



## Is organic greenhouse production of tomato in Scania feasible?

Experiences and reflections according to Swedish growers in Scania.

---

NICOLAE HILMKVIST 2015  
APPLIED CLIMATE STRATEGY, MASTER DEGREE PROJECT 30 HP  
MILJÖVETENSKAP | LUNDS UNIVERSITET









**Is organic greenhouse production of tomato in Scania feasible?**  
Experiences and reflections according to Swedish growers in Scania.



*Own source*

**Nicolae Hilmkvist**  
**2015**

**Nicolae Hilmkvist 2015**

**Applied climate strategy, Master Degree Project 30 hp**

**Environmental Science / University of Lund**

**Internal supervisor:**

Erkki Palmu

Biodiversity unit, Lund University

**External supervisors:**

Helena Ensegård,

Miljöbron Skåne, Lund

Laura Mustonen,

Total Produce Nordic A/S, Valby - Denmark|

## Abstract

Sustainable agriculture is an important aspect in ensuring environmental protection. There is low agreement on the universal definition of the issue. One of the most pertinent aspects of sustainability in food production is organic farming. Sustainability is associated with a system of farming and a philosophy, which has a focus on both ecological and social realities that affect people and the systems. For sustainable agriculture, farming has to involve systems and designs that are in concert with nature (Björk, 2003). The approaches used work with the natural processes in conserving the environment, resource, and minimizing waste. Organic agriculture takes advantage of the natural soil nutrients, pest control, water cycles, and energy flows. This study investigates the strength and weaknesses of conventional growing of tomato in Scania, the southernmost province of Sweden and the very nature of the difficulties which might arise if the conventional growing of the tomatoes will be substituted by the organic growing.

The main aim of the study is to assess the level of resource usage in the growth of tomatoes among growers in Scania County. The focus of the research is to assess the variation of different components in the greenhouse farming of tomatoes in the county. By understanding the use of energy, water, fertilizer, and pesticides, it is possible to determine the environmental sustainability of the practice and determine whether it can be improved in order to enhance outcomes for the growers, the economy, and consumers. The main reason for the poor performance of the agricultural sector is the increase in availability of tomatoes during the entire year. This is sometimes affected by the importation of tomatoes from Spain when the tomatoes Swedish season ends (IFAJ, 2012). Organic production of fruits and vegetables is considered to have a double benefit to the society because of the reduction in the environmental load and the fact that they do not have potentially harmful chemicals.

In the case of Scania County, the demand for tomatoes has increased considerably and many are produced using conventional greenhouse technology. The findings indicate that many growers in County have positive perceptions about the effectiveness of organic farming, but they lack support from the government and adequate knowledge. They are significantly sceptical about aid from the Swedish government or the EU. They would be willing to shift to organic tomato farming with a commitment from the government in aiding the sector through technical professionals.

## Table of content

<b>Intoduction</b> .....	7
Background on sustainable agriculture.....	7
Environmental quality objectives .....	9
Organic production .....	10
Environmental impact of horticulture farming in Sweden .....	12
Research gap .....	12
Problem statement.....	13
Aim and Objectives.....	14
Research questions.....	15
Significance of the study.....	15
Delimitations.....	16
<b>Methods</b> .....	17
Overview.....	17
Study Design.....	17
Information and data collection .....	18
Measures of environmental impact.....	19
Data analysis .....	20
<b>Findings</b> .....	21
Connections between grower attitudes and environmental impact .....	21
Characteristics of tomato growing activities in Scania County.....	22
What are the different aspects of tomato growing in Sweden that may influence the switch to organic farming?.....	27
Environmental impact of tomato growing.....	29
Is there a valid business case for organic tomato growing in Scania County in Sweden as a substitute for conventional greenhouse growing? .....	30
<b>Analysis</b> .....	36
Strategies applied by growers .....	37
Aspects of tomato growing that influence the switch to organic practices .....	38
Comparison of conventional and organic tomato growing in Sweden.....	39
Benefits and challenges to the adoption of organic farming .....	41
<b>Conclusions and recommendations</b> .....	44
Conclusions.....	44
Recommendations.....	46



<b>Acknowledgements</b> .....	48
<b>References</b> .....	50
<b>Appendix 1</b> .....	54
<b>Appendix 2</b> .....	58

# Introduction

## Background on sustainable agriculture

Sustainability of agriculture is a major issue that has gained a lot of attention in recent years. The interest of growers and other stakeholders on the efficient use of resources and preservation of the environment has grown because of information on the beneficial effects it has. In this case, tomato growing may have particular issues or factors that may influence the willingness or ability of growers to incorporate sustainability. This informs the second research question that was considered in the study. Food production is a wide issue because it is associated with the overall changes in the global environment. Issues such as the rising global temperatures and carbon levels in the earth's atmosphere are posing significant challenges to the sustainability of food production. In line with the current environmental challenges at the global level, food production has become increasingly difficult using conventional means especially in developing countries where adoption of agricultural technology is low. Ecological product is a critical aspect that has to be considered in the production of food in order to ensure that the foods are produced sustainably. Sustainability in food production is considered highly beneficial for the environment because it maintains the ecological balance among the different elements hence ensuring that there is no destruction of the land, air, or water (Seppänen, 2004). The aspects of sustainability in agricultural systems are associated with savings on water, energy, and other inputs. These aspects may differ significantly for conventional agriculture in relation to organic farming.

Sustainable agriculture is an important aspect in ensuring environmental protection while increasing the productivity of farms. However, there is low agreement on the existence of a universal definition of the issue. One of the most pertinent aspects of sustainability in food production is organic farming. According to an organization known as Ecological

Agriculture Products (EAP), sustainability is associated with a system of farming and a philosophy, which has a focus on both ecological and social realities that affect people and the systems. For sustainable agriculture, farming has to involve systems and designs that are in concert with nature. The approaches used work with the natural processes in conserving the environment, resource, and minimizing waste. Organic agriculture takes advantage of the natural soil nutrients, pest control, water cycles, and energy flows (EAP, 2012). In this case, it is important to assess the differences between organic and conventional agriculture especially in relation to tomato growing in the county. This presents the third question that was addressed in the research because it highlights how the two philosophies of agriculture differ especially for tomato growers.

Use of sustainable approaches such as ecological agriculture systems is beneficial because it reduces the need or use of artificially compounded fertilizers, pesticides, and growth stimulators. Despite the benefits of these products on the growth and productivity of farms, they are rejected because of their environmental disruption, reliance on a non-renewable resource, and adverse effects on soil organisms. Organic farming activities rely on animal manure, farm residue, rotation, green manure, off-farm organic waste, and appropriate cultivation methods. The drive for sustainable agriculture using organic strategies is influenced by the adverse effects of the current practices, the declining economic situation for producers, and deterioration in health owing to the products used to grow food items. The negative environmental effects of conventional agriculture practices include contamination, soil degradation, and water depletion. Loss of biodiversity, energy wastage and destruction of non-agricultural habitat are also cited as negative effects of conventional agricultural strategies (Östergren & Ohlsson, 2009). Based on the advantages and benefits of organic farming coupled with the environmental conditions in Scania County, is it viable as an alternative for conventional approaches in the growing of tomatoes. It is necessary to assess

and understand the benefits and economic value of organic farming of tomatoes in Scania County to determine its viability. The relevance of organic farming is that it has been cited as one of the most efficient philosophies for reducing the consumption of materials while enhancing productivity. It is also beneficial as a way of preserving the environment and presents significant potential for boosting production hence making it relevant to understand how it might help tomato production in Scania County.

The EU regulations provide a positive list of commodities and additives that the organic producers can include in their products. Substances and ingredients that are not expressly indicated in the positive list may not be used. In terms of the processing of the different organically grown products, all ingredients of agricultural origin have to be organic. Exceptions are allowed up to 5% of the total product of the processed commodity. The EU regulations on organic plant production include conversion provisions for farms with plant production. Growers are also required to engage in crop rotation and special tillage approaches to preserving soil fertility (Seppänen, 2004). Organically propagated seed stock is considered as one of the most effective ways of ensuring the success organic production. The supplementary fertilizers and pesticides allowed for use are only those indicated in the positive lists.

## **Environmental quality objectives**

In Sweden, the parliament has adopted 72 interim targets and 16 environmental quality objectives (Naturvårdsverket, 2015). The quality objectives indicate the quality and conditions of the environment including the cultural heritage and natural resources that are considered sustainable in the long term. The interim targets indicate the timelines and orientation for achieving the set objectives. The interim targets and objectives indicate the framework for compliance with the convention on biological diversity. Some of the



environmental quality objectives are directly connected to agriculture such as zero eutrophication, the non-toxic environment, and a varied agricultural landscape. The environmental objectives are also associated with agricultural production such as thriving wetlands, quality of groundwater, and reduced adverse impact on the climate (Naturvårdsverket, 2015).

Swedish environmental laws are based on the environmental code and related ordinances. They cover a wide range of issues including the use of pesticides, spreading plant nutrients, and conservation of biodiversity. Work related to the quality objectives is performed using a number of instruments such as legislation, skills acquisition, and economic instruments. The formulation of the Common Agriculture policy (CAP) by the EU has a significant effect on the achievement of environmental objectives set by the Swedish government. Some of the approaches used for ensuring the achievement of environmental objectives include reduction of root zone nitrogen leaching through high nitrogen efficiency and reduction in the cultivated field area. Provision of payments for reducing nitrogen leaching is also beneficial to the environment because it presents an incentive for the growers to lower the use of artificial nitrogen fertilizers (Naturvårdsverket, 2015).

## **Organic production**

The level of organic production in the country has been on a steady increase with 180,000 hectares of organic arable land being used in 2006. The main commodities that are produced organically in Sweden include onions, carrots, beet, cabbages, fruits, and berries (Table 1, Jordbruksverket, 2009). Agricultural practices can be unsustainable even when they are chemical free and containing low artificial inputs. The main aspect of organic and sustainable farming is the incorporation of naturally resilient systems of agriculture that allow continuous production with low adverse effects on the environment. As a result, the inputs

used and tillage methods are only part of the picture and should be incorporated in the consideration of the need for environmental, social, and economic sustainability. Ecological responsibility is the main issue that has to be considered in defining sustainable agriculture and ensuring that the approaches adopted are efficient in producing beneficial outcomes for the environment as well as the food consumers and producers (Östergren & Ohlsson, 2009).

Table 1. Area under organic cultivation for certain horticultural products in Sweden (1000 m<sup>2</sup>).

<b>Crop</b>	<b>Year 2001</b>	<b>Year 2006</b>
Onion	38	39
Beet	41	25
Carrot	178	155
Berries	154	199
Cabbage	18	33
Fruit	51	88

Although there has been an increase in the number of stores offering organic products, their percentage as a proportion of the total is low. More traders are choosing to stock organic products with 90% of all grocery stores having organic lines in their shelves. The main issue is that organic products account for less than 5% of total grocery sales. The KRAV Association is involved in eco-labelling and is a well-known standard in Sweden among the consumers (Jordbruksverket, 2009).

## **Environmental impact of horticulture farming in Sweden**

Greenhouses are a major part of horticulture farming in Sweden being mostly used for vegetables and ornamental plants. In 2008, the total land area under greenhouse farming was 2,657,000 square meters. About 800 enterprises had average greenhouse area of 3,400. Greenhouse farming is mainly dominated by tomatoes and cucumbers, which account for 76% of the total reserved area for vegetables and berries in greenhouses. As a proportion of the total area cultivated in greenhouses, tomatoes and cucumber account for 34% (IFAJ, 2012). Yield in greenhouse farming is a critical parameter in highlighting the productivity and utilization of different resources. The yield for tomatoes in greenhouses in 2008 was 44 tons per 1000 square meters. For cucumber, the yield was 37 tons per square meter. Cultivation of aromatic plants has been on the rise in recent years with an increase of 47% from 2005 to 2008. As indicated in, most of the workers in horticulture farming are family members, but the sector employs only about 17,000 workers. Due to the small size of the sector, it was considered necessary for the horticulture producers association to merge with the Federation of Swedish Farmers (LRF). Many horticultural producers find it necessary to cooperate in order to sell their commodities efficiently to wholesalers and retailers. Some of the largest wholesalers of vegetables and fruits in Sweden are ICA Frukt, Everfresh, and SABA Frukt (IFAJ, 2012).

### **Research gap**

The literature indicates that few studies have been undertaken on the relevance and application of organic farming practices in Sweden. As a result, a study of the conditions and other aspects facing farmers in Scania regarding organic farming is necessary in order to enhance understanding of the area. Assessment of the changes in the agriculture sector in relation to the increasing need for sustainability has influenced the outcomes for producers

and consumers. Policies have been developed both in Sweden and the EU, in general, to enhance the sustainability of agriculture. While the focus of EU policies on fruits and vegetables seems to give an unfair advantage to some players, it is important to determine the opportunities arising from them.

There has been a change in consumer perceptions with the increased demand for fruits and vegetables because of their health benefits. Fruits and vegetables are considered to have beneficial qualities to the health of individuals. The health benefits are considered to increase if the fruits and vegetables are grown organically. Organic production of fruits and vegetables is considered to have a double benefit to the society because of the reduction in the environmental load and the fact that they do not have potentially harmful chemicals. In the case of Scania County, the demand for tomatoes has increased considerably and many are produced using conventional greenhouse technology. Because of the intensive nature of chemicals and other artificial components in this agricultural technology, there is interest towards a move towards organic and sustainable agriculture in the sector. This study focuses on the problem of whether it is economically and logically sound for tomato producers in Scania County in Sweden to use organic agricultural strategies for their tomatoes.

## **Problem statement**

The assessment of the changes in the agriculture sector in relation to the increasing need for sustainability has influenced the outcomes for producers and consumers. Policies have been developed both in Sweden and the EU, in general, to enhance the sustainability of agriculture. While the focus of EU policies on fruits and vegetables seems to give an unfair advantage to some players, it is important to determine the opportunities arising from them. There has been a change in consumer perceptions with the increased demand for fruits and vegetables because of their health benefits (IFAJ, 2012). Fruits and vegetables are considered



to have beneficial qualities to the health of individuals. The health benefits are considered to increase if the fruits and vegetables are grown organically. Organic production of fruits and vegetables is considered to have a double benefit to the society because of the reduction in the environmental load and the fact that they do not have potentially harmful chemicals. In the case of Scania County, the demand for tomatoes has increased considerably and many are produced using conventional greenhouse technology. Because of the intensive nature of chemicals and other artificial components in this agricultural technology, there is interest towards a move towards organic and sustainable agriculture in the sector. This study focuses on the problem of whether it is economically and logically sound for tomato producers in Scania County in Sweden to use organic agricultural strategies for their tomatoes.

## **Aim and Objectives**

The main aim of the study is to assess the level of resource usage in the growth of tomatoes among growers in Scania County. The focus of the research is to assess the variation in the utilization of different components in the greenhouse farming of tomatoes in the county. By understanding the use of energy, water, fertilizer, and pesticides, it is possible to determine the environmental sustainability of the practice and determine whether it can be improved in order to enhance outcomes for the growers, the economy, and consumers. The study takes a qualitative approach to the problems statement. The qualitative approach was considered essential because it provided a good way of understanding the issues facing tomato farmers and the likelihood that they would consider organic farming in their activities.

The specific objectives of the study are:

1. To assess if there are any connections between grower attitudes and the environmental impact at their greenhouses.
2. Assess the different aspects of tomato growing activities that may influence the switch to organic farming
3. Evaluate the economic relevance and possibility of organic tomato farming in Scania County in Sweden.

### **Research questions**

1. How do growers' attitudes and opinions relate to the environmental impact at their greenhouses?
2. Do the growers' greenhouse size and type of tomatoes grown affect environmental impact?
3. What are the different aspects of tomato growing activities that may influence the switch to organic farming and is there a valid business case for organic tomato farming in Scania County in Sweden?

### **Significance of the study**

The current study is significant because it indicates the challenges and opportunities facing tomato growers in Sweden. It shows the key issues that these growers have to consider in their activities in order to ensure the sustainability of their operations. Sustainability of agricultural systems has been recommended as one of the main platforms that will aid in ensuring that there is environmental responsibility. In many cases, agriculture systems may not be adequately sustainable. The growers may be focusing on artificial ways of increasing productivity and fail to acknowledge the benefits arising from the utilization of natural cycles and systems (Seppänen, 2004).

The study addresses this question by assessing the business case of organic farming for tomato producers in Southern Sweden. As a matter of fact, organic farming is one of the approaches in which agriculture can be made sustainable and responsible. The findings of the study also play a major role in highlighting the characteristics of tomato growers in the country in terms of their usage of different resources. Utilization of varied resources such as energy and water in tomato growing works to shed light on how much savings can be achieved by engaging in more productive strategies. It also works towards providing literature on the application of organic farming in the fruits and vegetables sector to highlight the benefits and challenges that policymakers should address in legislation.

## **Delimitations**

The study focuses on quantitative analysis of the information and views expressed by the growers in Scania County in Sweden. By focusing on a particular area, the researcher is able to assess the specific challenges and situations that the growers have to consider in their activities. The key limitation of the study is that it is directly related to the challenges and situations facing tomato growers in Scania County. This means the information may not be directly applicable to other areas in the country or the EU. The study was undertaken using open-ended questions to result in unstructured data, which makes it more difficult to analyze and generalize to other areas in Europe or Sweden. Although the data is not applicable or generalizable across regions, it is loaded with information that allows it to generate in-depth information on the state of tomato growing in Scania County in Sweden.

# Methods

## Overview

This methods chapter describes the strategies and techniques applied for collecting data and addressing the study questions. The methodology indicates the main issues that the researcher considers when undertaking a study including how to select the sample as well as the design used for the investigation. This chapter indicates the main issues that were considered by the researcher in determining the best methods to use for the study as well as the instrument applied for the analysis and interpretation of the data. The chapter also shows the theoretical approaches applied in selecting the sample and how it was analyzed for interpretation.

## Study Design

The key aim of the study is to provide information on how the growing of tomatoes in Scania County takes place in relation to productivity and usage of resources. There are limited studies in the county assessing the activities of tomato farmers and the challenges they face as well as the possibility of changing their operations towards organic farming. Since the research is meant to gather new information on a phenomenon that has not been studied much, it is geared towards in-depth data. As a result, the study uses a qualitative research design to gather information from the respondents using face to face interviews with the growers (Patton & Cochran, 2002).

Face to face interviews have been considered efficient in providing first-hand information to researchers on the phenomenon and finding out the opinions and views of the research participants on issues that have not been explored. The qualitative research design



using face to face interviews allows the researcher to gather as much information from the participants as possible because the interviewer can seek clarification on issues. This also allows the researcher to gather the information that is directly linked to the area of the study and can aid in assessing trends and formations that have previously not been observed (Patton & Cochran, 2002).

### **Information and data collection**

The sample for the study was selected using convenience sampling. One of the main aspects of the study was the need to determine efficient ways of getting the right information from growers in the tomato sector using conventional greenhouses (Onwuegbuzie & Leech, 2005). The inclusion criterion was that the respondents selected were involved in the production of tomatoes using conventional greenhouse technologies. The growers in this case also had to have been in the industry for more than three years in order to have the relevant data about the industry and how it operated over time. Convenience sampling was applied in the study because of the focus on in-depth and qualitative information as opposed to quantitative trends (Patton & Cochran, 2002). The sample selected for the study consisted of ten growers that were selected based on their capacity to provide adequate information because of their experience and activities in the sector.

A face to face approach was used because it better covered all aspects and angles of the questions under review. In order to ensure that no detail of the interviews was overlooked, there were two questionnaires having the same questions that were used for each growers. One was used to write down important aspects by the author and the other was used by the growers to indicate responses to the questions. The interview schedule was administered over a period of 1 – 2.5 hours in which the author engaged with the respondents in efforts to gather as much information as possible about the state of tomato growing in their greenhouses.

The growers were asked both to answer qualitative questions, but also semi-quantitative Likert type questions (cf. Willock, 1999) and statements concerning their production and views on organic or sustainable approaches to tomato growing (Appendix 1). The focus of the data collection instrument was to ensure that it captured all relevant information regarding the growing of tomatoes in Scania County and the challenges that the growers faced in their activities. The interview schedule, which was meant to be administered to the respondents by the author, consisted of open-ended questions that allow the researcher to seek clarification for the responses and issues raised. Although the instrument presents significant difficulty in coding the responses for statistical analysis, it is a good way of getting in-depth data for assessing an issue qualitatively. The interview schedule was pretested on two growers to assess whether they understood the questions. It was found to be effective in addressing the issues raised in the research questions and the responses from the pilot study were in line with the expectations.

### **Measures of environmental impact**

A number of greenhouse production parameters were selected to represent the environmental impact of each grower, these were: amount of mineral fertilizer ( $\text{kg m}^{-2}$ ), energy usage in terms of electricity and heating per kg produced tomatoes ( $\text{kWh kg}^{-1}$ ). Additional relevant greenhouse production parameters were also established: greenhouse area for tomatoes ( $\text{m}^2$ ), yield of tomatoes ( $\text{kg m}^{-2}$ ) and proportion of “ordinary” round tomatoes. These environmental impact factors were based on the amount used on yearly basis. Questions relating to these parameters were included in the questionnaire (Appendix 1).

## **Data analysis**

Simple Kendall rank correlations were used to explore the connections between grower attitudes (Likert items) and the environmental impact/greenhouse parameters. By using rank correlations, no assumptions regarding linearity of the data were necessary. In order to reduce the risk for false positives, correlation tests were not considered between different Likert items only between the Likert items (attitudes) and environmental impact/greenhouse parameters. Kendall correlations between variables were considered as noteworthy trends if  $p < 0.1$  and as significant if  $p < 0.05$ . Correlation analysis was performed PAST 2.17c (Hammer et al., 2001).

## Findings

The interviews were undertaken over a period of at least one hour and not more than two and a half. The interview schedule consisted to 22 questions(see Appendix 1) that had to be answered by the growers who were carefully selected from Scania County. The sample of ten growers selected for the study was conveniently sourced in order to ensure that adequate information would be gathered. The design of the study was appropriate in ensuring that any individual who was not willing to participate would be replaced until the required sample was obtained. This chapter highlights the responses that the different growers selected for the study gave to the interview questions posed by the researcher.

### **Connections between grower attitudes and environmental impact**

Results of the Likert items from the questionnaire (Appendix 1) are given in Table 2. Growers that were positive towards producing only organic tomatoes in the future (Q3) had significantly lower proportion of round tomatoes in their greenhouses (Kendall's  $Tau = -0.53$ ,  $p = 0.034$ ). Proportion of ordinary round tomato was also significantly positively correlated to tomato yield (Kendall's  $Tau = -0.52$ ,  $p = 0.037$ ). This implies that the main type of tomatoes grown is connected to attitudes towards organic production, but also that compared to other types of tomato, ordinary round ones may have less environmental impact when adjusted to kg tomatoes produced. Growers that thought that lowered tomato prices could negatively affect their capacity to invest in modernizations of their greenhouses (Q8) tended to have smaller tomato production area (Kendall's  $Tau = -0.45$ ,  $p = 0.068$ ). This indicates that growers with small greenhouses were more sensitive to income losses. Willingness to work sustainably and to reduce use of harmful chemicals (Q1) tended to be negatively correlated to the amount of mineral fertilizer that they used in their production (Kendall's  $Tau = -0.48$ ,  $p =$

0.099), indicating that growers that want to work sustainably to some extent have lower environmental impact as compared to ones that do not. In additions to correlations between attitudes and environmental/production factors, the tomato yield also tended to be positively correlated to the size of the greenhouse (Kendall's  $Tau = -0.45, p = 0.07$ ). This trend indicates that growers with large greenhouses more effectively produce tomato, which in term also means that per kg their tomato have lower environmental impact.

### **Characteristics of tomato growing activities in Scania County**

The growers were asked questions about the quantities of different materials that they used in their farms. It was meant to show the amounts and their considerations regarding effectiveness and effect on sustainability. One of the main areas of controversy in farming is the use of sludge from treatment plants. Sludge is used in some cases to increase the quality of the soil and provide nutrients for the plants, but it has rare metals and other impurities that have negative effect on human beings (Vogl, Kilcher, & Schmidt, 2005). The growers surveyed indicated that they did not use sludge because of its disadvantages and the negative perceptions that people have about it. They also indicated that their main growth medium was pumice, which does not allow solid adding. The level of productivity for the different farms varies considerably and it is clear as shown in the table in appendix 2 that the greenhouses enjoy economies of scale since the largest ones in terms of area have higher yields.

Fertilizer used in the farming activities was artificial as opposed to compost or manure. The growers indicated that the nature of their activities did not allow the use of other fertilizers. The growers indicate a lack of choice in deciding to use chemical fertilizers. Conventional growing of tomatoes does not offer much variety in the use of fertilizers. The growers also felt that it was the only alternative if they expected any significant production from their farms. The growers also indicated a heavy reliance on different fertilizer types in

quantities of 0.7 to 5.3 kg/m<sup>2</sup> for the whole season. The average fertilizer usage levels for the farmers in the interview are indicated in appendix 2 as 2.2 Kg/ m<sup>2</sup>.

Table 2. Questionnaire results of the Likert items that were issued to each grower in the study. Growers were asked to choose on a scale from 1 to 10 (Do not agree = 1, Fully agree = 10) how much they agree with topic relating to different aspects of their greenhouse production

Grower	Q1	Q2	Q3	Q5	Q6	Q7	Q8	Q9	Q10
s1	10	7	7	3	2	2	10	10	1
s2	10	5	5	3	5	1	8	10	2
s3	10	1	1	4	10	1	10	10	1
s4	8	10	1	4	4	10	10	5	4
s5	5	10	1	1	1	1	1	5	8
s6	9	5	9	3	7	3	9	8	6
s7	9	8	6	3	7	7	8	2	6
s8	10	10	1	3	8	10	9	5	5
s9	9	9	7	2	8	8	7	9	6
s10	8	4	5	3	2	8	2	9	9

Table 3. Total tomato production area (Plant), tomato yield (Yield), proportional area of standard round tomatoes (Round), proportional area of special tomatoes (Special) and amount of mineral-based fertilizer (Mfe) used by the ten growers per growing season.

Grower	Plant area (m <sup>2</sup> )	Yield (kg m <sup>-2</sup> )	Min.fert (kg m <sup>-2</sup> )	Electricity (kWh kg <sup>-1</sup> )	Heating (kWh kg <sup>-1</sup> )	Round tomatoes (proportion)
s1	3900	37	0.018919	0.540541	7.297297	0
s2	10000	26	0.105769	0.661538	12.30769	0.015
s3	53300	53	0.022642	0.141509	5.309434	0.91
s4	4000	47.5	0.078947	0.974737	28.42105	1
s5	14000	43	Missing	Missing	6.509302	0.714
s6	4000	35	0.151429	0.857143	11.57143	0
s7	7500	45	0.069556	0.133333	3.555556	1
s8	10650	38.4	0.022005	0.080729	6.140625	0.512
s9	120000	57	0.049649	0.877193	7.105263	0.333
s10	11000	42	Missing	0.280952	9.285714	0.636

Source: The Growers

This indicates significant variations in the amount of fertilizers used by the tomato growers. Another major issue was the development of new systems that allow the collection and reuse of mineral fertilizers in the greenhouses. These systems ensure that all the mineral fertilizers applied in the farm are used completely and efficiently.

Advancements in sustainable agriculture in recent years have focused on the use of different predators that protect the plants from pests. This method is beneficial because it reduces the amount of chemicals that are used in protecting the crops. Fungicides were used significantly in the greenhouses in order to address diseases such as leaf rust and blight (Pimentel et al, 2005). However, none of the growers was using herbicides, which is significantly beneficial for the environment. Insecticides are also common and used in varying quantities per farm, but the growers indicated that in some years, the use of hybrid seedlings and natural predators reduces the need for these products. The main agrochemicals used in the tomato greenhouses are indicated in the table 4. It shows that the rates of usage vary considerably across farms and they also differ with seasons. The rates indicated here were the most commonly cited by the growers, but they differed widely with some not using any of them. Others also reported that the usage of fungicides and insecticides was not always necessary and it was influenced by the level of infestation experienced.

Table 4. Average fungicide and insecticide usage among the interviewed growers.

<b>Agrochemical</b>	<b>Brand</b>	<b>Average value</b>
<b>Fungicides</b>	Scala	1 L per season
	Previcur	1 L/ ha/ year
	Tildore	1.5 L/ year
	Amistar	0.5 L/ year
<b>Insecticides</b>		
	Floramite	0.5 L/ season
	Flumite	0.5-1 L per year
	Vertimec	1L / season/ Ha

*Source: The Growers*

### **Strategies applied by growers for water usage, energy, chemicals utilization and waste water management**

The growers were asked to explain their views on the relevance of sustainability in agriculture and avoiding the use of agrochemicals. The relevance of the question was to highlight how much information the growers had about important aspects of agricultural sustainability such as organic farming and use of agrochemicals. The responses indicated the level of awareness that the different growers had regarding sustainability in agriculture and use of agrochemicals. The responses given by 8 of the ten growers showed a positive outlook on the relevance of practicing sustainable farming in order to protect the limited natural resources on earth. Most of the growers felt that reducing the amount of agrochemicals used would greatly help in reducing the adverse effects on the environment. The growers indicated that the use of agrochemicals had to be kept under meticulous observation and reduced gradually. The main issue that was highlighted by most of the growers was that the amount of



chemicals used in their farming activities was not very high, but their sudden elimination without proper alternatives would adversely affect their tomato plantations (Watson & Redman, 1999).

The growers indicated that their use of agrochemicals was relatively low because of factors such as the large distances between the farms. The distance between farms was beneficial in reducing the risk of parasites, weeds, and diseases spreading between them and causing epidemics. Another positive attribute of Sweden is the quality of ambient air, which is better than other countries. The high quality of ambient air improves the health of the plant and the clarity of the sunlight they receive hence enhancing productivity without necessarily using large amounts of agrochemicals. The water that they use on the farms is also of high quality, which plays a major role in ensuring the quality of their agricultural activities. The attributes of water, sunlight, and the quality ambient air was considered beneficial for tomato farming because it enables the plants to develop natural resistance against pests (Jordbruksverket, 2009). The responses indicated that although their use of agrochemicals was relatively low, the consumers were asking for products without harmful chemicals. A major theme in this issue was that the growers did not consider the use of agrochemicals as a necessary part but was only considered when absolutely necessary and limited to the plants that were infested or damaged.

Some of the growers were significantly sceptical about the relevance of organic farming. They felt that reverting to organic farming would result in an abandonment of science by failing to utilize all the innovations that had been developed over the years. The use of inventions and scientific innovations such as pesticides and herbicides was responsible for the reduction in labour requirements and overall expenses (Östergren & Ohlsson, 2009). As a result, they felt that there should be better options for enhancing agricultural sustainability besides focusing on organic farming and elimination of agrochemicals.

Nine of the ten interviewees indicated that agrochemicals such as pesticides had negative effects on human health. As a result, many indicated efforts to replace the use of chemical pesticides with natural predators in their farms. The growers who did not agree about the negative effects of agrochemicals indicated that their use according to the instructions and the small portions used reduced the risk of dangerous exposure.

***What are the different aspects of tomato growing in Sweden that may influence the switch to organic farming?***

The issue of government intervention is critical for socially and ecologically relevant industries or practices. In essence, the government has to intervene in areas that are socially beneficial to ensure that the benefits are maximized. In line with the need for government intervention, the growers were asked whether they thought the state was doing enough. The question was not focused on assessing the level of satisfaction that the growers had in relation to organic farming, but rather their recommendations or expectations for the government in order to help them improve overall production and sales. Most of the respondents were unhappy with the intervention that the government was providing for them. They felt that the government was not taking adequate steps to help them improve the state of the industry or shift to organic production (Watson & Redman, 1999). According to most growers, the government did not provide much help to the industry players and when it came, it was insufficient and mostly in the form of tax increases.

One grower indicated that *“The only thing the government gave me was rules”*. This statement indicates that the growers feel that the government should be involved more adequately in subsidizing agriculture in order to improve it. One grower felt that the government was investing in many other sectors and leaving out agriculture despite its relevance. He also noted that the little scientific and professional help provided in the industry

was limited to organic production. One grower expressed concerns about the conditions placed by the government for providing subsidies. Some of the subsidies provided by the government to growers are based on their reduction of the level of energy consumption. As a result, the growers are required to engage in activities that lower their energy consumption if they expect any subsidies from the government. This was a challenge because the growers required subsidies in order to develop and implement strategies for producing such energy savings (Seppänen, 2004). The main recommendations made by the growers in this respect include promotion of agricultural products by the government. The government loan guarantees are 30 years old and have been criticized for being inefficient. The growers feel that the government should update and reconsider these loan guarantees in order to make financing more accessible to them. Another aspect of government involvement is the reduction of taxes on their activities. They felt that the government needs to reduce the growth rate of taxes in order to improve their outcomes.

The respondents were required to indicate their willingness to engage in organic farming if they got support from the EU or Swedish government. The responses from the growers varied considerably with most growers being very sceptical of any help because of the subsequent conditions that are imposed. They felt that help from the Swedish government or the EU would adversely affect them because they would lose some of their freedom. Some growers indicated willingness to engage with the government if they could get assurance that they would get commitment and constant involvement. Some growers were concerned at the effects of expanded organic production because of the need to increase the area of production (Hansen, Alroe, & Steen, 2001). Other issues such as the need to sanitize the area for use have to be addressed because of the adverse effects they may have on production in the short run. Organic farming was faulted by some growers because it requires cultivating outdoors and the weather elements present significant challenges such as hailstorms, extreme cold, and

flooding. Issues such as a maintaining track of the available nutrients in the soil also pose significant problems for growers seeking to go organic. In effect, the growers were unanimously agreeing that money was not the only challenge affecting their willingness to move to organic production. Even with help from their government or the EU, the growers had a myriad of issues to consider.

### ***Environmental impact of tomato growing***

The main fuels used for transportation in conventional tomato growing are diesel and gas. The growers indicated that the need for transport in greenhouse farming was significantly limited and they only needed small tractors and forklifts for the materials. As a result, the amount of fuel used for transportation was found to be very low. The growers indicated that electrical energy was highly relevant to their tomato growing activities because of lighting, irrigation, and heat distribution. The growers indicated that they used electricity from the energy distributors, but they were confident that most of it was green because it was sourced from hydroelectricity dams and wind power. The growers indicated that although their greenhouses required a lot of electricity, they were sustainable because most of it was green.

In terms of water usage, tomato growing in greenhouses for the growers interviewed required 1.5-2.5 litres for each plant. The amount of water provided for the tomato plants differed considerably with the weather as well as the age of the plant. The growers indicated that they tried to use the available water efficiently because they were aware of the increasing desertification and reduction of available groundwater (compare with Troeh, Hobbs, & Donahue, 1999).

The main aspects of repair for the greenhouses are the annual maintenance of the foundation and glass sections. The growers indicated that minor repairs were undertaken in the heating and irrigation systems on a daily basis. Since most of the greenhouses are made of

aluminium, glass, concrete, and steel, they have relatively long lifespan of 30 years. Damaged parts of the greenhouse and other inorganic waste are transported to reuse centers for recycling.

***Is there a valid business case for organic tomato growing in Scania County in Sweden as a substitute for conventional greenhouse growing?***

The growers were asked for their opinions regarding the possibility of exercising organic growing under the current natural conditions and policies. The relevance of the question was on the need to understand how the growers consider organic growing in terms of its effectiveness in enhancing productivity and ensuring sustainability. Most of the growers had positive views about the relevance and effectiveness of organic farming. However, they faced many challenges in implementing the practices considered necessary for organic farming. Some of the main issues that the growers cited as being major impediments to the success of organic farming include the fact that some plants such as tomatoes are not native in Sweden. As a result, growing plants away from their native environment requires them to be adapted through adequate breeding techniques (Watson & Redman, 1999).

The growers can also make the environment more suited for the plants through the use of greenhouses with heating and lighting. This presents a problem for organic farming because it requires minimal artificial intervention. The growers argued that the different agricultural activities may be significantly hampered by financial challenges. Over 90% of the growers indicated that they did not want to depend on subsidies from the state. Depending on state subsidies indicates that there is a problem because the enterprises are not self-sufficient (compare with Östergren & Ohlsson, 2009). They argued that the need for government support indicates that organic farming is not adequately effective and profitable to support the growers and their enterprises.

The issue of rapid changes in the agricultural environment is a major challenge that may adversely affect the possibility of using organic farming. The growers, in this case, indicated that farming is highly sensitive and risky especially when it involves large scale changes. Small farms may not be capable of taking the new risks and absorbing the potential losses resulting from the changes ( compare with Vogl, Kilcher, & Schmidt, 2005). A major theme that was expressed by a number of growers is that they felt that conventional growing is more environmentally sound than organic. This is because they felt that conventional farming reduces the amount of natural resources such as water that are used by optimizing the plants for production. The environmental characteristics of Sweden differ significantly from other regions with precipitation being short and intense while other issues such as the seasons also differing significantly. These factors significantly affect the level of harvest that the farmers get hence making it highly necessary for conventional methods to be used.

The questions posed in relation to the future application of organic growing sought to determine whether the growers would be willing to engage in organic agriculture. Eight of the ten growers indicated that they did not think organic growers would be possible and expressed concerns at the high expenses that it might involve. One of the growers indicated that according to his expert assessment, a change to organic growing would require 20 to 30 million Swedish Crowns for a one hectare piece of land. In their view, immediate investment in organic growing was not plausible for different reasons that would adversely affect the growers. One of the main themes why organic growing was not considered as being immediately plausible was the high cost of organically produced vegetables. They argued that the organically produced vegetables are sometimes four to five times the price of conventional ones, which makes them sceptical that the consumers are willing to cover the difference.

One grower argued that there were low knowledge and competence about the practice of organic farming. In this view, the possibility of success and high productivity was

considered low and the growers were very likely to suffer from bankruptcy. Growers in the area also indicated a lack of adequate scientific data and research on the effectiveness of organic farming. This was expressed as a personal concern by some growers that the practices touted lacked enough hard data to back them up ( compare with Mc Neely & Scherr, 2002). The farmer argued that most of the evidence provided in support of organic farming was anecdotal when he was seeking scientific information on the effectiveness of the different approaches and how they may be applied for best results.

The growers argued that they needed information on which practices were profitable and practical for their region and situation ( compare with Vogl, Kilcher, & Schmidt, 2005). In line with this question, a follow-up on the challenge with the available evidence. The growers indicated that maybe the research was available but it was not being availed to them. In effect, they wanted the agriculture ministry and other institutions to make efforts to provide them with the information. Organic growing was also considered a problem because of the high possibility of production declining considerably after switching to organic. Most of the growers estimated that the amount of tomatoes produced would decline from 50 to 20 kg per square meter for standard round tomatoes, which are the most common in the county.

An interesting theme was highlighted in the responses by the growers indicating that what they planted in their greenhouses was not always up to them. This was fascinating considering that the growers may have the best information on what is profitable or suited for their farms. In explaining how the crops planted in their farms was not up to them, the growers indicated that the growers rely on recommendations from their customers on what to plant and how much of it they should have. The buyers tell the growers what they need and when they will be expecting it ( compare with Vogl, Kilcher, & Schmidt, 2005). As a result, the growers may not have any significant influence in determining what they will plant in their greenhouses or farms.

A major theme that was sought in the study was the likelihood of having major impediments that prevent the growers from practicing ecologically sound farming. In essence, the growers indicated that the conditions placed on the labelling and sale of organic produce in Europe were a significant challenge. The argument was that many countries in Southern Europe demand that organically grown tomatoes should not be cultivated with the help of artificial lighting. One grower indicated that the condition of requiring organically grown tomatoes to be grown without artificial lighting was an impediment to his ability to produce and it would adversely affect the capacity of the industry to meet consumer demand (Östergren, & Ohlsson, 2009). He was significantly concerned with the conditions placed on the organic production of tomatoes that he felt they made it implausible for large scale production.

Another major issue was the level of energy consumption required for the switch. One grower argued that the production from organic farms was almost half that of conventional practices, but required the same amount of energy. According to him, it was implausible to consider practices that involved the same energy and inputs but gave only half of the produce. In his view, this was highly inefficient because the higher energy consumption was directly associated with negative environmental outcomes. Another aspect associated with this was the need for direct cultivation of the ground, which would require more steam in order to deal with parasites such as the nematodes (compare with Fried, Zihlmann, Tschachtli, & Dubois, 2000). In the view of one grower, this would directly affect the load placed on the environment because of the high level of different technique required to address the challenges.

Competition is a major aspect of all free market economies. One grower felt that increased production of organic tomatoes would adversely affect the prices that the customers would be willing to offer. In this case, the grower was arguing that organically grown



tomatoes fetch a high price because of the inputs required as well as their relative scarcity. The growers felt that increased production of organic tomatoes would affect the price negatively and force the growers to revert back to conventional (compare with Watson & Redman, 1999).

Bureaucratic practice is another major challenge that directly affects organic production of tomatoes in Scania County. One grower argued that there was a lot of bureaucracy regarding the innovations and inventions used in organic farming. The growers complained about the slow pace of the process. The long bureaucratic processes are disastrous for the growers because they may prevent the Swedish growers from utilizing novel farming technologies.



## Analysis

The application of sustainable agricultural practices is a significant aspect in today's economies because of the challenges being experienced. The issue of organic farming has been touted as one of the best ways to ensure sustainability in agricultural practices. Growers in Scania County in Southern Sweden have expressed significant concerns over the requirements for organically grown produce and other related aspects. The focus of the study was to assess the level of resources usage in tomato farming and the possibility of the growers shifting to sustainable practices. Assessment of different issues such as the use of energy, fertilizers, water, and insecticides was assessed with the aim of assessing how much they may be changed in relation to sustainability challenges. Tomato farming in Scania County is mostly practiced through conventional means with the use of greenhouses. Tomato growers in the area rely heavily on conventional agrochemicals including mineral fertilizers, pesticides, and other growth stimulants. The tomato growers in the county mostly use pumice in their greenhouses and do not rely on natural fertilizers because the medium does not allow the addition of solids like manure or sludge.

## **Strategies applied by growers**

The use of chemical fertilizers in the sector is significantly high, but the growers have developed ways of ensuring its efficient use by collecting excess and reusing it. This plays a major role in managing the expenses incurred by the growers because the amount of fertilizer used and more wastage are minimized. The rates of fertilizer usage among the growers in the study range widely from 0.8 – 2.5 kg per square meter. As indicated by some growers, the amount of fertilizer used varies considerably based on factors such as the stage of growth, type of fertilizer, and the quality of the seedlings used (compare with Pimentel et al, 2005).

A key issue that came up in the interviews was the need for the growers to manage their costs by ensuring that the materials were got from cost efficient suppliers. While the quality of the products and their reliability were highlighted as significant factors in the decisions made by the growers. The price was also considered in order to ensure that the products were competitive. This has been considered as a relevant issue because of the need for the producers to be competitive in comparison to other producers as well as imports from the EU. Although pricing is a major issue for the growers, they unanimously expressed confidence in the competitiveness of their products because Swedish consumers go for domestic products, which they know and trust. In this respect, the growers highlighted that issues of quality also play a critical role in reducing the use of some inputs and enhancing overall productivity.

## **Aspects of tomato growing that influence the switch to organic practices**

Tomato plants are susceptible to different threats such as diseases, pests, fungus, and extreme weather. The growers indicated that they had to ensure that their plants were safeguarded from the different parasites and other challenges by being monitored all season round (compare with Mc Neely & Scherr, 2002). The growers clean their greenhouses in between seasons and use insecticides, fungicides, and other chemicals to protect their plants. The aspect of quality in relation to the use of these chemicals includes the fact that high-quality seedlings are high in productivity as well as disease resistance. High-quality seedlings are also resistant to some pests hence reduce the need for the grower to use such products in large quantities to ensure production. Some of the growers indicated their use of natural predators as a pest control strategy instead of insecticides. This approach has been highlighted as highly sustainable and safe because it eliminates the need for chemicals and protects biodiversity. This approach has been praised by the growers as being effective and a major positive step in efforts to become sustainable.

In line with the issue of sustainability, some growers argue that they are green because the grid electricity they use is sourced from hydroelectric dams and wind power. While this aspect is true, the growers could do more by developing strategies for reducing energy consumption levels in their greenhouses. Because of the need for constant heating and heat distribution, some growers have sought to rely on wood chips and other biological waste from the lumber industry as an alternative to gas. This allows reduction of greenhouse gas emissions because the energy from wood can be considered renewable (Pimentel et al, 2005).

Water usage in the greenhouses is a significant factor because it accounts for one of the biggest inputs. The growers indicated that the tomato plants require 1.5 – 2.5 litres per plant. Although there is no water scarcity in the country, the growers indicated interest in conserving what they have. A major issue regarding water use and conservation in Scania

County is the need for the farming activities to avoid contaminating ground water. This concern was highlighted by a number of growers regarding the switch from conventional to ecological farming.

## **Comparison of conventional and organic tomato growing in Sweden**

Many of the growers argued that ecological growing was not environmentally friendly as indicated by some people. The issue of chemical fertilizers and other inputs such as pesticides making their way to the surface and ground water was the main challenge that the farmers highlighted. Chemical fertilizers such as nitrates and phosphates change the pH of the water and can affect the biodiversity of oceans, lakes and rivers because of their effect on aquatic plants and animals. These chemicals also increase the rates of growth for the aquatic plants and fungi. The effect is wild growth aquatic flora that may eventually choke the oxygen out of the water resulting loss or reduction of fish populations. The argument placed by the growers is that ecological agriculture involves farming in the soil with high possibilities of the chemical inputs being swept away by the water or leaching into the ground (compare with Mc Neely & Scherr, 2002). As a result, the growers felt that the practices have to be carefully weighed because the concerns for the environment should be considered in line with the demand for the produce.

The need to consider the different aspects of organic growing and ecological approaches is a major issue the growing are quick to point out that conventional tomato growing has gone a long way in enhancing efficiency through reuse of nutrients and other approaches. The growers expressed concerns that the change to organic and ecological practices requires moving away from these practices and the benefits they have accrued over the years.

As indicated by one of the growers in the interviews, the belief in ecological growing is strong, but growers are unlikely to adopt them fully in the near future. In his view, the markets for agricultural commodities will be dominated by products grown in sensible conventional farms. For instance, the respondent indicated reservations for ecological growing because the procedure required expensive strategies for getting rid of nematodes, which have adverse effects on yields. The rules of organic growing require natural methods to be used for removing the parasites, which are likely to lower the yields (Hansen, Alroe, & Steen, 2001). Instead, the growers argued for the application of biological pesticides to get the same pure product and higher yield. As a result, the application of natural strategies for crop protection and nutrients enhancement should be integrated into conventional growing. This would produce the highest benefit in terms of producing synergies between the concerns for the environment and scientific innovations.

Many growers indicate significant reservations in changing from conventional tomato growing to organic. The main reasons were the difficulties of implementing some of the practices being highlighted in the media. For example, a major theme among tomato growers in Scania County is that the sudden elimination of inputs like chemical fertilizers with proven productivity benefits would affect them negatively. These included the argument that they consider agriculture as a business enterprise hence it would be inefficient for them to abandon strategies that allow them to increase productivity. As argue by one grower, organic growing has a high risk and possibility of losses because of the lower production levels. They felt that the approach would be counterproductive because it results in reduced production while energy and other inputs like seeds and water are used at the same rate (compare with Mc Neely & Scherr, 2002).

## **Benefits and challenges to the adoption of organic farming**

The tomato growers in Scania County express a lot of interest in changing their agricultural practices to organic and argue that the government can play a key role in aiding the switch through subsidies and reduction of bureaucracy especially in certification. Most of the growers in the area seem to be unhappy with the intervention that the government provides for them in boosting the agriculture sector. They felt that the government was not taking adequate steps to help them improve the state of the industry or shift to organic production. According to most growers, the government did not provide much help to the industry players and when it came, it was insufficient and mostly in the form of tax increases. Another issue of concern by the growers that hinder their willingness is the conditions that the government may impose on them in exchange for subsidies (compare with Geier, 2001). In this respect, the growers feel that the loss of freedom is too big a price to pay for help by the government. In effect, the government should review the approaches adopted for subsidizing and aiding the tomato growers in order to motivate them to adopt organic agriculture. Issues such as credit accessibility and reduction of the taxation levels have been highlighted by the growers as significant in improving adoption of organic growing.

It is clear that very few tomato growers in the area are considering switching to organic growing because of the different challenges that it presents. The growers would consider organic farming as a beneficial aspect of sustainability although they are faced with many challenges. The main issue was that tomatoes were not native in Sweden hence they required the application of scientific strategies in order to adapt them to the environment and enhance productivity. Organic farming is highlighted as having significant risks of losses that the growers may not be able or willing to absorb (Hansen, Alroe, & Steen, 2001). The issue of low production levels using organic growing strategies was highlighted as a major impediment. A related issue, which is the higher production costs and overall prices of



organically produced vegetables, was also indicated as an impediment that reduced the plausibility of organic in Sweden in the short run.

The issue of knowledge and scientific research was also reported as a major impediment to the adoption of organic farming. The growers cited lack of hard evidence on the effectiveness and applicability of different strategies for organic agricultural production. Most of the evidence that interviewed growers could access was anecdotal. This means they lacked the necessary information to know how to adopt the different approaches and how they could improve production. This issue can be considered as a major impediment that the government can apply in enhancing the adoption of organic growing by providing education and training to the growers (Mc Neely & Scherr, 2002). The responses given in the study indicate that although the research and evidence may be available, it is not accessible to the growers. As a result, they were unable to make adequate decisions regarding the adoption of sustainable practices.

The issue of support from the government or other agencies such as the EU was considered with mixed feelings from the growers. The major themes in this respect were scepticism from some individuals because any help from the government would be accompanied by imposed conditions. Another critical theme was the low willingness of the growers to engage with the government unless they could get assurance of commitment and constant involvement. This indicates that the growers worry that the industry is likely to suffer significantly if the government does not provide adequate and complete commitment to aiding them in improving their agriculture (compare with Fried, Zihlmann, Tschachtli, & Dubois, 2000).

Some growers were concerned that the effects of expanded organic production would put pressure on the land. Organic farming would require them to increase the area under cultivation, which involves different costs such as preparation of the land as well as the

relatively high cost of such land in the county. Other issues such as the need to sanitize the area for use have to be addressed because of the adverse effects they may have on production in the short run. Organic farming was faulted by some growers because it requires cultivating outdoors and the weather elements present significant challenges such as hailstorms, extreme cold, and flooding. These issues were considered by most growers as being significant impediments to their switching to organic production because of the high costs involved.

The quality objectives indicate the quality and conditions of the environment that should be applied for sustainability in the long run. The interim targets and objectives indicate the framework for compliance with the convention on biological diversity (Fried, et al., 2000). Some of the environmental quality objectives are directly connected to agriculture such as zero eutrophication, non-toxic environment, and a varied agricultural landscape. The environmental objectives are also associated with agricultural production such as thriving wetlands, quality of groundwater, and reduced adverse impact on the climate (United Nations, 2005). These objectives and targets can be met through the enhancement of agricultural practices. However, the responses in this interview indicate some concerns regarding the ineffectiveness of ecological agriculture. They indicate a need for the researchers in the area to determine how best to adopt ecological agriculture without endangering quality and quantity of production.

# Conclusions and recommendations

## Conclusions

It is necessary to consider Östergren & Ohlsson (2009) who argued that agricultural practices can be unsustainable even when they are chemical free and containing low artificial inputs. In order to be fully organic and sustainable, agriculture has to incorporate naturally resilient systems that allow continuous production with low adverse effects on the environment. The inputs used and tillage methods are only part of the picture and should be incorporated in the consideration of the need for environmental, social, and economic sustainability. Sustainable agriculture means interacting with the biological systems and cycles in a life-enhancing way. Ecological responsibility is the main issue that has to be considered in defining sustainable agriculture and ensuring that the approaches adopted are efficient in producing beneficial outcomes for the environment as well as the food consumers and producers (Mc Neely & Scherr, 2002). In this respect, growers have to be provided with adequate training and information in order to implement the different practices efficiently for sustainability as well as meeting the demands of consumers. The study is essential in providing information on the different aspects of organic and conventional farming. It provides primary data on how tomato growers in Scania County address the issues of sustainability and materials usage. Without the primary data provided from the interviews, it would be impossible to assess how they perceive organic farming and incorporating its practices in their activities.

Issues such as keeping track of the available nutrients in the soil also pose significant problems for growers seeking to go organic. Growers may have significant difficulties in providing and maintaining the optimal nutrient levels that their tomato plants require growing. (Mc Neely & Scherr, 2002). The effect is that the plants may not be growing in the best

conditions and their productivity is significantly hampered because the growers cannot adequately determine the level of nutrients available and those required. The tomato growers in Scania County unanimously agree that money is not the only challenge affecting their willingness to move to organic production. Even with help from their government or the EU, the growers have many other issues to consider. This means subsidies and tax breaks or provision of professional help are just some of the approaches that the government can apply. In order to get tomato growers to switch to organics, the government has to provide them with high levels of commitment as well as professional help and extension services.

This indicates that training may offer one of the best approaches to enhancing the adoption of organic farming. This view is consistent with the experiences of growers in Järna Stockholm County who have adopted biodynamic farming with the help of researchers and advisors who work with them from the Biodynamic Research Institute (Seppänen, 2004). Growers can significantly benefit from government services that aid them in accessing credit as well as technical training on how to make the best from organic farming.

A significant issue that was highlighted by some growers was the possibility that organic produce would decline in price if the production levels increased significantly. This was a concern because of the high costs involved in the production and the fact that low prices would cause losses. The growers argued that low prices are likely to attract customers away from their produce and cause them to experience double tragedy with low production, high costs, and supply surpluses (compare with Watson & Redman, 1999). The growers also had mixed feelings regarding the price effect of imported tomatoes. The issue of cheap imports is a major challenge because it may affect the interest of growers on sustainability.

It is a well-known fact that environmentally sustainable energy may be more expensive in the short run compared to conventional ones. Price pressure may force producers to consider what is most economically efficient without necessarily addressing the

sustainability issue. In the case of cheap imported tomatoes, some growers expressed the concern that cheaper products are always preferred over their more expensive counterparts (compare with Pimentel et al., 2005). In relation to the price issue that growers show confidence in the consumers preferring their produce compared to imported cheap ones because of trust in domestic production. As a result, the growers are unlikely to suffer from low demand or high competition from foreign companies encroaching on their market.

## **Recommendations**

1. Subsidies and tax breaks or provision of professional help are just some of the approaches that the government can apply in aiding growers in the county to achieve their objectives. Government intervention has been cited in the study as a relevant aspect in determining the willingness of growers to apply sustainable approaches. The growers need incentives as well as extension services in order to understand the practices more effectively.
2. In order to get tomato growers to switch to organics, the government has to provide them with high levels of commitment as well as professional help and extension services. Commitment from the government is required by the growers in terms of knowing that they will have a reliable partner. The growers would not be willing to switch to organic if they are not sure that they will get support in terms of regulation, financial support, and marketing.
3. The imposed conditions on growers in exchange for subsidies or other forms of support should be relaxed to enhance innovativeness and willingness of the growers to engage. This is derived from the views of different growers that the conditions imposed by the government for support are inefficient. For examples, the need for growers to prove their use of green energy in order to get support requires heavy

investments that they do not have. This reduces the ability of many growers to engage in organic farming despite their willingness to do that.

4. Accessibility to credit through improved loans guarantees have been cited as being highly beneficial to the adoption of organic farming. The issue of loan guarantees from the government is critical to the success of growers in Scania County and their willingness to go organic. The issue of loan guarantees and access to credit has been cited in the study as a major impediment to investments in agriculture. This is because growers need more efficient credit facilities to access the necessary funds for investment.

## **Acknowledgements**

The following master thesis would not have been possible to write without the help of the association Miljöbron representative Helena Ensegård, Everfresh representative Laura Mustonen, internal supervision Johanna Alkan Olsson and the internal supervision Erkki Palmu.

Last but not least I would like to show my appreciation to the ten growers that even during the high season they made themselves available and provide the necessary data and insights without which the realisation of this project would not have been possible.

**Thank you all!**

**Nicolae Hilmkvist**





## References

- Björk, C. (2003). *Driving forces, motives and hindrances for the consumer*. Stiftelsen Biodynamiska Forsknings Institute, Järna, Sweden.
- EAP. (2012). *Definition of the term "Sustainable Agriculture"*. Retrieved July 22, 2015, from <http://eap.mcgill.ca/sustain.htm>
- Fried P.M, Zihlmann, U., Tschachtli, R., & Dubois, D. (2000), Inputs, yields and economic parameters of three farming systems compared at Burgrain (Switzerland), *13th International scientific Conference of IFOAM*, August, Basel.
- Geier, B. (2001). Organic certification nightmare? *Ecology and Farming*. 26 (12).
- Hammer, Ø., D. Harper, and P. Ryan. 2001. PAST-Palaeontological statistics. [www.uv.es/~pardomv/pe/2001\\_1/past/pastprog/past.pdf](http://www.uv.es/~pardomv/pe/2001_1/past/pastprog/past.pdf), acessado em 25:2009.
- Hansen, B., Alroe, H.F. & Steen, K.E. (2001). Approaches to assess the environmental impact of organic farming with particular regard to Denmark. *Agriculture Ecosystems and Environment* 83(1-2), 11-26.
- IFAJ. (2012). *Solutions For A Green Future*. Stockholm: FSLJ, Föreningen Skogs och Lantbruksjournalister.
- Jordbruksverket. (2009). *Facts about Swedish Agriculture*. Retrieved July 27, 2015, from [http://www2.jordbruksverket.se/webdav/files/SJV/trycksaker/Pdf\\_ovrigt/ovr2gb.pdf](http://www2.jordbruksverket.se/webdav/files/SJV/trycksaker/Pdf_ovrigt/ovr2gb.pdf)
- Mc Neely, J. A. & Scherr, S. J. (2002). *Ecoagriculture—Strategies to feed the world and save wild biodiversity*. Island Press; Washington, USA.

- Naturvårdsverket, 2015. Mål i sikte Analys och bedömning av de 16 miljökvalitetsmålen i fördjupad utvärdering. Retrieved July 22, 2015, from [http://www.miljomal.se/Global/24\\_las\\_mer/rapporter/malansvariga\\_myndigheter/2015/mal-i-sikte-volym-1.pdf](http://www.miljomal.se/Global/24_las_mer/rapporter/malansvariga_myndigheter/2015/mal-i-sikte-volym-1.pdf)
- Onwuegbuzie, A. J., & Leech, N. L. (2005). On Becoming a Pragmatic Researcher: The Importance of Combining Quantitative and Qualitative Research Methodologies. *International Journal of Social Research Methodology*, 8 (5), 375-387.
- Östergren, K. & Ohlsson, T. (2009). The Challenge of Sustainability in the Food Sector – general aspects and practical approaches. *Presented for the Swedish Institute for Food and Biotechnology*.
- Patton, M. Q., & Cochran, M. (2002). *A guide to qualitative research methodology*. <http://fieldresearch.msf.org/msf/bitstream/10144/84230/1/Qualitative%20research%20methodology.pdf> /Retrieved July 27, 2015.
- Pimentel, D., Hepperly, P., Hanson, J., Seidel, R., & Douds, D. (2005). Environmental, energetic, and economic comparisons of organic and conventional farming systems. *Bioscience* 55(7), 573-582.
- Seppänen, L. (2004). Local and organic food and farming around the Baltic Sea. *Ecological Agriculture*, 40, 1-93.
- Troeh, F. R., Hobbs, J. A. & Donahue, R. L. (1999). *Soil and Water Conservation*. Prentice Hall: Upper Saddle, NJ.
- United Nations. (2005). *Sweden: Agriculture*. Retrieved July 25, 2015, from
- Willock, J., I. J. Deary, G. Edwards-Jones, G. J. Gibson, M. J. McGregor, A. Sutherland, J. B. Dent, O. Morgan, and R. Grieve. 1999. The Role of Attitudes and Objectives in Farmer Decision Making: Business and Environmentally-Oriented Behaviour in Scotland. *Journal of Agricultural Economics* 50:286-303.

Vogl, C. R., Kilcher, L., & Schmidt, H. (2005). Are Standards and Regulations of Organic Farming Moving Away from Small Farmers' Knowledge? *Journal of Sustainable Agriculture*, 26 (1), 5-26.

Watson, S. & Redman, M. (1999). BSE—Counting the costs of a crisis. *Ecology and Farming*, 21, 20-21.



# Appendix 1

## Appendix 1: Interview questions

**From a scale of one (not important at all) to ten (very important):**

1. Question nr. 1: Do you believe is important to work sustainable and in parallel to try to diminish or avoid totally the use of harmful chemicals in agriculture?

From a scale of one to ten:

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

**Comments:**

2. Question nr. 2: Is at present possible to produce only organic vegetables, given the Swedish natural conditions (temperature, soil properties, sun intensity etc.) or other difficulties?

From a scale of one to ten:

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

Comments:

3. Question nr. 3: Would be possible in the future to produce only organic tomatoes and if so do you want to be part of it?

From a scale of one to ten:

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

Comments:

4. Question nr. 4: Given the condition changes from one farm to another, is it something that prevents you, in particular, cultivate ecological tomatoes?

From a scale of one to ten:

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

Comments:

5. Question nr. 5: Do you think that the Swedish government is doing enough to encourage the development of tomato cultivation?

From a scale of one to ten:

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

Comments:

6. Question nr. 6: Do you feel any kind of concern for foreign companies?

From a scale of one to ten:

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

Comments:

7. Question nr. 7: Does in any way the imported tomatoes in terms of price affects you? How much?

From a scale of one to ten:

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

Comments:

8. Question nr. 8: Does the price differences affects you capacity of improving the conditions of your greenhouse?

From a scale of one to ten:

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

Comments:

9. Question nr. 9: How important is for you to diminish the use of chemical plant protection product?

From a scale of one to ten:

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

Comments:

10. Question nr. 10: Would you be willing to start growing organic if Swedish government or EU would support you?

From a scale of one to ten:

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

Comments:

11. Question nr. 11: Depending on what criteria you choose materials?

Comments:

12. Question nr. 12: Are you using sludge from the treatment plant in the greenhouses?

Comments:

13. Question nr. 13: What sort of tomatoes are you producing? How much and how big the area is?

Comments:

14. Question nr. 14: What kind of fertilizers are you using?

Comments:

15. Question nr. 15: How do you protect the plants?

Comments:

16. Question nr. 16: How many kinds of fertilizers do you use and how much?

Comments:

17. Question nr. 17: How many motor vehicles and how much fuel do you use in one year?

Comments:

18. Question nr. 18: How much energy do you use for one kilogram of tomatoes?

Comments:

19. Question nr. 19: How many liters of water do you use each season for one square meter?

Comments:

20. Question nr. 20: How often the greenhouses need repairs?

Comments:

21. Question nr. 21: What types of residual products occur?

Comments:

22. Question nr. 22: How do you think that the market will change regarding the organic vegetables?

Comments:



## Appendix 2

Energy consumption, heat consumption, water usage and the type of nutrient recycling systems.

uid	Electricity (kwh/m <sup>2</sup> )	Electricity type	Heating (kwh/m <sup>2</sup> )	Heating system	Water usage (dm <sup>3</sup> m <sup>2</sup> )	Nutrient recycling system
s1	20	green	270	chipping	4.9	recycling
s2	17.2	green	320	CNG	4.4	recycling
s3	7.5	standard	281.4	central heating	650	recycling
s4					5.6	
s5		standard	279.9	chipping/CNG	600	mineral
s6	30	standard	405	chipping	5	recycling
s7	6	standard	160	CNG	5	recycling
s8	3.1		235.8		5	
s9	50	standard	405	chipping	650	recycling
s10	11.8	standard	390	chipping/CNG	0.7	recycling