, 2012) and researchers (Breman et al, 1997; Ramachandran et al, 2011; Garrity et al, 2012;

[3] GRAIN is a small international non-profit organisation that works to support small farmers and social movements in their struggles for community-controlled and biodiversity-based food systems.

Cooper et al, 1996) as one of the most successful practices for combating land degradation.

2.4 Comparison to Sustainable Intensification approach

Promoted as a solution for the environmental downsides of industrial agriculture by several policy and research organisations (Tittonel, 2014) - Consultative Group on International Agricultural Research (CGIAR), the Food and Agriculture Organisation of the United Nations (FAO), the World Economic Forum (Davos, 2012), the Montpellier Panel (2013) or the Sustainable Development Solutions Network (SDSN, 2013) - SI is said to represent a change in agriculture and rural development by reconciling sustainability with industrial/intensive farming (Xie, *et al*. 2019). For example, a report by the Royal Society (2019:09) defines SI as a strategy "in which yields are increased without adverse environmental impact and without the cultivation of more land". This approach seeks to conciliate industrial approaches with some agroecological practices so as to provide better management of natural resources and application of external inputs (Petersen, *et al*. 2015). Thus, rather than advocate for a transformation of agrifood systems, SI has a reformist agenda which aims to offer a framework where 'no techniques or technologies, such as GMOs, should be left out' (Altieri & Holt-Giménez, 2013). The main differences between SI and EI can be seen in the table below.

Table 9: Differences between sustainable and ecological intensification (Struik & Kuyper, 2014:75)

	Sustainable Intensification	**Agroecological Intensification**
Adherents	Utopians	Arcadians
Philosophy	Business as we know it	Business as usual is no longer an option
Model	Specialisation, one function	Diversification, multi-functionality
Relation with nature	Land-sparing	Land-sharing
Science	Advanced technologies	Local knowledge
Exemplar	IA	Peasant agriculture
Labour	Labour-extensive	Labour-intensive
Labour productivity	High	Low
Energy	Based in fossil fuels (low efficiency)	High efficiency of energy

Capital	Intensive	Extensive
Epistemology	Reductionist	Holistic
Methodology	Mono and multi disciplinary	Trans-disciplinary
Major driver	Global markets	Grass root organisations
Seed system	Global companies	Local
Externalization of costs	High	Low

Therefore, this approach differs substantially in terms of spillover effects when compared to agroecological intensification. SI puts on table a half-way solution in terms of the three dimensions of sustainability for a series of reasons, such as: i) it keeps the farmers dependent on expensive external inputs - seeds, fertilisers, pesticides, fossil fuel derivatives - further affecting their economic performance; (ii) due its associated high costs SI maintains the capitalistic dynamic of fusion and acquisition which leads to increased land concentration and rural exodus; (iii) dependence on fossil-fuel derivatives keeps the agrifood system as one of the biggest contributors of GHG emissions; (iv) it is not resilient to external shocks.

Under the light of the aforementioned problems, SI has raised criticisms between grassroots movements and researchers. Their argument is that SI represents the new phase of the green revolution "window-dressed" or with a "green-washing strategy" (Tittonel, 2014:04), since most of the hopes are concentrated in the emergence and use of a package of new technologies that claim to be climate smart (Altieri *et al*, 2013; LVC, 2014; Collins *et al,* 2012). Furthermore, Altieri and Rosset (2017) argue that SI approach seeks to co-optate agroecology into a mere set of practices, excluding its transformative social and scientific dimensions, so as to "fine-tune" IFS. They defend that the interest of agribusiness and financial capital in agroecology is due its capacity to "help them escape from the latest of the periodic crises of capitalism and from the persistent contradictions inherent to the extractivism that characterises industrial agriculture" (Altieri & Rosset, 2017:125).

2.5 The Swedish case

The Swedish government is aware about the necessity to change from a nocive activity into an activity that regenerates ecosystem services (Eskvärd & Marquardt, 2018). From the description of the SAS, it is possible to state that its main sustainability challenges are: low profit margins of the farms due high costs of production (MISTRA, 2019), risky working conditions - especially in dairy farms - (Knus, 2021), ageing of rural workforce, dependence on fossil fuels

derivatives (SOU, 2021), eutrophication (Jordbruksverket, 2013), biodiversity loss (The European Red List, 2013) and water pollution (Jordbruksverket, 2013; The European Red List, 2013).

In order to tackle these challenges, the Swedish government adopted - among other minor and more specific incrementation/reform policies - the "National Food Strategy for Sweden – more jobs and sustainable growth throughout the country" (Ministry of Enterprise and Innovation, 2017) that will shape the Swedish food policy until 2030. In general terms, the goal of the food strategy is "a competitive food supply chain that increases overall food production while achieving the relevant national environmental objectives, aiming to generate growth and employment and contribute to sustainable development throughout the country" (Ministry of Enterprise and Innovation, 2017:10). The increase of both industrial and organic food could contribute to a higher self-sufficiency. More specifically, the strategy sets out three strategic areas: rules and regulation - designed to support the overall objective of a competitive and sustainable food supply chain in which production increases, consumers and market - where the first should have a good knowledge and confidence to make informed and sustainable choices, and knowledge and innovation - so as to contribute to increased productivity and innovation in the food supply chain.

The Swedish policy approach towards agriculture is very compartmentalised. Seeking to address the profitability problem, the Swedish government has encouraged the restructuring of farms leading to increased average farm size to further improve their competitiveness - i.e. intensification of economies of scale guiding to greater productivity using smaller amount of resources (mainly land, capital, and labour) (Marquardt *et al,* 2021). After a quick check on the historical series of agricultural productivity in Sweden, It is undeniable that the farm restructuring has led to highly efficient farms regarding yields and labour (See Figure 5). On the other hand, these farming systems increase the negative spillover effects for the environment and landscape diversity. Thus, it affects the achievement of national environmental objectives.

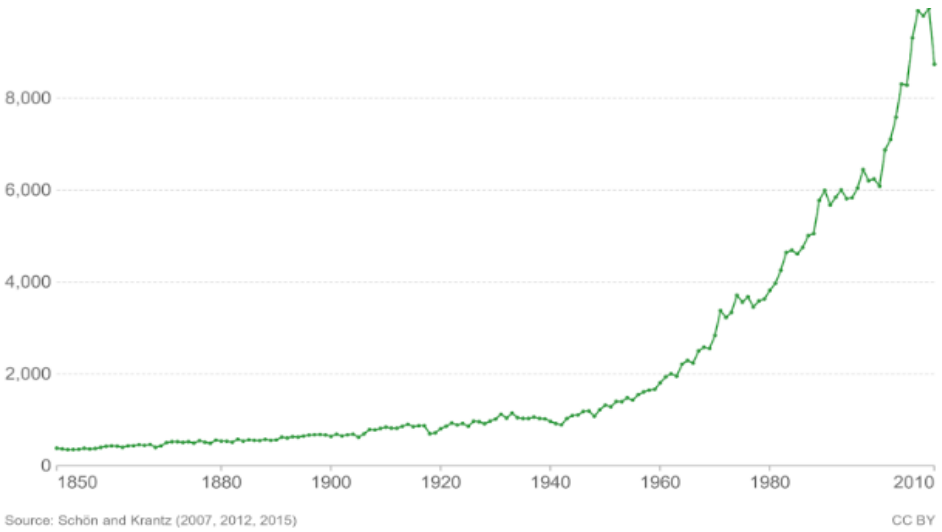

Figure 5. Labour productivity in agriculture, Sweden, 1850-2010 (Schön & Krantz, 2015)

The second policy approach contemplates the environmental aspects. It is based on 'green' Common Agricultural Policy (CAP), i.e., to enhance environmental regulation of farming practices and designing economic incentives by means of agri-environment schemes (AES) so as to face mitigation challenges and decrease environmental impacts. As pointed out by Eskvärd & Marquardt (2018), the farmers are sceptical with this strategy due: the feeling of being trapped by the regulations, and being powerless in respect to the control agency and lack of control of their finances. They also show that the strict adoption of AES-related conservation metrics can, in some cases, have the undesired effect of forcing the farmers to interrupt their own efforts to improve the farm's biodiversity.

Marquardt *et al* (2021:03) argue that these policy approaches are problematic because "they emphasise only specific farm components or aspects, thereby simplifying complex farm settings and failing to see the farm as an interconnected system". They use the farm restructuring agenda to exemplify how the emphasises on labour efficiency, and to a lesser degree, yield, affect the environment by ignoring other components of the agroecosystem that are merely taken as externalities. Moreover, the authors also show - through semi-structured interviews analysis - that even industrial farmers see their farms as an integrated system that include environmental and farming (land use, animal keeping, grazing and feeding regimes, crops choices, machinery, and on-farm labour availability) characteristics as well as market conditions and regulatory regimes. These combinations of factors, the authors further argue, determine what farmers distinguish as their space for taking decisions about the future of their farms and act.

Thus, it is possible to state that an integrated policy strategy, where all the factors composing an agroecosystem are taken into consideration jointly, is required. A policy approach guided by agroecological principles constitutes a great way to encompass all the factors affecting the whole farming system without compartmentalization. Since Agroecology touches the three dimensions of sustainability, it is possible to follow a single approach that drastically reduces the trade-offs between economic and ecological sustainability. In practical terms, the redesign of farming systems aiming to mimic ecological processes leads to a sharp decrease of external inputs use. It directly faces the profitability challenge on its main issue by reducing the costs of production. As a consequence of the redesign, the beneficial second order effects contribute to: the mitigation challenges through carbon sequestration and generation of other ecosystem services, decrease the GHG emission associated with agriculture by eliminating the dependence of fossil fuels derivatives, increase the biodiversity in terms of crops and insects, and control/eradicate eutrophication processes. By last, this integrated approach can also bring up repercussions that can facilitate the confrontation of social sustainability problems of the SAS, such as: more security to dairy farms workers since the livestock production under agroecological principles would cause less stress to the animals, increase the interest of younger generations in farming through more attractable profitability margins as well as reducing the entrance barriers associated with the high costs of production in IFS, significantly increase the self-sufficiency of food in Sweden, promote more diversified diets, decrease land concentration, and further increase women's participation in the SAS.

2.6 Approaches for agroecological transitions

How to upscale agroecology? This question has been in the centre of the debate of agroecological research. Researchers have delved into this topic through different scales and lenses. This subsection aims to summarise the main findings within the subject of agroecological transitions/transformations.

The most well known proposed approach is, perhaps, the levels of conversion developed by the agroecologist Stephen Gliessman. According to him, the conversion can happen in 5 levels (Gliessman, 2015:342): 1) increase efficiency of industrial practices; 2) substitute alternative practices and inputs; 3) redesign whole agroecosystems; 4) reestablish connection between growers and consumers, develop alternative food networks; 5) rebuild the global food system so as to make it sustainable and equitable for all. The scale as well as the agroecological dimensions characteristics of each level can be checked in the table below.

Table 10. Gliessman's Levels of conversion: From IA to a sustainable world food system (Gliessman, 2015:342)

Level	**Scale**	**Ecological research**	**Farmer practice and collaboration**	**Social change**
1- Increased efficiency of industrial practices	Farm	Primary	Important: lower costs and diminishes environmental impact	Minor
2- Substitute alternative practices and inputs	Farm	Primary	Important: Supports shift to alternative practices	Minor
3- Redesign whole agroecosystems	Farm, region	Primary Develops indicators of sustainability	Important Builds true sustainability at the farm scale	Important Builds enterprise viability and behaviours changed
4- Reestablish connection between growers and eaters, develop alternative food networks	Local, regional, national	Supportive Interdisciplinary research provides evidence for need for change and viability of alternatives	Important Forms direct and supportive relationships	Primary Economies restructured; change of values and behaviours
5- Rebuild the global food system so that it is sustainable and equitable for all.	World	Supportive Transdisciplinary research promotes the change process and monitors sustainability	Important Offers the practical basis for the paradigm shift	Primary World systems fundamentally transformed

Moving from a strict/monodomain bottom-up approach, different studies have highlighted multiscale approaches for the transformation of agrifood systems. Within this line of action, researchers have called attention to: the institutionalisation of supportive policies that break the cycle of policies which create disadvantages towards non-industrial farmers (Parmentier, 2014; Weber *et al,* 2020; Lopez-Garcia *et al,* 2021; Lopez-Garcia & Molina, 2021; Duru *et al*, 2015; HLPE, 2019); prioritisation of agroecological research based in participatory approach in agricultural sciences (Parmentier, 2014; HLPE, 2019; Lopez-Garcia & Molina, 2021; Sachet *et al,* 2021); support farmer-to-farmer and farmer-to-consumer networks so as to increase the co-production and sharing amongst communities (Wezel *et al*, 2020; HLPE, 2019; Sachet *et al,* 2021; Collin

et al, 2019) as well as the development of marketing structures that promote a direct channel of communication between farmers and consumers (Lopez-Garcia *et al,* 2021; Lopez-Garcia & Molina, 2021; Duru, 2015; Sachet *et al,* 2021; Collin *et al,* 2019); decentralisation of decision-making processes as a way to facilitate the emergence of inclusive and participatory forms of innovation governance (Wezel *et al*, 2020; HLPE, 2019; Parmentier, 2014; Lopez-Garcia *et al,* 2021; Colin *et al,* 2019). This information is summarised in the table below.

Table 11. Domains of Transformation

Domains	Reasons	Authors
Policies	● Enable the adoption of agroecological practices ● Break the disadvantages created by rural policies that exclusively benefit IFI	Parmentier, 2014; Weber *et al,* 2020; Lopez-Garcia *et al,* 2021; Lopez-Garcia & Molina, 2021; Duru *et al*, 2015; HLPE, 2019
Agrarian research/Education	● Transform the farmers from a research object into a research actor. ● Improve and/or develop new agroecological practices. ● Disseminate agroecological approaches. ● Promotion of food culture	Parmentier, 2014; HLPE, 2019; Lopez-Garcia & Molina, 2021; Sachet *et al,* 2021; Weber *et al,* 2020
Farmer-to-farmer networks	● Promote the co-production and co-creation of technologies and solutions. ● Dissemination of information. ● Enhance human capital ● empowering of communities	Wezel *et al*, 2020; HLPE, 2019; Sachet *et al,* 2021; Collin *et al,* 2019
Farmer-to-consumer networks	● Development of direct (no intermediate) market structures ● Develop new channels of	Lopez-Garcia *et al,* 2021; Lopez-Garcia & Molina, 2021; Duru, 2015; Sachet *et al,* 2021; Collin *et al,* 2019

	communication between farmers and consumers.	
Decentralisation	• Promote the emergence of participatory forms of governance • Increase the direct participation of farmers in the decision-making process • Potential to self organize in the context of power in the dominant regime	Wezel *et al*, 2020; HLPE, 2019; Parmentier, 2014; Lopez-Garcia *et al,* 2021; Collin *et al,* 2019

Regarding conceptual frameworks for agroecological transition, Wezel *et al* (2020) draw attention to the entry points of agroecological principles - 1) diversity; 2) circular and solidarity economy; 3) co-creation and sharing of knowledge; 4) responsible governance - and their transformative impact on agricultural systems. In a similar way, Collin et al (2019) focus on the interaction of multiple domains of transformation - access to natural ecosystems; knowledge and culture; systems of exchange; networks; discourse; and gender and equity - and their synergistic potential to generate transformation. Duru *et al* (2015), in their turn, propose a participatory methodology for designing agroecological transitions. The method is composed of five main steps: (i) analyse the current functioning of local agriculture, (ii) identify future drivers of changes that may determine its future, (iii) design local organisation of the expected agroecological agrifood system, (iv) design the major steps of the transition from the current situation to this new form of local agriculture and (v) design governance structures and management strategies adapted to guide the transition.

On the other hand, different authors have delved into the methodological approaches to deepen on agroecological transition in different contexts without developing specific frameworks. The inclusion of methodologies that enable the participation of non-academic stakeholders is a consensus between these authors. Lopez-Garcia *et al* (2021:02), for example, defend that agroecological transitions are embedded in the "epistemological standpoint that proposes to do science with people". While Sachet *et al* (2021) argue that a positional shift in agriculture is translated into the inclusion of participatory methodologies which are able to facilitate research co-design in agroecological transitions through alliances among scientists and farmers. Lopez-Garcia & Molina (2021) state that it is imperative to further develop and renovate participatory action research within the reality of food systems. Hence, the incorporation of participatory methods in the research process that allow their transformation from objects of research into political

subjects - in a Freirean meaning (Freire, 1975) - able to collectively develop their social-ecological place is crucial.

In the matter of practical challenges for agroecological transitions, researchers have called attention to: 1) Adaptation of farming systems has to be local (Duru *et al*, 2015; Wezel *et al,* 2020; Parmentier, 2014; HLPE, 2019), 2) Uncertainty of farmers regarding agroecological practices may lead to risk aversion (Duru *et al*, 2015; Weber *et al,* 2020; Parmentier, 2014), 3) Coordination between stakeholders with different interests (Duru *et al*, 2015; Wezel *et al*, 2020; Weber *et al,* 2020; Niggli *et al*, 2021), 4) The early phase of conversion may affect the economic performance of farmers and problems in the supply chain (Duru *et al*, 2015; Parmentier, 2014), 5) Since IFS and SI are strongly supported by international institutions, agroecology has few opportunities to upscale through only bottom-up approach. Necessity of coherent public policy in favour of AFS (Duru *et al*, 2015; Parmentier, 2014; Weber *et al,* 2020; Niggli *et al*, 2021; HLPE, 2019), 6) Democratise the access to natural resources (Parmentier, 2014; Niggli *et al*, 2021; Collin *et al,* 2021; HLPE, 2019).

Going more in depth, Gonzalez *et al* (2018) investigates the translation of agroecology into policy by analysing the French and British cases. In the United Kingdom case, the researchers pointed out that agroecology was merely considered as a set of practices to be implemented alongside SI practices. The recommendations to introduce payments for ecosystem services (PES) and market-based policies (e.g., product certification) were a simple extension of instruments of the European Common Agricultural Policy. Regarding the France experience, the French government called out for ecological intensification. The main proposed measures were: to support agroecological farming through subsidies by including agroecological practices as a condition to receive them and support for research and innovation projects intended to foster the validation of agroecological practices. According to the authors, the analysis from the case studies raises three main themes: 1) lack of understanding and definition of agroecology as a set of practices, science and social movement; 2) common dependencies - path dependence - to existing social configurations conditionals the translation of agroecology into policy; 3) need for a democratic discussion on how to upscale agroecology.

3. Material and Methods

In order to fulfil the aim of this research, a participatory approach is adopted that should result in hands-on-results. Participatory research is a research-to-action approach that encompasses research designs, methods and frameworks developed in direct cooperation with the people affected by the study (Vaughn & Jacquez, 2020; Cornwall & Jewkes, 1995). This scientific approach has developed into many branches. Participatory Rural Appraisal (PRA) is one of them. It is increasingly used to enable the local population to share their world visions as well as decision-making strategies and policies that affect them, to plan and to act (Chambers, 1994). According to Chambers (1994), PRA has three core principles: decentralisation, democracy and diversity. Furthermore, VSO (2004) lists three aspects of participation research (see figure 2): learning, empowerment and partnership. Thus, by adopting the PRA approach it is expected to enhance the farmers' position as a mere object of study into an active member of the study.

Therefore, the chosen methods for this study are: semi-structured interview, thematic analysis and backcasting. The detailed descriptions and intended use of each method are exposed in the sub-sections below.

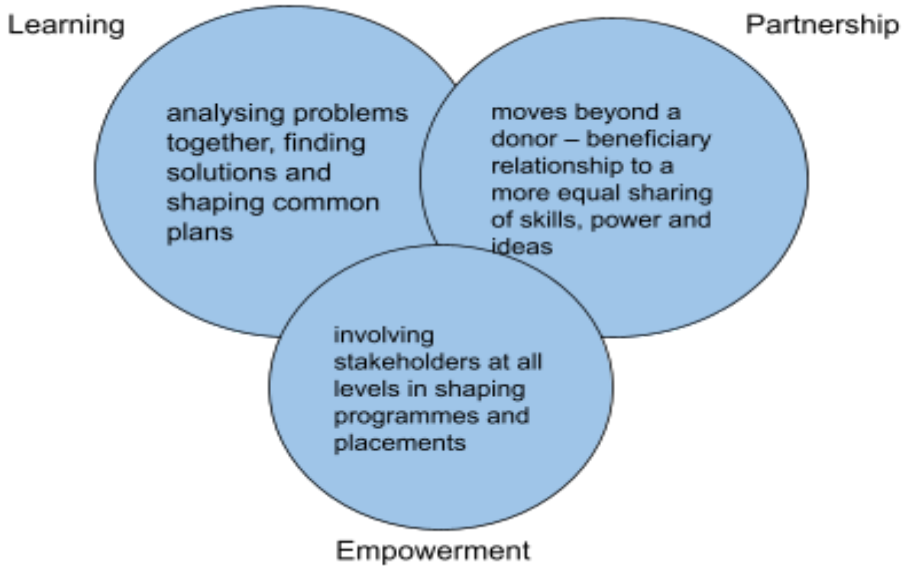

Figure 6: Aspects of Participation in research (Adapted from VSO, 2004:10)

3.1 - Semi-Structured Interview; Data Collection

Semi-structured interview is a guided conversation with predetermined topics. The questions are divided into four different groups: open, closed, reflective and probing (VSO, 2004). This framework has the potential to provide an open exchange of information, allowing the exploration of different themes. The structure is organised in a way that keeps the focus of the interviews so as to ensure consistency, limit bias and increase the comparability of collected data. Since the questions were designed in a way to keep an open conversation, the use of a question script neither blocked the interviewees' free expression nor conducted them to pre-established answers.

This method is adopted to extract qualitative data from farmers, researchers and grassroot organisation about how they envision an agroecological agrifood system in Sweden, the main differences between the current agrifood system and the envisioned scenario, the main characteristics of the agroecological scenario, and which policies could facilitate/promote the agroecological transition of the swedish agrifood system. In total ten farmers, three researchers and one grassroot organisation were interviewed. The interviewed farmers were chosen based on the adopted practices in the farms as well as willingness to participate in the study. While the researchers were chosen with regard to their interest for agroecological studies. By last, the organisation Nordbruk was chosen for being the representative of La Via Campesina in Sweden. Four of the interviews were held *in situ*, while the others were held via online video calls. All the interviews were held in English by the same interviewer.

3.2 Sample profile

Ideally the farmers who were interviewed for this research would have been sorted out through some sampling method - snowballing, stratified/stata-proportional, theoretical, purposive/judgemental, random - in order to capture a wide range of farmers' profiles. However, despite the numerous attempts of contacts, no industrial farmer accepted to join this study. Thus, all of the interviewed farmers apply principles and practices within the agroecology spectrum.

The sample was dominated by male researchers and farmers. More specifically, all the three researchers who participated in this study were men. Regarding the farmers, seven out of the ten farmers interviewed were men. However, it needs to be considered that among the interviewed farmers five were taken as family business, i.e. both men and women run the farm. While the Nordbruk's representative was a woman. The age of interviewees ranged between 26 and 72 years old. The researchers had different areas of interest, such as: reduction of GHG emissions in agriculture, reduction of pesticide use, agroforestry, integrated

pest management, innovation in agriculture, innovation management and agroecological systems.

In relation to farm characteristics, the farms' sizes ranged from 1 hectare to 350. Although five of the farm holdings were below 15 hectares, two of the farm holdings were above 330 hectares. This is why the average size of farm holdings in this study was 100 hectares - way higher than the national average size of farm land in Sweden, 36 hectares (Knus, 2021). In terms of adopted practices, all the farmers adopted alternative methods, such as: regenerative, intercropping, integrated pest management, integration of livestock and crop production and agroforestry. However only three of them had the organic label certificate. The other farmers justified not having the label due its high cost.

The activities of the farmers varied significantly ranging from urban market gardens to wheat flour and bread production as well as livestock production. It suggests the adoption of a diversification strategy by the farmers. All of the farmers were involved in some sort of farm marketing and/or direct marketing. In terms of localization, 6 farms are situated in Skane county, two in Kalmar county and the other two in Västragötland county.

3.3 - Thematic Analysis; Data Analysis

The data collected from the interviews is analysed through thematic analysis. It is a method for identifying, analysing and reporting patterns (themes) within qualitative data (Braun & Clark, 2006). Following the steps in Braun & Clark (2006:95-98), the analysis is developed as follows: (0) transcription of the data; (i) familiarisation with the data through repetitive reading of the transcription; (ii) generate initial codes - it means that each text string is given a code. A code is a short description of the depicted text; (iii) searching for sub-themes - 'theme' is a coherent and meaningful pattern in the data found in answers of different interviewees; (iv) review and define themes - consists in checking that themes 'match' in relation to both the codes and the full data-set ; (v) defining and naming themes - all sub themes are sorted within a number of overall themes; (vi) use the collected data for the development of backcasting: idealised swedish agrifood scenario, main differences between the current swedish agrifood system and the top-down solutions (policies).

Adding to the above, the thematic analysis will be performed in an inductive - "bottom up" way. It is a process where the coding of the data is done without trying to fit it into a pre-existing coding frame, or my personal analytical preconceptions. This approach is data-driven - it is strongly linked to the data (Patton, 1990). It is necessary to highlight, however, that any approach for analysing either qualitative and quantitative datasets carries a number of

assumptions about the nature of the data. Despite the inductive approach to thematic analysis, the extraction, collation, interpretation and presentation of the data - as in any research of any scientific field - is tied up with the subjective position of the researchers. As pointed out by Taylor & Ussher (2001:310), the 'themes' are not laying around waiting to be discovered, they are sought out through a process that " is unavoidably informed by the researchers' disclosures, comments and choice of questions and by their preconceptions and their personal, theoretical and political orientation".

3.4 - Backcasting

Backcasting can be defined as a method "for determining the steps that need to be taken to deliver a preferred future" (UK Go-Science, 2017:68). The goals of this methodology are to agree and create a preferred future, what needs to change between the present and the normative scenario, build a timeline - pathway that points out the key changes, determine and address what needs to be done to deliver the desired scenario (UK Go-Science, 2017). As emphasised by Vergragt & van der Wel (1998:173) "Future visions alone are not enough: backcasting implies an operational plan for the present that is designed to move toward anticipated future states. backcasting, then, is not based on the extrapolation of the present into the future—rather, it involves the extrapolation of desired or inevitable futures back into the present."

The adoption of the backcasting approach is done because it constitutes an "effective way of connecting a given future to the present and identifying what needs to be done to deliver it" (United Kingdom Office for Science 2017). Moreover, due its normative and problem-solver features, backcasting is a better suited approach for long-term challenges and long-term sustainability solutions (Quist & Vergragt, 2006). Quist & Vergragt (2006) also argue that backcasting "is especially promising in case of complex problems, a need for major change, dominant trends are part of the problem, externalities that cannot be satisfactorily solved in markets and long time horizons"; all common characteristics of sustainability problems. Due to its 'ability' to deal with sustainability challenges, different studies have adopted this methodology to investigate sustainable future scenarios, such as 'beyond gross domestic product growth' (Svenfelt *et al,* 2019), 'proposed methods for policy making and analysis' (Robinson, 1982) and 'developing images of desired futures and pathways to its achievement' (Vergragt & Jansen, 1993) to cite a few.

Since the backcasting approach is based on workshop discussions held in different sessions, an adaptation of this methodology is implemented. Instead of having workshops with the presence of the stakeholders, the results of the thematic analysis are used to: identify the main features of an agroecological agrifood

system in Sweden, identify the main changes between the current SAS and the idealised SAS, propose the policies that can facilitate/promote the agroecological transition. The method is going to be developed in 6 steps:

Step 1 - Introduce the preferred future: On this step, the normative scenario is built based on the data collected through the semi-structured interviews.

• Step 2 - Identify the key differences between the present and the preferred futures. On this step, the data gathered from the semi-structured interviews is used to identify the key differences between the current SAS and the idealised scenario.

• Step 3 - Build a timeline, between 2023-2050, that sets out the key changes needed to move from the present reality to the preferred future. Once the critical differences are identified, a timeline is developed containing the chronological order of the critical events identified in step 2.

• Step 4 - Identify which changes are in our control and which are not. On this step the critical events in the timeline are evaluated so as to so as to classify them as: (i) wholly under the control of top-down solutions; (ii) partly under the control of top-down solutions; (iii) wholly out of control of top-down solutions.

• Step 5 - Identify what you need to do to deliver the steps that are in our control: On this step, the goal is to point out the participatory built policies for addressing the key changes under the policy making control.

• Step 6 - Identify how you can influence or facilitate the steps that are outside or partly outside our control: Similarly of what is done in the previous step, the goal here is to point out policies that can influence the agroecological transformation.

The unconventional use of backcasting in this research is due to the impossibility of mobilising different stakeholders ,who are scattered across Sweden, in workshop sections with limited amount of available time and resources.

4. Results

The results are divided into two parts. In the first part, the results of the thematic analysis are exposed. Secondly, the findings of the backcasting approach are presented.

4.1 Thematic Analysis

The results of the thematic analysis are divided into two sections. The first section shows the emerging patterns of answers around the characteristics of agroecological SAS as well as the main changes that need to occur, while the second section displays the identified government actions that could promote the upscaling of agroecology.

4.1.1 Characteristics of an agroecological SAS and necessary changes

Seven themes and eleven sub themes emerged when the interviewees were asked to envision how an agroecological SAS would be and the correlated key changes that need to happen. This section presents these sub themes according to their thematic categories (see Table 12).

Table 12: Themes and subthemes regarding the pointed characteristics of the desired agroecological scenario

Themes	**Subthemes**
SAS characteristics	● Adoption of agroecological practices and principles ● Diverse, multifunctional and resilient farming systems ● Important role of urban and peri-urban farming
Political Focus	● Favorize local production to enhance resilience and self-supply ● Role of public actors to enhance local production
Economic Incentives	● Shift subsidies focus
Innovation	● Increased communication between farmer for knowledge sharing

Markets	● More decentralised market system ● New labelling system
Education	● Agroecological education taught in different levels
Food Culture	● Increased awareness among consumers

4.1.1.1 Theme 1: SAS Characteristics

- *Adoption of agroecological practices and principles*

Without surprise, all respondents stated that the main or one of the main features of an agroecological SAS is the adoption of agroecological practices and principles. During the great majority of the interviews, both farmers and researchers identified monocropping systems and the consequent use of agrochemicals as a "*great environmental danger*" or "*threat*". As said by a farmer "*We must understand that the cost of industrial farming is the environmental cost, it's the cost of declining soil. The soil fertility is decreasing because we overuse the soil with high usage of fertilisers and pesticides*".

Thus, they highlighted the necessity "to move away from monocropping systems that dominate the SAS" through "*the adoption of a more sustainable way of production, based in agroecological principles, that takes into consideration the environment and also has positive societal impacts*". More explicitly, farmers and researchers pointed out practices that would be common in such agroecological SAS scenario, such as: "intercropping", "IPM[4]", "cover layers", "no dig and no till techniques", "alley cropping", "forest farming", "managed grazing", "composting", "livestock integration", "silvopasture". While Nordbruk's representative, underlined that more than "favouring specific methods, We envision an agricultural system based on agroecological principles'.

- *Diverse, multifunctional and resilient farming systems*

This sub theme emerged as a natural follow-up to the previous one during the interviews. Both groups of interviewees were emphatic when envisioning the spillover effects of the adoption of agroecological practices and principles. This excerpt from a farmer is a good example, "*what i feel would happen is a good solution is to have a lot of diversity and it's hard to imagine a clear landscape. And now the landscape is composed of endless canola fields and sugar beets fields. This is not what I envision as a solution to the food system. So what I see is like a patchwork of different farming systems with each of them responding to different needs that the country has and we're not using just one landscape for*

[4] IPM stands for Integrated Pest Management.

one need and then we try to integrate as much biodiversity into the landscape as possible. That actually responds to the natural advantages and characteristics of each specific location. So needs for the people and needs for the environment it's what should form the landscape."

In a similar way, a researcher stated "*I think that in general, for example, when you take a highway in Sweden passing through the countryside - especially in Skane - have this open landscapes with monocultures and it might look nice when rapeseeds are flowering and people are taking picture for 'gram'. But to me it's a landscape that is pretty bear that grows only a few crops and that could grow many many different crops. I think it's a system that might not be as resilient as we think towards different shocks like climate change, or social events, for example. So as to improve this system, I envision us diversifying the field to a higher degree by growing many crops. I've seen these crops are getting more popular now, but let's say hemp or different types of legumes. I envision us growing more trees, bushes. It could be trees of different kinds that have been grown here for very long time like hazelnut and reintroduce those crops to provide many different ecosystem service and while doing so improve aesthetics of the countryside landscape and it also contribute for community to have a more direct access to products that we've been having to import for a very long time*."

The important role of social and environmental dimensions of farming systems were put light on by a researcher "*farming systems that target people and environment needs*" and two farmers "*people can come to the farm interact with food and see how the food is grow*" and "farming systems are seen as part of a bigger ecosystem, so as to people understand the ecological value of diversified farms".

- *Important role of urban and peri-urban farms*

By last, the role of urban and peri-urban farms in a Swedish agroecological agrifood system (SAAS) was another common feature that emerged during the interviews. For some farmers, increasing the urban production represents a key characteristic, as can be verified in the following excerpt "*I think increasing the amount of urban farming or even like peri-urban farming is crucial, right? I think that's really important for a couple of reasons. One, like I said, it gets the farmers closer to the consumers. So then there's better knowledge sharing and it's just healthier for people as well if they know where their food is coming from. But also I think that it provides more opportunity for more small businesses, right? And I think that that's what we need to move towards*".

While other farmers also linked urban farming as an opportunity to enhance aesthetic value of cities and create a bigger integration between man and nature, "*I*

think it's fascinating the potential of urban farming to turn the urban landscape more green and sustainable, how this environment can be more integrated with agriculture and generate not only ecosystem services but also social services that go beyond the supply of food by offering an opportunity to be in nature within the city".

The researchers also highlighted the role of urban farms and their importance in a SAAS scenario, through the lens of their social sustainability dimension. One particular statement was "*the important potential that urban and peri-urban farms have to generate jobs in a time of high unemployment. Besides that, these farms can work as important sources of food for low-income families*".

4.1.1.2 Theme 2: Political Focus

- *Favorize local production to enhance resilience and self-supply*

The change of political orientation towards food supply was a common topic during the interviews and was also pointed out as a key characteristic of a SAAS. The interviewees often criticised the current Swedish food strategy. As it was stated by a farmer "*the national food plan relies mostly on the imports of food. So it favorizes trade. It makes the work for small scale farmers like me much harder and can have bad consequences for the country's self-supply capacity*". While the Nordbruk representative argued that "*the food strategy limits food sovereignty by favouring industrial production for international trade and the import of cheap food*". The need for support of local production was also highlighted through the lens of Swedish agrarian and labour legislation "*I think there needs to be support for local food. Trying to increase local production because Sweden has more strict laws about how animals are kept and how workers are treated so there is a higher chance to meet these standards if the production is taken in Sweden. It is almost hypocritical to condemn bad practices within the Swedish borders, but keep importing food from countries with slave labour and bad environmental practices.*", stated a researcher.

Another farmer linked the necessity to favour local production and its potential to increase resilience and self-supply "*What I could say is that I feel really strong now after I started being a producer is that the governments of Europe and of this world have to prioritise local production. That's where I feel we're gonna get a big shift. we have to switch to think how much we can make ourselves as resilient as possible to be able to self-sustain ourselves. In Sweden it is possible to produce food to feed the Swedish population. So yeah, that's where the shift needs to be - local resilience. I really think this is more clear now with the current crisis whether they are sanitary, climatic or military. One can clearly see the huge crisis we have in our supply systems.*" This link was reinforced by another farmer "*as you can see, We have right now we have bird flu in Sweden and last year there*

was like fifteen percent of the hens in Sweden had to be killed because of bird flu. So these really big farms with all the hens like twenty thousand hens in one building they would all the hens died in like one day and yeah, some small farms also got bird flu. We didn't get it, but I'm just saying having these giant farms. It's not really safe when you think of disease or small farms being more resilient because we use local sources. We're not importing things, we're not using diesel, so when there's these crises like in Ukraine. Diesel prices going up. It doesn't really affect us. We're not really experiencing anything with what is happening in Ukraine or Russia with fertiliser diesel. It doesn't affect us here because we use local sources".

- *Role of public actors to enhance local production*

The role of public actors to increase local production emerged as a natural follow-up of the previous subtheme. As stated by a farmer "*I think that cities and municipalities could be pioneers saying we want to start a revolution through locally produced food and we truly want to decentralise the food production. But they're not there because the alternative is cheaper, faster and so on*". This argument is reinforced by another farmer when visualising an ASAS, "*I guess that bigger actors would shift the way how they buy food, and target locally produced food. It could really accelerate the upscaling of agroecology and would constitute a key feature for agroecological agriculture in Sweden* ".

Researchers also emphasised the decisive role of public actors to upscale agroecology by favouring local production with possible positive side effects. In the words of a researcher, "*municipalities have a pivotal role regarding the increase of local production. It is fundamental that public schools, elderly houses and other public institutions support local-production through the direct purchase of urban and peri-urban farmers' production. It would also have an enormous impact on how the children and people who frequent those spaces perceive food and sustainability. So, I think that this is something that definitely needs to happen*".

4.1.1.3 Theme 3: Economic incentives

- *Shift of subsidies focus*

Subsidies or, to be more specific, the nature of subsidies orientation was extensively discussed during every interview. Alongside with the change of political focus, the interviewees claimed for a shift of subsidies focus as a key change for promoting agroecology. They identified the farm size criteria[5] to

[5] . "This means that farmers receive support based on how much land they maintain, instead of how much is produced on that land. The general idea is that consumer demand shall guide production. The EU hopes that this change will result in lower surpluses for certain products. The farmer can receive the single payment for all farmland, i.e. both arable land and pastures, that he or she maintains and claims support for. In order to receive the full amount, the farmer must comply

receive subsidies as a barrier for the upscaling of agroecology. As similarly commented by different farmers "*change subsidies focus is a very important way to promote agroecological change. We need to start shifting subsidies from big farms to small farms*" and is a form to fasten up the process "*I think that if we want to speed up the system change, I think that subsidies we get from the EU should be more targeted to alternative farming systems. I think that it'd change quicker*".

The interviewees looked at this topic under several lenses, such as: cost of food, competitiveness, barrier to systemic change and use of public money. Regarding the first lens, a farmer stated that "*I think everyone in Sweden should be allowed, should be able to afford good, healthy food. It shouldn't be for rich people, but we have to charge the prices that we have. I mean we have to make money. The industrial food is not cheap only because of scale and specialisation, the government helps to reduce their production cost a lot. So, definitely if we were subsidised in the same way as big farms then our food would be affordable for everyone*", clearly correlating subsidies with the higher prices of small scale diversified farming systems when compared to the industrial farming ones. Another farmer goes deeper on this topic by arguing that "*Of course I'm upset with the authorities bringing financial incentives to farmers that are doing something that the market tells them not to. The State creates fake competitiveness bubbles, by supporting businesses that are destined to die due their use of unsustainable resources. We're having a crisis of subsidies. We all know that in the long term these inputs are going to get more and more expensive because they aren't renewable. So we should accept the change and not fight it with financial incentives*". This argument was reinforced in a very similar way by a researcher when talking about how politicians are not prepared to deal with change "*The first thing I think we should do is to embrace the change and adapt the systems to new situations. Governments, all around the globe not only in Sweden, should stop subsidising production systems that are not sustainable. It creates huge distortions and raises a barrier for sustainable solutions like agroecological farming*". While a researcher and a farmer also looked the subsidies topic in a institutional way, by highlighting that "*the public money and resources should be used in a way that benefits the countries' population in general and not only a targeted group of farmers and international companies*" and "*the public resources have to be used to finance more biodiversity and social sustainability and subsidising industrial farms goes on the opposite direction of that*".

Therefore, the interviewees have shown during the interviews that the shift of subsidies focus from industrial to small scale farming represents a keystone change for the upscaling of agroecology in Sweden due a set of reasons.

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with requirements regarding i.a. the environment as well as animal health and welfare. This is referred to as cross compliance." Jordbruksverket, 2020.

4.1.1.4 Theme 4: Innovation

- *Increased communication between farmers for knowledge sharing*

When the interviewees expressed their view around innovation, They were emphatic pointing out the need for change from a focus on high tech solutions for IFS to expanding the adoption of low tech solutions through knowledge sharing. The following excerpt, from a researcher, is a good example to summarise this sub theme "*all the innovation system is focused on the development of high tech solutions for monocropping systems. It englobes machinery, automation, big data, digitalization and so on. I think this is something that has to change for an agroecological agricultural system to happen here in Sweden or anywhere else in the world. I like to think more in the direction of low tech solutions that are already available like intercropping, cover layer, and different constellations to maximise the benefits between animal and crops. There are farmers that employ these technologies in their farm but it's a niche. So the question is how to transform this niche into a regime*". This argument is reinforced by a farmer "*when one looks to industrial farming or any other sector of society like big scale industries there's a lot of government funds to inceptive innovation and public-private partnerships. Of course because there's a lot of money and interests involved in that. On the other hand, the simple methods that we have used for generations are kept closed within a very small group of farmers because we don't have a good way to communicate with each other. So, I think this is something that must change the focus on innovation to spread more traditional knowledge*".

Two farmers who classified themselves as "innovative farmers" shared common thoughts on what is needed to mainstream low tech solutions, as can be noted in the next excerpts "*I consider myself innovative, because I feel like I like to explore new ways of low tech solutions that are cheap and can be repliable. It's not rocket science, this is what people used to do 100-200 years ago. I think that all the farmers would like to be less harmful to the environment and spend less money on their farms, so I think that - well, at least, personally I'm really eager to share what I know with other farmers - I think that there's mutual interest from farmers that try new things and farmers that want to learn how to become more sustainable. All we need is a way to get together*". While the other farmer stated that "*If I talk from my own view, I've done some innovation in terms of seeding tools, producing local variety wheat, milling and baking with it as well as combining different crops. So I might say I'm an innovator in what I do. I think that it'd be great to see other farmers replicating what I do. However we all lack an actual network that brings us to work together. All these projects work a bit in isolation. We don't work with the same goal together. But there's no association between farmers involved in this type of farming and people have a lot of knowledge to share. If we were up to harness and put this work together I think that could be really impactful*".

Interviewees also pointed out that knowledge sharing and co-creation of new methods and tools would be highly important in a SAAS. One of the interviewed researchers was very direct when saying that "*the share of knowledge between farmers and also a bigger integration between farmers and academic community would be an essential feature of any agroecological agricultural system in the world*" which a farmer corroborated under a different lens "*I guess that if other farmers both big and small farmers get to know successful examples of what other farmers are doing, It can help to make alternative innovations more common until the time they become the most used ones*".

Thus, through the above excerpts one can note that there's a common identification on the need of change in relation to innovation for small scale producers and the key role of increasing farmers' communication among themselves.

4.1.1.5 Theme 5: Markets

- *More decentralised market system*

The need for a more decentralised marketing system was a recurrent topic during the interviews. Both researchers and farmers raised issues, such as: the power of "middle man", increasing the contact between farmers and consumers, local markets, and the impact of supermarkets on the way people think about food. The following excerpts represent the thoughts shared by the farmers. "*It's really hard to be a farmer nowadays, we do all the work, we do the whole investment, take the risk and at the end of the day the companies that run the groceries stores, like ICA, are the ones that get the biggest share of the pie*". Another farmer called attention to what she called "rabbit traps", "*they say (companies) that they can share the risk of production with us by buying everything we produce before the season, but this is a rabbit trap because they can put us against the wall by offering real low money to buy our production in consecutive years and we'll have no one else to sell to. It's what people say 'one shouldn't put all the eggs in one basket*'".

A farmer and a researcher shared a common view about how most of the farmers do not really choose what they are going to produce, "*the things are organised these days is actually sad, I have so many farmers friends who see themselves obliged to keep producing crops that they don't want to with methods that they don't like. Some of them are almost all workers of the companies. They do it because of huge debts contracted with the banks*". While the researcher stated "*the costs of production are so high that what we see in the current days is that farmers can no longer decide the crops that they are going to produce because the retailer companies buy the whole production beforehand. So they determine what the farmers have to grow*".

The interviewees went beyond the current market problems for farmers by suggesting a more decentralised market system built on a close relationship between farmers and consumers. As stated by a farmer "*if we really want to transform food systems we must change the way food is commercialised, bring people close to us. This way, they can see how food is produced, by who. It helps to increase the relation with food. It's perfect for the farmers and consumers because we'll have the full share of our work and the consumers will spend less than in a grocery store*". Another farmer highlighted the positive spillover effect of direct markets, "*I mean, we want to grow more for local market, we've actually just started our own farm shop to sell eggs, grains and also we have just bought a mill, so we'll start in the summer to mill our own grains to sell mjöl (flour). So, I mean, we want to sell more directly to consumers, but it's difficult to sell everything in a local market. We're located very close to a city, so we have consumers right around the corner and we also have reko-ring. I mean it's a totally different way to farm when you sell directly to the consumers. I mean we go straight from a bulk-production to sell straight to consumers. It's more interesting because then we don't need to have so much land because we can have the money we need with less hectares and also less inputs. Everything is so expensive, land, machines, inputs.. So we have very little margin. But when you sell directly to consumers, the whole farm would be more resilient and sustainable*".

Urban agriculture was also explored during the interviews as a way to make people create a close relationship with farmers and food produced by them. As brought up by a researcher "*I think that urban farms play a determinant role on bringing the consumers close to the farmers. It has the potential to decrease the dominance of retailer stores and increase consumers' awareness around food*". This argument is reinforced by a farmer, "*I think that, maybe I'm biassed for being an urban farmer, urban farms have a different characteristic: it brings people to agriculture, making them see how food is produced. It is good for us who benefit economically, for them who see things that they had never seen before and for the planet because it contributes to sustainability*".

- *New labelling system*

The way that the labelling system for organic products is organised was criticised during the interviews. Both researchers and farmers pointed out how the current label organisation creates discrepancies that favorize food produced in IFS. A farmer gave his opinion on how unfair the label system is for non-industrial farmers, "*it's extremely unfair to have a sustainable production system and being obliged to spend more money in order to prove that. It should be done the other way around*". Almost like a follow up, another two farmers stated "*it makes absolutely no sense to pay for an organic certificate. The farmers who use chemical pesticides and fertilisers should be the ones to pay for a label that says*

'this food is not organic' or 'this is not sustainable" and "*organic farmers, if you want to be certified as organic right, you have to pay money, but somebody who's like spraying their food with a bunch of poisonous sh... They don't have to, like, certify that. You know what I mean?! It should be the opposite way. Like if you're using chemicals, you should have to get some sort of licence or something. You should have to pay money, not the organic farmers'* '.

While a researcher reinforces the farmers opinion by highlighting the same problems related to the current label system, "*I think that a new labelling system that penalises industrial farmers is essential for an agroecological transition. The way it is organised today only penalises non-industrial farmers and makes it almost impossible for small-scale farmers to prove that they produce food organically. It should be the other way around, industrial farmers should be the ones penalised for adopting unsustainable practices*".

By last a farmer also raised attention to the economic barrier of having an organic certification. As pointed out by one, "*For me it is unrealistic to have an organic certification, it'd affect my expenditures too much. So, even though I have regenerative practices on my farm, I can't sell my products as organic to grocery stores only through direct marketing*".

4.1.1.6 Theme 6: Education

- *Agroecological education taught in different levels*

Education was a subject raised under different lenses during the interviews. Farmers pointed out the necessity of agricultural education following principles of ecology so as to shape a new generation of farmers as well as a new generation of consumers, while researchers gave emphasis on the teaching of agroecology in all levels of education.

According to a farmer "*non-conventional farming requires advanced knowledge about how the soil works, interaction between different crops and the use of livestock. When you have a conventional farm, I know this because I had one myself, you don't need to think so much about what to do. It's like following a recipe. So, yeah, it's definitely important to teach a type of agriculture that is not conventional*". While another farmer stated that "*I think that there are many cool courses for people who are interested in alternative ways to produce food, but it's still a bubble. Only people who know or are interested in these practices look for it. So I think that for an agroecological system to come true, not only in Sweden but in other parts of the world, it's essential that such alternative practices start to be taught in traditional degree programmes*". A third farmer took a different direction on his argumentation "*I think that it's important to have courses that teach sustainable methods, but I do think that the change should start by educating the consumers about food. I mean, I think it must start by explaining to*

consumers what food is good for my body and that cheap food is not good for the environment. So, I think that we must teach consumers what they shall eat and what regenerative is because it offers so much for society. It stores carbon dioxide in the soil, it gives more biodiversity, it cleans up the water, it gives much more wildlife and beauty to the landscape. So I mean if you can sell that to the consumer and also the most important the nutrition density is much higher in regenerative farming".

Researchers were aligned with the arguments given by the farmers, but they were slightly more focused in the teaching of agroecology in all levels of education. For example, as put by one researcher, "*agroecological education should be offered at the university level and also at high school level, municipal and regional level. So the children can understand the current challenges of agricultural systems and how agroecology can face them or biodiversity loss*". In a very similar way to what was pointed out by the last farmer excerpt, a researcher stated "*education is super important. I run a school and I have a cook there, and I wanted to change the food we serve to 100% organic and then budget kicks in because it's more expensive and the government is thinking about cutting the budget of schools so we're really stuck. But then I suggested cutting out the meat. I'm not against meat, but just to send a signal that we can do with less and to be creative. Make the children aware that one can eat good without meat and it's also more sustainable. This is the sort of thing that makes change happen because it teaches children where the food they eat comes from. It feeds back to sustainable production and food sovereignty. What will happen? We don't know. I think that change comes from demand. I think that each consumer has an enormous power in both ways to yourself and how you influence others. This can have a trigger effect. I'm hopeful because of the children at school. More than ever they are aware about the limitations of global systems. So we need to increase the pace of their awareness. They are going to make the change. Change comes from underneath and they are the future for this change*."

Thus, through the excerpts above, it is possible to note that agroecological education was considered a key change for the transformation of the SAS.

4.1.1.7 - Theme 7: Food culture

- *Increased awareness among consumers*

The ascension of a new food culture through a more aware society was repeatedly brought up as a key change for the agroecological transition of the SAS. As put by a researcher "*in my opinion, the main ingredient for agricultural and or food systems transformation is the creation and or emergence of a new food culture where consumers are aware of what constitutes a healthy and sustainable diet and it stimulates a change of practices by the farmers*". Another researcher

corroborates with this argument by stating that "*I mean, by envisioning an agroecological scenario, I'd definitely think about a flowering food culture with consumers who are aware of the socio-ecological impacts of their diets and with farmers embedded with mindset ready for change and adaptation*".

Farmers also highlighted the necessity of aware consumers so as to build an agroeocological agricultural system in Sweden. As mentioned by one farmer, "*once the consumers change what they buy, farmers can start producing in a different way because these consumers would press the retailer companies to change the products*". While another farmer classified Sweden as being a perfect spot for the start of a new food culture "*I think that since you don't have a strong tradition around food in Sweden, like in France or Italy, it is easier to shift away from old habits of consumption*."

From these excerpts, it can be seen that the increase of awareness among consumers (what had already been mentioned in the education theme) plays a key role for the agroecological transformation of the SAS.

4.1.2 Government actions

The suggested government actions so as to address the key changes and bring up an agroecological SAS were grouped into five themes and seven sub themes. This section presents these sub themes according to their thematic categories (see Table below).

Table 13: Themes and subthemes regarding government's actions in order to promote an agroecological transition of the SAS.

Themes	**Subthemes**
Financial Instruments	● Subsidies available to small scale holders; ● Reward the generation of ecosystem services;
Regulation	● Agricultural practices and consumption
Innovation	● Creation of a national platform to enhance the communication between farmers; Grants to promote innovation between farmers
Markets	● Enhance communication between farmers and consumers; ● Labelling system targeting unsustainable producers
Conscientization Process	● Implement agroecological education

	at different levels;

4.1.2.1 Financial Instruments

- *Subsidies available to small scale holders*

Corresponding to the many complaints regarding the subsidies focus on large farms, the respondents were categoric when pointing out the approach that the government should take. The statements of the farmers in favour of a policy that aim to incentivize small and medium holders were varied and numerous, to cite some: "*I don't have so much knowledge regarding policy, but I think that - as I said before - there's one thing that could facilitate my life and the life of other farmers like me is the shifting of subsidies from big farms to smaller farms like it doesn't have to be, you know, cut completely and then shift it. But just, you know, go slowly progress*", "*now talking about the size of the farm. If the government would compromise to develop an agricultural system that is not conventional, we should create financial incentives to small scale producers here in Sweden* ", and "*the more the government postpone unsustainable production through subsidies, the harder it gets to achieve a transformation. So I think that the government should change this logic by subsidising farmers that are committed to sustainable production for the local community*".

The researchers showed to have aligned opinions with the farmers about promoting financial incentives to small holders. One researcher, for example, stated that "*I think that if we do want to transition to an agroecological food system, then we should finance part of the production of farmers who adopt sustainable practices*". While another researcher highlighted the importance of financial incentives in regard to the affordability of non-industrial products "*The real prices of industrial products are masked by subsidies, which is not the case for small scale farmers. Which means that only wealthy people can afford non-industrial food. I think that healthy food should be available to everyone and that the government is paying for healthcare. So if Everyone had healthy food to eat, They would be healthier. There would be less diabetes, less heart problems and less cancer cases. So the government could save money on health care by financing agroecological production. I think healthy food should be part of healthcare. And therefore I think the government needs to subsidise healthy production of food rather than just. In these terms, the first step would be to subsidise small and medium scale farmers*". To complete, the representative of Nordbruk brought up that "*the shift of subsidies from big to small and medium scale farms is determinant for scaling-up agroecology in Sweden and it's one of the policy agendas that we advocate for* ".

Thus, it is easily noticeable the consensus among farmers and between farmers and researchers regarding the necessity of financial incentives which target small and medium farms for the agroecological transitions of the SAS.

- *Reward the generation of ecosystem services*

Despite being under the same theme, this sub theme has a distinctive characteristic when compared to the first one. While the first sub theme emerged from the desire of farmers and researchers to facilitate agroecological production as well as decrease the price of its associated products, this sub theme emerged as a desire of the farmers to be compensated by the generated services and also from the potential transformative impact it could have on industrial farmers, as stressed by the researchers.

According to a farmer "*the generation of ecosystem services should be compensated somehow, maybe through a discount on taxes or through subsidies, you know? If we provide a service that is important to society, besides producing food, we should definitely be compensated for this*". Another farmer gave a similar opinion "*I'd say that the compensation for the generation of ecosystem services is a way to say 'look you're doing something great for people, so you deserve an extra money'. We work a lot to create and keep a farm that can produce these services, so I think that the government should incentivize us by giving more subsidies*' '.

The researchers went through another direction. One of them stated that "*the introduction of payments for the generation of ecosystem services could have a big transformative impact in the industrial farming sector. It would attract different industrial farmers to promote certain degrees of agroforestry, for example. So my best guess is that these sorts of payments are essential for agricultural transition*". Almost as a combined complement, another researcher gave examples on how it could be done "*Of course along the lines with CAPs, we should reward producers that are generating ecosystem services by doing soil samples, biodiversity analysis, arthropods occurrence. These are the tests that could be done to make the farmers prove they contribute to the ecosystem. It'd have a big impact on the agricultural industry*".

Therefore, this policy would represent an incentive for industrial farmers to adopt agroecological practices and compensate the farmers who are already generating such services.

4.1.2.2 Theme 2: Regulation

- *Agricultural practices and food imports*

Seeking to limit the adoption of industrial practices and proportionate the expansion of local production, the interviewees suggested government's regulation on agricultural practices and food imports. The next excerpts highlight these suggestions.

A researcher pointed out the necessity of government intervention regarding the use of external inputs, "*there should be a strict policy to reduce the use of external inputs, especially the ones derived from fossil fuels. They pose a huge challenge not only for environmental but also social sustainability since these kinds of inputs have an expiration date. The more we wait to make this change the more catastrophic it will be. The russo-ukrainian war has shown some consequences of fossil fuel dependence. So the government has to act in order to limit inputs such as mineral fertilisers and diesel*". Another researcher added with a very similar vision, "*the new policies that decrease the price of diesel because farmers need a lot of it. That is terrible, it goes completely against the transition process we need. If you look at the automotive industry, for example, policies for transitioning were given towards electricity. We had a system in which if one buys a car driven by diesel one would have to pay extra taxes for it. On the other hand if one buys an electric car, a subsidy for one third of the car's price. In that way bad behaviour is penalised and good behaviour is encouraged. I think that something similar should happen in agriculture. I think that it's difficult to happen in that way because somehow you have to choose a side and make a statement around what is good and bad and that's just not convenient for politicians*".

While a farmer and another researcher shared similar suggestions regarding the imports of food. According to the farmer "*I think that if we want to increase local production the government should take action against the imports of food, especially from late spring and early autumn. It's way more expensive to produce food here due to Swedish standards and we can't compete with cheap imported food from countries that use low paid labour and do not have the same environmental laws as Sweden. So the government should act so as to protect the Swedish farmers from the cheap food imported from abroad*". A researcher followed this same direction, "*There should be a policy to guarantee a certain amount of consumption of locally produced food. This is a must in order to give incentive to local production. The Swedish local producers must be protected*".

Thus, the interviewees suggested a direct intervention so as to decrease the use of fossil fuel dependence as well as defend the Swedish farmers from cheap imported food.

4.1.2.3 Theme 3: Innovation & Knowledge Sharing

- *Creation of a national platform to enhance the communication between farmers*

This sub theme was identified after the interviewees repeatedly suggested a new government approach towards innovation linked to the necessity of increasing the communication and cooperation among farmers so as to spread easily adaptable low tech solutions.

Starting with the farmers' thoughts, one of them stated "*I guess that information sharing is the main obstacle for applying new techniques in alternative farms. I think that's missing here. I don't know if it's all of Europe, maybe, but I think for sure in Sweden that kind of communication is missing. Because I mean, even if you just go on YouTube, right? And if you do like, If you search for Swedish farms, any kind of information, there's like nothing. But then if you do it in English, you'll find anything right? And it's all like Canadian and American farmers, just like talking about what they do. Actually, that's something that I would really appreciate here in Sweden is if there was some kind of platform or something where you could easily look up. Like any kind of information such as alternative practices, seeding rates or yields and prices and other important stuff one needs to know when starting a farm. But it's so hard you have to like you know find it independently on different little whatever sites and stuff. So that would be something really cool actually*". Another farmer expressed his suggestions for the spreading of low tech solutions by sharing his experience when starting his farm, "*It was really hard to find any kind of information regarding the best practices to be applied in my specific soil, most productive and profitable crops, market information. Basically all the things you need to know to start this kind of business. I found some broken information on facebook groups, but I was very lucky to have some farmers around me that could share this kind of information. So I guess that if there was some sort of public data bank where you access all this kind of information it would make it easier to popularise the implementation of practices of ecological farming*". While a farmer who is part of the innovator niche presented the same view through another angle, "*I can say that I'm very good at trying new things and making my farm more resilient through simple solutions that don't require big technologies. I receive many messages from farmers or people wanting to start a farm here in Sweden mainly asking about which practices apply and profitability. In my opinion it'd be almost revolutionary to have a physical and/or digital place where all people, not only farmers, could access this kind of information*".

The researchers also expressed their thoughts in line with the problem identified by the farmers, "*Regarding the spread of low tech solutions, I think that we should envision a top down approach that would facilitate the transition of a niche of*

innovative farmers to a regime where the farmers apply and share different practices. I would say that Jordbruket could create and administer a virtual space where farmers could exchange ideas". Another researcher shared a similar thought "*from what I've seen there are many farmers that apply low tech solutions in their farms, but it is still a small amount. At the same time there are many other farmers who are eager to implement such solutions, but don't know how to do it. So I think that We should focus on a way to put them together*".

Putting the suggestions of the interviewees together, one can notice the necessity to create a national platform where farmers and potential farmers can exchange information so as to upgrade the niche of innovative farmers into a regime.

4.1.2.4 Theme 4: Market Suggestions

- *Enhance communication between farmers and consumers*

Aligned with their claim for a more decentralised market system, the interviewees suggested an institutionalisation of the already existing marketing alternatives like reko-ring so as to have a more concrete platform to communicate with consumers.

A researcher elaborated on this topic as follows, "*I think that there are existing tools that already put farmers and consumers closer. The real challenge is to disseminate the use of such tools. Again the problem of niche regime. We need to make the alternative ways of buying food into a normal practice. I think the government could create some sort of platform where farmers and consumers would be directly connected. Maybe a phone app could work well for this end*". In the words of another researcher "*we must strengthen the alternatives that are already out there, like reko-ring and CSA. This is something that the government could work on*".

While the farmers gave their suggestions considering the adversities of building a regular consumer base. One farmer, for example, stated "*I think that one of the main obstacles of any independent alternative farmer is to establish a consumer base. This I tell from my own experience. I've been doing CSA, reko-ring and farm market. I can say that only after 5 years I was able to have a reliable customer base. When you hear about reko-ring, for example, one can think it's really great, but it's really hard to have continuity. While the facebook groups have over 20000 only a few show up at the meeting point. I think that if it was more organised, there would be more people participating. So this is something that the government could act on*". An urban farmer gave a more specific suggestion on how the government could act, "*the municipalities could organise some fix points throughout the cities - like what happens in Möllan*[6] *- where urban and peri-urban*

[6] Neighbourhood in Malmö, Sweden.

farmers could sell their products, exchange knowledge and directly talk with the consumers. I think that it'd make a great difference".

Thus, the interviewees defended a more official way to commercialise their products through two different governmental interventions: institutionalisation of existing methods, and creation of fixed market points scattered throughout the cities.

- *Labelling system targeting unsustainable producers*

Following dissatisfaction with the current labelling system, the interviewees suggested government actions under different approaches. Despite the differences on how the government should apply such actions, all of them shared the same goal: change how the labelling system is organised.

A farmer elaborated on how the government could organise the new label system "*I think that one action to be done regarding organic certification would be to create a tag showing that the product was not produced in a sustainable way. Of course, the farmers who are not within sustainability standards would be responsible for the payment. Clearly one thing to be discussed is how Jordbruket would establish a sustainable production, since some of the organic farms operate like conventional farms, but use organic inputs*". Adding to this, a researcher used the example on how to reward ecosystem services to suggest a framework that could be used for evaluating sustainable farms, "*something similar to what I proposed for evaluating the reward of generation of ecosystem services - the quality of the soil, biodiversity, utilised inputs, and so on - could be done in the farms so as to check their overall sustainability. It would also make both processes easier and cheaper*".

Another farmer, on the other hand, suggested only two modifications of what is done now "*regarding the organic certification, I'd say two main things have to change: the conventional farmers should pay the certification of sustainable farmers, and the government should also change organic to sustainable. My products are grown under regenerative farming practices and it holds a completely different nutritional value than a typical organic farm. Nowadays these organic farms can be certified just because they don't use chemical inputs, but if you do soil examinations you'll find out that they have the same quality as a conventional farm. So I don't think that these farms should be considered organic*".

As shown through the excerpts, both farmers and researchers present their thoughts on how the government should act varying from a more drastic action to more simpler alterations.

4.1.2.5 - Theme 5: Conscientization Process

- *Implement agroecological education at different levels*

This policy suggestion emerged as follow up - in a similar process of the suggestions presented above - of the identified key change for transitioning the SAS, raising societal awareness about food production and consumption. Both researchers and farmers converged for the implementation of agroecological at different levels.

A farmer justified this vision as follows, "*as I was saying before about change, I think that the major part of our change as producers depends on what people buy. So I think the best way to shape the agriculture we want is teaching people what is good or not. And it should happen starting from childhood not only for agriculture education. The government should act in this direction, implementing agroecology and sustainability education in primary schools*". While a researcher highlighted that "*policies regarding education, again at the university level and also at high school level municipal and regional level so the children can understand the current challenges of agricultural systems and how agroecology can face them or loss biodiversity. This is a key action to transform agricultural systems here in Sweden and everywhere else*". This argument was reinforced by another researcher "*I think that education is key to raise awareness in consumers and farmers. This is the only way to change the current mindset and consequently transform food systems*".

The Nordbruk's representative shared the institution's actions towards education and simple actions that could be done by the government, "*So, Nordburk has a lot of competence when it comes to forestry and agriculture and that's something we are most known for and also pastures and stuff like that. And also Tory's book. He wrote a book based on his lectures and so now it's also translated to english. So it's English and Swedish and we are promoting this book to like different types of programs or education in schools. We're also to the public and like trying to get it into libraries and stuff like that. The propagation of different practices and methods is a key action against unsustainable agriculture and the government should act with this aim*".

Other interviewees also pointed out for more intermediate actions, as can be seen in the following statements of a farmer and researcher, respectively, "*I think that some public advertisements campaigns could influence the way people think about food and they would care more about what to eat*" and "*I think that besides the implementation of education, publicity and the adoption of a goal of a new food culture could be determinant to change people's modus operandi and the food system*".

Thus, it was possible to verify that the interviewees consider the government intervention towards the implementation of agroecological education as determinant policy to transition the SAS.

4.2 Backcasting

The findings from the backcasting approach are presented highlighting how an agroecological SAS would be, the key changes that would need to happen organised in a timeline, and the policies that could promote these changes.

4.2.1 The normative agroecological SAS scenario

This scenario is built according to the aforementioned visions of the farmers, researchers and the Nordbruk representative who participated in this study regarding the main characteristics of an agroecological SAS scenario.

In this scenario the political focus is twofold: i) enhancing local production so as to increase the self-supply and resilience and ii) develop a new food culture. To do so the government: i) subsidise smallholders committed to local production and marketing, ii) regulate the adoption of unsustainable agricultural practices, iii) act as the main buyer, in the municipal and regional level, or one of the main buyers of local produced food in order to supply public schools, elderly houses and public institutions, iv) establish a new labelling system that benefits the producers who adopt sustainable practices and v) creates a national platform where farmers can exchange information and look for reliable data.

People in Sweden have increased their awareness towards sustainable food consumption habits and agricultural production. This is a result of a continued educational process established at different levels by the government. A flowering food culture is the consequence of consumers and producers fully conscious about the socio-ecological consequences of their diets and production methods.

In terms of agricultural characteristics, the agricultural system is built on the thirteen principles of agroecology. Within this frame the most adopted practices are: intercropping, integrated pest management, cover layers, no dig and no tilling, alley cropping, agroforestry, regenerative, managed grazing, composting livestock integration and silvopasture. As a result the countryside landscape is composed of a set of different farming systems which responds to the natural advantages and features of each specific location. Thus, it attends to the needs of people and the environment. Urban agriculture is also blooming, generating a more direct contact between urban dwellers and food production as well as an important generator of jobs. It is a resilient agricultural system, capable of adapting against environmental, social and sanitary crises. By last, the generation of several ecosystem services is another important feature of this SAS.

The innovation process is characterised by a focus on low-tech solutions that are easily replicable. These solutions are disseminated through a national platform made to facilitate the communication among farmers and wanna-be farmers. In a similar way, the marketing of food occurs in a more decentralised way. It happened through the direct communication between farmers and consumers through the institutionalisation of farmer-consumer channels like reko-ring.

4.2.2 Timeline with key changes

As highlighted throughout the previous section, the main changes that would need to occur for the rise of an agroecological SAS are: i) political focus, ii) subsidies orientation, iii) increase the communication among farmers, iv) marketing system and v) adoption of agroecological principles. Each of these changes congregates other minor correlated changes that were pointed out during the interviews.

The change of political focus englobes the favorazing of local production so as to increase self-sufficiency and resilience as well as developing a new food culture. While the change of subsidies focus includes the need of supporting smallholders, payment for the generation of ecosystem services and stopping to incentivize unsustainable agricultural practices, such as use of diesel and chemical fertilisers. The third main change entails the change of innovation process, spread of low tech solutions, access to specific crop and marketing information. In regard to the fourth main change, it encompasses the need to increase the communication between farmers and consumers, decentralisation of food marketing and new labelling system. By last, all these changes would accumulate and result in the generalised adoption of agroecological principles. It comprehends the change of adopted practices, the important role of urban farming and transformation of the countryside's landscape.

Below, on figure 7, it is possible to check the chronological order of the aforementioned events. Observe that with exception of the first main change, all the other four changes are indicated to happen in a time span. This is due to the lack of consensus shown by the interviewees when asked about more specific dates.

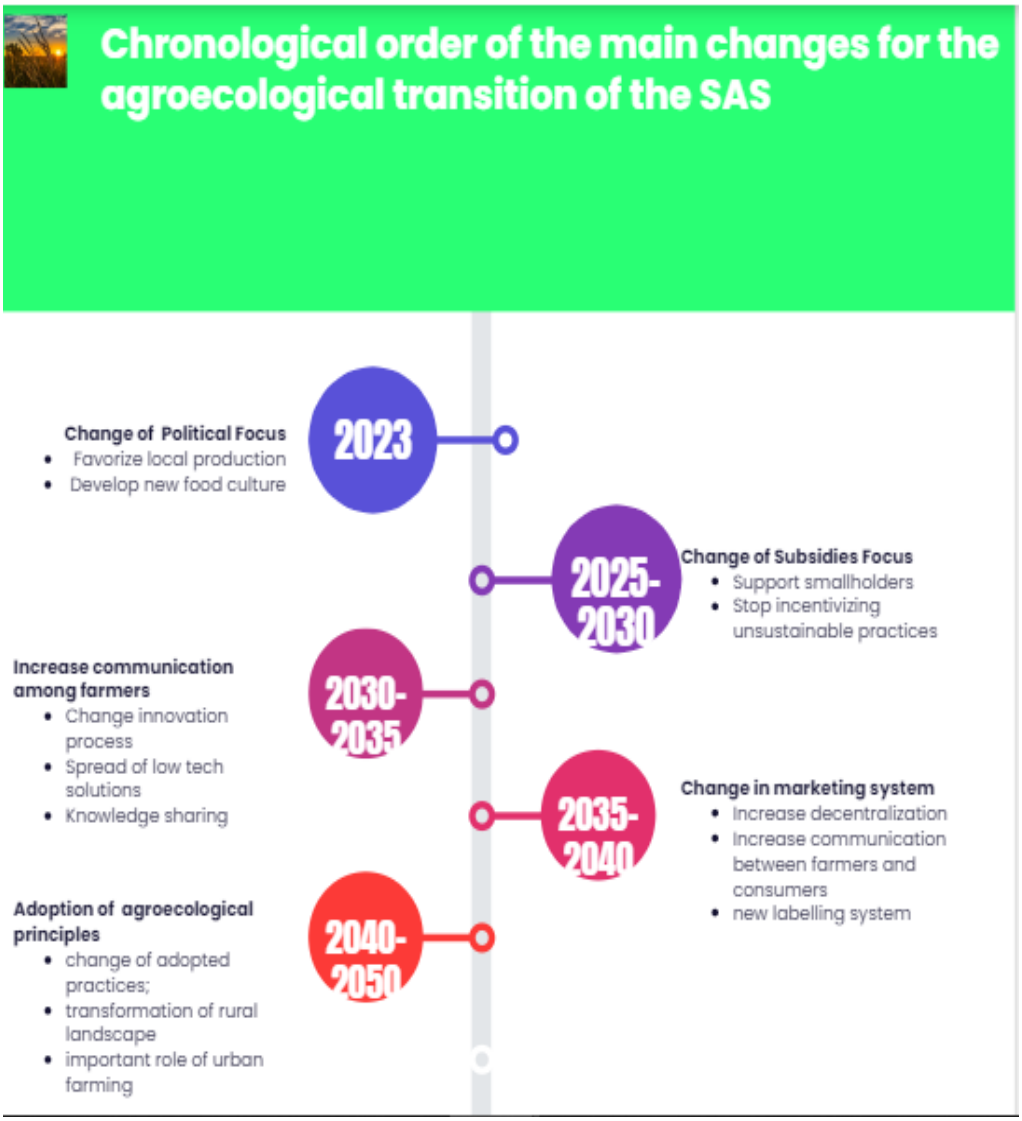

Figure 7. Timeline containing the chronological order of the critical changes necessary for the agroecological transition of the SAS.

4.2.3 Appointed Policies

The suggested policies presented in this section were formulated so as to correspond to the critical changes exposed in the previous section. These recommendations were formulated based on the interviewees' opinion regarding the most suitable government actions. Each policy suggestion is introduced in a separate sub section.

Moreover, before starting to describe the policies, it is necessary to point out whether the key changes are partially or totally under the control of top-down solutions. Although the change of political focus is directed related to the government's will, the establishment of a new food culture depends on the

increasing awareness of both farmers and consumers. Since policies can only influence this type of change (Tummers, 2019), the first identified change is considered to be partially under control of governmental interventions. In relation to the change of subsidies orientation, the change is considered totally under the control of policy instruments. Regarding the third identified change, it is totally under the reach of the government to create tools that can facilitate the communication amongst farmers. On the other hand, it is not guaranteed that such tools would be widely used in the farm community. In terms of the marketing system change, it is also considered to be partially under the control of policy interventions. While the establishment of a new labelling system is totally under control, the other aspects of this change depend on how farmers and consumers react to the proposed policy. By last, the adoption of agroecological principles is also considered to be partially under control. Although the government can implement regulation against determined practices, the process of decision making on adopted practices depends on the individual choices of the farmers.

4.2.3.1 New food strategy

The new food strategy symbolises the governmental change of orientation towards agriculture. The vision for 2050 is to significantly increase the country's self-sufficiency, build a new food culture that is socially, economically and environmentally sustainable. The overall objective of the new food strategy is twofold: i) increase local production and resilience by prioritising agroecological local production which aims to attend to the needs of the people and the environment and ii) contribute to the arise of a new food culture composed by consumers and producers who are aware about sustainable diets and agricultural practices.

So as to meet these goals the following objectives for strategic areas - rules and regulation, consumers and food marketing, knowledge and innovation - must be addressed. Rules and regulations are designed to support local production, adoption of agroecological principles and to increase national resilience against natural and social shocks. This is aimed to be achieved by means of financial instruments, seasonal higher taxes on imported products, regulation of unsustainable agricultural practices. In regard to the second strategic area, consumers and food marketing, the focus is to spread information about sustainable diets and agricultural methods. In terms of food marketing, the strategy is to increase the communication between farmers and consumers in order to increase its decentralisation. It contributes to better profitability and lower prices. Besides that, a new labelling system is to be developed aiming to facilitate the recognition of an unsustainable product by the consumers as well as uncharging the farmers who adopt sustainable practices from the financial burden of organic certification. Lastly, in terms of knowledge and innovation, the main

goal is to create official channels of communications amongst farmers in order to spread the adoption of low-tech solutions that are able to increase productivity and decrease the use of external resources.

4.2.3.2 Subsidies and financial incentives

The change of subsidies and financial incentives orientation is a necessary action to be taken so as to achieve the vision for 2050 established in the new food strategy. Thus, it is to be fully implemented by 2030. The goals of this policy suggestions are to: i) facilitate agroecological production through the increase of smallholders farmers, ii) decrease the final price of agroecological products for the consumer, iii) incentive the adoption of practices that generate ecosystem services, iv) weaken the current process of land concentration, and v) hinder the use of inputs made with non-renewable sources.

In order to fulfil these goals, the following measures are recommended:

§ The minimum size of farmland required to get subsidies is 1 hectare

§ Constantly decrease - over a timespan of ten years - the subsidies for diesel as well as chemical fertilisers

§ Introduce payments for the generation of ecosystem services in accordance with guidelines to be established by the Swedish Board of Agriculture

2.2.3.3 - Regulations

The following regulations have also been pointed out as primordial so as to accomplish an agroecological transition in Sweden by 2050. Therefore, they are also expected to be implemented by 2030. The regulations seek to: i) limit the use of external inputs, specially from fossil-fuels derivatives, ii) encourage the adoption of sustainable practices, iii) protect the Swedish farmers from the import of cheap imported food.

So as to to address these objectives, the following measures are recommended:

§ Increase of tax on fossil-fuel derivative products

§ Implementation of seasonal customs taxes on imported agricultural products that are produced in Sweden

§ Implementation of tax discount system for farmers who are transitioning from industrial to agroecological methods in accordance with the guidelines to be developed by the Swedish Board of Agriculture.

4.2.3.4 Education

These recommendations have the role to influence the changes that are not totally under the government control. The objectives of these policy recommendations are to: i) shape consumers and producers with a sustainable mindset; ii) influence the formation of a new food culture composed by aware producers and consumers.

Thus, the recommendations to meet these objectives are:

§ Implementation of agroecology and sustainability education from primary to advanced level

§ Advertisements campaigns developed to inform about healthy and sustainable diets

4.2.3.5 - Diffusion of Innovation

The following recommendation regards the change of orientation in innovation that would need to happen for an agroecological transition of the SAS. The goal of this recommendation is to increase the communication among farmers with the aim of spreading the adoption of existing low tech solutions as well as developing new ones.

The recommendation to address this goal is:

§ Implementation of a national platform where the farmers can communicate about their experiments, use it as a data source and develop new methods.

4.2.3.6 Market of Food

By last, the following recommendations are intended to reshape the Swedish food market system. They aim to: i) increase the decentralisation of food markets, ii) increase the communication between farmers and consumers, iii) transform the certification system in order to beneficiate non-industrial farmers.

For the purpose of meeting these goals, the interventions below are recommended:

§ Institutionalization of already existing marketing alternatives into a platform where consumers and producers can communicate,

§ Implementation of an “unsustainable product” tag pointing out to the consumers that the product was produced with non-renewable resources.

§ Change of organic certification to sustainable certification tag. The farms are assessed on the basis of guidelines to be implemented by the Swedish Board of

Agriculture. This new certification shall be financed with the resources gathered from the “unsustainable product” tag.

5 Discussion

This section is divided into four subsections which aim to interpret the results and relate them with previous literature, discuss the effectiveness of the proposed methods as well as the feasibility of planned sustainable transitions and recommend both practical actions and follow-up scientific studies.

5.1 Discussion of results

As previously exposed, the question of how to upscale agroecology through top-down solutions is still a blind spot in the literature. The results of this research advance the discussion around this challenge by collectively envisioning how an agroecological agrifood system would be in Sweden, identify the key changes between such a scenario and the current state as well as design policies which address such changes.

The interviewees envisioned an agroecological agrifood system characterised by: a government compromised to enhance the self-supply and resilience as well as shaping a new food culture, aware consumers, focus on low-tech solutions, more decentralised market system, application of agroecological principles, and attending the needs of people and the environment. The identified key changes, which encompass other minor changes, consist of: change of political focus and subsidies orientation, increasing the communication among farmers, decentralisation of the market system and adoption of agroecological principles. Regarding the proposed policies, the elaboration of a new food strategy represents the new governmental approach towards agriculture. It is followed by interventions divided in five different groups: i) financial incentives - decrease of minimal farmland size required to get subsidies, decrease the subsidies for non-renewable sources, and payments for the generation of ecosystem services; ii) regulations - adoption of seasonal custom taxes for agrarian products, increase of tax on fossil-fuel derivatives, and adoption of tax discount system for farmers who are transitioning from industrial to agroecological practices; iii) education - implementation of agroecological education at all levels, and advertisement campaigns; iv) diffusion of innovation - implementation of national platform for farmers communication; v) food marketing - institutionalisation of existing platforms so as to increase the communication between farmers and consumers, and change of labelling system through the implementation of sustainable and unsustainable tags.

These findings are especially important for two main reasons: i) the backcasting results elucidate a possible direction on how to upscale agroecology in Sweden.

The differential are the designing of an agroecological scenario as well as the policies that could address the necessary changes and hence facilitate/promote the upscaling of such a scenario. Such results do not have precedents in scientific literature. ii) while the results of the thematic analysis show that both the envisioned agroecological agrifood system scenario and most of the identified changes were previously highlighted in the literature on multiscale approach for the transformation of agrifood systems. Thus, this analysis corroborates with such an approach - as it will be seen thoroughly ahead. Moreover, the results meet the expectations around the three research questions by: 1) identifying key features of a normative agroecological agrifood system in Sweden; 2) identifying key changes necessary to upscale agroecology, and 3) designing policies that tackle the necessary changes.

Adding to the above, in the scientific sphere, this research contributes to: i) advance the discussion on top-down approaches for agroecological transition, ii) application innovative methodological approach that mixes future studies techniques and participatory design, and iii) reinforce the literature on domains of transformation for agroecological transitions by finding four themes that correspond to different domains. In terms of social contribution, the findings of this study contribute to: i) advance the discussion on how to integrate agroecology in agricultural public policies agendas, ii) envision an agrifood system in Sweden that is environmental, social and economical sustainable, iii) identify key changes, and iv) design policies that address such changes.

5.1.1 Comparison with previous studies

There is a clear correlation between previous research on multi domains of agroecological transformation and the patterns emerged from the analysis of the qualitative data. With exception of the theme ‘SAS characteristics’ all the other indicated themes with regard to the main features of an agroecological scenario and key changes - political focus, economic incentives, marketing, innovation, education and food culture - have been highlighted by specialised research on agrarian change. So as to be more specific, each domain of transformation is compared with its matching themes. The following information is summarised and displayed on table 14.

Starting with the political focus and economic incentives themes, Parmentier, 2014; Weber et al, 2020; Lopez-Garcia et al, 2021; Lopez-Garcia & Molina, 2021; Duru et al, 2015; HLPE, 2019 call attention for policies that create barriers for the development of agroecology and solely benefits IFI. They argue that policies with agroecological orientation have the transformative potential of facilitating the adoption of agroecological practices as well as creating mechanisms that break disadvantages created by policies oriented towards industrial farming. In this

study, this domain is translated into the up cited themes. The interviewees highlighted the necessity of change of political orientation. More specifically, it was claimed a change of focus from the production of bulk crops, the increase of 'cost efficient' farms and trade to favour local production so as to enhance national resilience. Moreover, the findings also indicate which policies are considered pernicious - perpetuator of disadvantages - to the upscaling of agroecology in Sweden: the national food strategy which determines the focus on IFI, the farm size criteria so as to receive subsidies, and the subsidies targeted for non-renewable sources like diesel and mineral fertilisers.

In relation to the market theme, it is correlated to the farmer-to-consume networks domain of transformation. The studies led by Lopez-Garcia et al, 2021; Lopez-Garcia & Molina, 2021; Duru, 2015; Sachet et al, 2021; Collin et al, 2019, defend the development of direct market structures through new channels of communication between farmers and consumers as a key mechanism for agroecological change. In a very similar way, here, the interviewees also bring attention to the need of a more decentralised market system. Both previous literature and interviewees point out common problems, such as: power of 'middle man', loss of decision power over what to be produced, and the share of the final price that remains with the producer. Similarly to what has been proposed by the researchers, aiming to enhance the contact between farmers and consumers the interviewees claimed for the strengthening of Reko-Ring and CSA as well as creation of market points in the cities.

Likewise, the innovation theme and the farmer-to-farmer networks domain of transformation present common characteristics regarding identification of problems and suggestions to address such problems. Wezel et al, 2020; HLPE, 2019; Sachet et al, 2021; Collin et al, 2019 argue that due the focus of agrarian innovation systems in IFS, these technologies cannot be implemented in AFS. Therefore, they defend co-production, adoption and dissemination of low-tech solutions. The thematic analysis suggests that the perception held by farmers and researchers in Sweden around innovation is no different than the previous literature. The interviewees identified a need for a change of focus of innovation from high to low tech solutions that are highly adaptable and interchangeable between different crops. It was also reported that low-tech technologies are being developed and applied by 'innovative farmers', but they are still a niche that needs to upgrade into a regime. To do so, the interviewees defend the implementation of a national platform that provides a reliable source of information and channel of communication among farmers.

By last, the domain of transformation referred to education encompasses the themes of education and food culture. Both previous literature (Parmentier, 2014; HLPE, 2019; Lopez-Garcia & Molina, 2021; Sachet et al, 2021; Weber et al,

2020) and the interviewees defend that the implementation of agroecological education is a necessary change for an agroecological transition. There is, however, a difference: while past studies focus on agroecological education at the university level so as to develop new methods and improve the role of farmers in agrarian research, the participants of this study go beyond by claiming in favour of the teaching of agroecology at all educational levels in order to build a new generation of farmers, consumers and researchers. Besides that, the promotion of a new food culture is also approached differently. In past studies, it was considered as a consequence of the implementation of agroecological education. On the other hand, the interviewees claimed that the promotion of a new food culture - composed by aware consumers - is a key change so as to achieve an agroecological agrifood system in Sweden.

Table 14: Comparison between previous research and this study findings

Domain	**Comparison**	**Themes**
Policies (Parmentier, 2014; Weber et al, 2020; Lopez-Garcia et al, 2021; Lopez-Garcia & Molina, 2021; Duru et al, 2015; HLPE, 2019)	● Change of political orientation ● Facilitate the adoption of agroecological practices; ● Decrease/eliminate disadvantages created by agrarian policies that only benefit IFS	Political focus, Economic incentives
Farmer-to-consumer networks (Lopez-Garcia *et al,* 2021; Lopez-Garcia & Molina, 2021; Duru, 2015; Sachet *et al,* 2021; Collin *et al,* 2019)	● Increase decentralisation of food marketing ● Implementation and/or strengthening of direct channels of communication between farmers and consumers	Marketing
Farmer-to-farmer networks (Wezel et al, 2020; HLPE, 2019; Sachet et al, 2021; Collin et al, 2019)	● Increase communication among farmers ● Co-creation of low-tech technologies ● Dissemination of information ● Dissemination of low-tech solutions	Innovation
Agrarian research/Education (Parmentier, 2014; HLPE,	● Implementation of agroecological	Education, Food Culture

2019; Lopez-Garcia & Molina, 2021; Sachet et al, 2021; Weber et al, 2020)	education ● Disseminate agroecological knowledge at different levels ● Promote food culture	

In terms of differences, some aspects of social sustainability - such as the decreasing number of rural workers, role of women in agriculture and the high number of accidents in dairy farms - were not mentioned by the interviewees. Considering that half of the farmers who participated in this study run the farm as a family business, do not hire workers and are not specialised in dairy products, the reason for the absence of these topics might be due to the non-participation of industrial farmers in the data collection process. Nonetheless, it is still surprising that none of the interviewees mentioned the problem of labour scarcity. This question is particularly interesting when dealing with agroecological transitions since AFS are much more labour intensive than IFS. Since most of the agrarian technology and innovation are centred towards large scale farming and few specific crops, a pertinent question to be answered is '*is the agroecological transition of the SAS feasible with the current amount of available rural workers ?*'

5.2 Discussion of methods

The adopted methodology of this study is partly new. Although Duru *et al* (2015) propose a methodology for designing agroecological transitions mixing backcasting and participatory approach, there is no exploratory application of such a framework in the literature up to date. Here, seeking to put the farmers' desires and ideas at the centre of the study as well as meeting the research objectives and answering the research questions, is proposed a combination of semi-structured interviews, thematic analysis and backcasting. This section aims at pointing out what has worked and what can be improved for future applications.

The proposed methods were overall successful at addressing the objectives and led to hand-on findings. It was seen that the adaptation of the backcasting approach, from workshop discussions among researchers or between different stakeholders to semi-structured interviews followed by thematic analysis, is proved to be efficient in researches that aim at designing participatory transitions through the envisioning of a common normative scenario, identification of key changes and development of top-down solutions to facilitate the necessary changes. The main differential of this methodology is dual: i) to include and put the world visions, decision-making strategies and political desires of the main affected stakeholders in sustainable transition processes. Thus, enhancing the

chances of a just transition. ii) increase the decentralisation, democracy and diversity of future planning.

On the other hand, identifying the most important changes and developing a timeline containing the chronological order of the events, proved to be a complicated exercise due the impossibility of weighting the degree of importance of the changes and establishing a more precise timeline with only qualitative data. Therefore, in order to improve the robustness of the findings of future studies and its specificity, an incrementation of the proposed methods can be done through the inclusion of surveys. By making use of surveys it would be possible to have a clear general result for the key changes timeline due the possibility of quantifying the answers, making step two more robust and less open to interpretation. Besides that, it would make it easier for the interviewees to point out a specific order for the key events and consequently for the researcher to design an explicit timeline.

5.3 Do we still have time to promote a smooth agroecological transition?

During the interviews, different farmers were cautious and/or pessimistic about the feasibility of promoting an agroecological transition in any timespan. Their arguments varied around the political willingness in developing the necessary policies, adaptation of industrial farmers as well as civil society and the current pace of environmental degradation. Above all, the farmers were very concerned about the effects of climate change. The most emblematic statement was given by a farmer based in Kalmar,

"*man, when you ask me about the changes I want to see or what I think should be done… I can answer you these questions, but for me these actions should have been taken 20, 30 years ago. I don't think we have time for a smooth transition anymore. I've lived on this farm since I was a child and I can tell you, it changed so much during this time: number of pests, temperature, wind, rain precipitation and so on. Everything got so much more unpredictable. On top of that, I've also worked in the energy sector and that just makes me more negative because I know and anyone with good will working in this sector knows that even if we actually manage to transition the energy model, we cannot keep living in this way, with this kind of market orientation. Not to say that the energy transition has been under debate for around thirty years. So, in my opinion and of many other farmers who I know it's not possible to have a planned transition, we don't have time and the disposition to do so. We're gonna face very hard times and it'll lead to desperate measures. That's when the change is going to happen, I think".*

While the farmers' opinions are pessimistic, researches show different results defending similar views or denying the need for change due catastrophic events. The divergent results in the scientific community are a consequence of different

conjectures and assumptions of future events that are assumed in the predictive models (Green, 2022). The pessimistic results are mostly based or built on the IPCC's scenarios which have the function of investigating possible futures so as to prepare for unfortunate events, as defined in their report from 2000 "the set of scenarios was developed to represent the range of driving forces and emissions in the scenario literature, so as to reflect current understanding and knowledge about about underlying uncertainties" (IPCC, 2000). Green (2022) claims that empirical comparisons regarding climate change show that the alarmist studies that defend extreme actions over predict man-caused global warming.

Therefore, it is not possible to state how much time we still have as a species to revert environmental degradation. However, it is necessary for the governments to act now and be prepared to adopt extreme measures in case of extreme events.

5.4 Recommendations

Which practical actions and scientific studies should follow this research? This section aims at indicating directions for both research on the field of agroecological and sustainable transitions as well as top-down interventions.

Regarding the scientific sphere, the next topics should be taken into consideration when developing follow up studies or replicating the proposed methods: i) inclusion of surveys so as to solidify the adaptation of backcasting, ii) investigate how the suggested policies can be implemented, iii) collect data from industrial farmers, iv) application of agent-based modelling (ABM) so as to test efficiency of laws. Since the reason to include surveys in the proposed methodology was explained in the previous section, it is possible to elaborate on the second, third and fourth points directly. These points are related to the limitations of this work findings.

Firstly, follow up studies should inquire which of the suggested policies can be applied independently, how to align the designed policies with the CAP as well as how changes can be implemented at the national level. Secondly, in order to expand the diversity of opinion and design policies that target the adoption of agroecological practices by industrial farmers, such farmers' opinions, visions and strategies should be collected. The inclusion of this kind of farmer shall result in policies that represent their needs for transitioning to agroecology as well as providing new insights on what are the biggest barriers for industrial farmers to convert their farming systems. Thirdly, studies that aim at testing the proposed policies should adopt an empirically grounded ABM methodology. An ABM can be defined as "a modelling and computational framework for simulating dynamic processes that involve autonomous agents" (Macal & North, 2014:02). The exercise of modelling a population of autonomous agents each one embedded

with its own features and behaviours is a key characteristic of an ABM. The model should deliver - at the agents' level - the outcomes of the selected policies on farmers' crop regime and if these policies are able to promote the normative scenario, in the aggregated level. ABM is a desirable approach because it provides a frame to represent real-world actors, their interactions between themselves and their interaction with the environment. It makes the approach appealing in a sense that it allows calibration, validation, prediction (to a certain extent), explanatory and explanative modelling of socio-ecological systems (Rounsevell et al, 2012). Thus, the ABM shall be used as an exploratory tool and to a certain extent to examine the validation of the proposed pathway.

Moreover, generally speaking, further research on top-down approaches for agroecological transition is needed. One direction to be followed is the investigation of common key changes, as a complement, the design of common policies that can tackle common problems and test their efficiency in different social, geographical and economical scenarios contexts through ABM. It would facilitate: the inclusion of agroecology in the political agenda around the globe, identification of general key changes for the agroecological transition and implementation of more adequate policies.

Delving into the recommendations for the government, the common vision regarding agricultural sustainability shared by Sweden and the EU encompass the reduction of environmental damage, increase of farmers' profitability and self-sufficiency capacity. However, as it was seen, the agricultural policy approach is compartmentalised - i.e. the policies are implemented aiming to affect single sustainability aspects - which compromises the achievement of the sustainability targets. The findings of this work, on the other hand, offer a top-down coordinated pathway for the agroecological transition of the Swedish agrifood. Therefore, it is recommended for the Swedish government to reformulate the current food strategy so as to set the new agrarian political agenda prioritising the increase of local production and resilience as well as facilitating the emergence of a new food culture. Moreover, the unpredictability of the future consequences of climate change adds an extra need for emergence planning. This would reduce the impact of extreme environmental shocks.

Key policies and interventions should follow the new food strategy in order to tackle identified barriers in strategic areas: subsidies, regulations, education, innovation and food marketing. Firstly, regarding subsidies, the recommended measures are: i) change of minimal farmland requirement that allows the payment of subsidies, ii) constantly decrease - over a timespan of ten years - the subsidies for diesel as well as chemical fertilisers, iii) introduction of payment for the generation of ecosystem services. Secondly, the recommended regulations are: i) Increase of tax on fossil-fuel derivative products, ii) adoption of seasonal customs

taxes against imported agrarian products, iii) tax discount system for farmers transitioning between industrial and agroecological farming systems. In terms of education, the following interventions are suggested: i) implementation of agroecology and sustainability education from primary to advanced level, ii) spread of information about healthy and sustainable diets through advertisement campaigns. In order to facilitate the diffusion of low-tech solutions, it is recommended: i) the implementation of a national platform of communication between farmers. By last, three measures are indicated to improve the food marketing for both producers and consumers: i) institutionalisation of alternative marketing platforms to facilitate the communication between farmers and consumers, ii) change of tagging system with the implementation of sustainable and unsustainable certificates tags.

6. Conclusion

Motivated by the socio-ecological challenge of increasing agricultural output while reducing negative social and environmental effects as well as the question of how to promote agroecological transitions through to-down solutions, this work aimed at: (i) advance the discussion on how to facilitate agroecological transitions through a state managed approach focusing in the SAS, (ii) design an agroecological SAS scenario, (iii) identify the key changes between the current SAS and the designed scenario, and (iv) suggest participatory designed policies that tackle such changes. To do so, a partly new methodology was adopted mixing semi-structured interviews - main source of data - and backcasting - framework to design the agroecological scenario and identifying necessary steps to achieve it.

The results of the thematic analysis referent to the semi-structured interviews were divided into two parts: (i) eleven sub themes representing the characteristics of an agroecological SAS as well as the key changes that are to happen for its emergence were identified and grouped in seven themes: SAS characteristics, political focus, economic incentives, innovation, marketing, education and food culture (ii) seven sub themes regarding government's actions so as to promote an agroecological transition of the SAS were identified and grouped in five themes: financial instruments, regulation, innovation, marketing and conscientization process. The findings of thematic analysis show a correlation with previous research on multi domains for agroecological transformation. It suggests that agroecological transitions across the globe have common challenges.

These findings were the main input for the backcasting. The normative agroecological scenario is built around the adoption of agroecological principles, a new political focus centred on enhancing self-supply and resilience as well as developing a new food culture. The key changes from the current days to 2050 - when the agroecological scenario would be achieved - were displayed in a timeline that indicates a possible chronological order of events - starting with a change of political focus and going through change of subsidies focus, increase of communication among farmers, change in the marketing system to finish with overall adoption of agroecological principles. By last, the appointed measures to be taken by the government were: (i) the adoption of a new food strategy that focus in the increase of local production and the emergence of a new food culture, (ii) financial incentives that increase the number of smallholder farmers, decrease the final price of agroecological products, encourage the adoption of agroecological practices, weaken the process of land concentration and difficult the adoption of non-renewable inputs, (iii) regulations that aim at limiting the use of external inputs and protect swedish farmers from cheap imported food, (iv) educational campaigns and reforms so as to shape conscient consumers and a new

food culture, (v) diffusion of innovation throughout the increase of communication among farmers.

The findings of this study are particularly important for two main reasons: i) advance the discussion on agroecological transitions through top-down measures, still a blind spot in the literature, (ii) highlight a possible top-down approach for the agroecological transition of the SAS by identifying how an agroecological SAS would look like and the key changes necessary to happen, (iii) recognizing universal patterns of hinders to agroecological transitions and thus reinforcing the literature on multi domains of transformation. Moreover, the application of innovative methods is an important contribution for researchers who wish to mix participatory methods with future studies techniques.

Considering the joint vision of Sweden and EU regarding the reduction of environmental damage, increasing both the profitability of farm business and the self-sufficiency capacity, it is recommended for the Swedish government to set a new agrarian agenda. It should favorize the increase of resilience and facilitate the emergence of a new food culture. The public policies should be planned accordingly with a new food agenda, addressing the identified hinders in key sectors: innovation, food markets, regulations, education and subsidies. Furthemore, due to the uncertainty regarding the pace and the spillover effects of climate change, it is also recommended that the government adopts paralel plans that would make the answer to extreme events easier.

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Popular Science Summary of MSc Thesis

Non-conventional farmers' visions for a sustainable agricultural system in Sweden and the road to get there

Pablo Ratti, Swedish University of Agricultural Sciences, Department of Biosystems and Technology, Master of Science in Agricultural Sciences with major in Agroecology

The content presented here was extracted from the MSc thesis "Upscaling agroecology in Sweden: A participatory-backcasting approach to investigate top-down measures for promoting an agroecological transition of the Swedish agricultural system"

The social, environmental and economical unsustainability of the agricultural systems around the world have been increasingly recognized. In Sweden the situation is not different. The Swedish Agricultural System (SAS) presents unsustainable features, such as: biodiversity loss, eutrophication, low profitability, aging of rural workforce, rural exodus and land concentration.

Under the light of these problems, agroecology has been pointed out by researchers, grassroot movements and FAO as a key framework to achieve a food system that is socially, economically, and environmentally sustainable.

Thus, this study seeks to (i) advance the discussion on how to upscale agroecology through top-down approaches, (ii) design an agroecological SAS scenario, (iii) identify the main differences between the current SAS and the idealized scenario and (iv) recommend participatory policies that address the necessary changes.

So as to deliver hands-on results as well as putting the farmers at the center of the decision making process, a participatory approach was adopted. The methodology is developed through semi-structured interviews, thematic analysis and backcasting.

The analysis of the interviews showed that according to the Swedish non-conventional farmers visualize an agroecological SAS with the following characteristics: focus on resilience, self-supply, developing a new food culture, application of agroecological practices, strong urban agriculture, sharing of information among farmers and decentralized marketing of food. Furthermore, they also indicated the necessary changes: subsidies orientation, focus on low-tech solutions, a more decentralized market of food, change of food culture, change of land use, and focus on local production.

By last, the farmers pointed out policies to facilitate the upscaling of agroecology. The policies were grouped in five different strategic areas - financial incentives, regulations, education, diffusion of innovation and market of food - under the umbrella of a new food strategy.

The overall objective of the new food strategy is twofold: i) increase local production and resilience and ii) shape a new food culture composed by aware consumers and producers. The goals of the strategic areas are to: i) increase the number of smallholders farmers, ii) decrease the final price of agroecological production, iii) incentive the adoption of practices that generate ecosystem services, iv) hinder the access to non-renewable sources, v) protect swedish farmers from food dumping, vi) influence the formation of a new food culture, vii) spread the adoption of low tech solutions and viii) increase the decentralization of food markets.

These results are particularly interesting for two main reasons: i) they point out a pathway for the government on how to promote an agricultural system that is economical, social and environmental sustainable and (ii) the results represent the non-conventional farmers' views regarding a sustainable SAS, and how to get there.

Therefore, it is recommended for the Swedish government to reformulate the current food strategy so as to set the new agrarian political agenda prioritizing the increase of local production and resilience as well as facilitating the emergence of a new food culture. Key policies and interventions should follow the new food strategy in order to tackle identified barriers in strategic areas: subsidies, regulations, education, innovation and food marketing.