Sustainable Horticultural Crop Production in Norway: Sustainability of Food and Fiber, and Future Research

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Introduction to Norway:

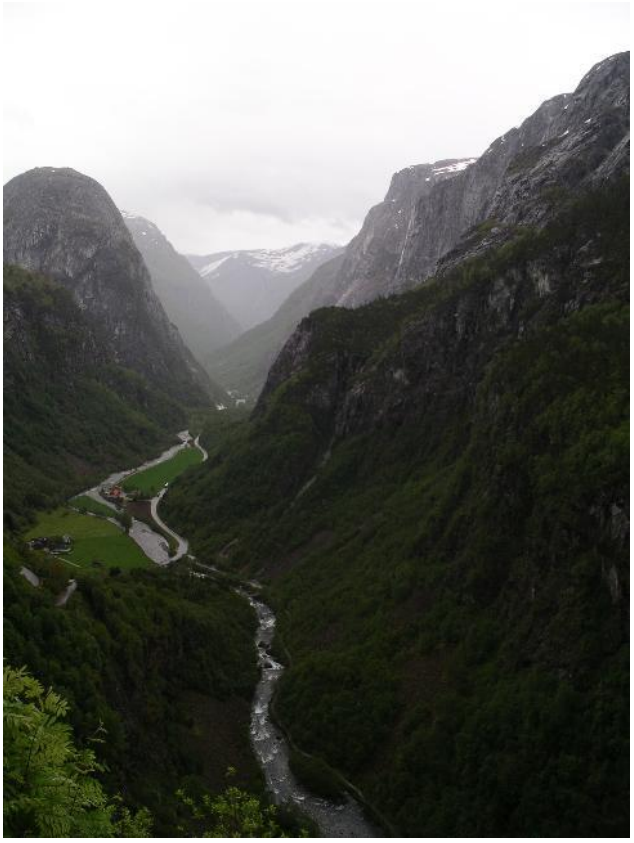
Located on the latitude and longitude of 62 00 N, 10 00 E, Norway is in North-Western Europe. Having one of the longest coastlines in the world, its borders touch the North Atlantic Ocean as well as the North Sea with nearly 50,000 islands off its coast. Strategically, its location has great access to the northern shipping and flight lanes. Norway also shares borders with Finland, Sweden and Russia.

With a total area of 323,802 sq km, Norway is, by comparison, slightly larger than New Mexico. The land here is predominantly rugged and of the country's total area, only 2.7% is arable. Nearly two-thirds is jagged mountain with intersecting fertile valleys and small plains. In the northern-most parts of the country, artic tundra is present. One of the most notable geographical features of the country are its numerous eye-opening fjords, evidence of Norway's once again rugged terrain. The elevation of the country goes from 0 m at the Norwegian Sea to 2,469 m at Galdhøpiggen, the highest mountaintop in the country (see map

Source: CIA World Fact Book 3/18/10

to the right) (CIA World Fact Book 2010).

The west coast is greatly modified by the North Atlantic Current, which makes it a temperate climate with rain year-round. The interior of the country has lower yearly average temperatures, with dramatically colder summers than those on the coast and less annual rainfall.



Source: CIA World Fact Book 3/18/10

As of July 2009, Norway has a population of 4,660,539 with a median age of 39.4 years. The life expectancy of the country is 79.95 years of age. The ethnic groups are few, with 94.4% of the population being Norwegian, 3.6% other European and 2% other nationalities. Norway has a concerted interest in the education of its people; 100% of the population (over 15 years of age) is literate, with 7.2% of the GDP going toward educational expenditures. Each citizen has the opportunity of free education through the collegiate level due to federal funding (CIA World Fact Book, 2010).

My interest in choosing Norway is rooted in a curiosity of my own Norwegian heritage. Both sides of my family have their origins in Norway and have retained some contact with the country over generations. In regards to my familial agricultural

background in the Unites States, Norway's history and people are an interesting study in terms of how they have found and solved the problems confronting them.

Defining Sustainability:

Sustainability is explained in Norway's Action Plan for Sustainable Development, with a widely used definition that was first thought of by the Brundtland Commission in 1987. It says that sustainability is "a form of development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Norwegian Government, year).

A similar definition with a few modifications has been used by the Norwegian Ministry of the Environment at the Oslo Roundtable on Sustainable Production and Consumption in 1994. Sustainability is " the use of services and related products which respond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardize the needs of the future generations" (Oslo Roundtable, 1994).

Sustainability has proven to be quite the task to define for those who dare to do so. How does one encompass all the factors of the most elaborate system ever known into one definition? It must address environment/resources, welfare of the people, and justice of all creatures as well as looking towards future generations with all of these same topics in mind.

Agriculture and Horticulture in History:

It is thought that the transition from hunter-gatherers happened between 5000 to 6000 years ago in Norway. Agricultural remains have been found that date back to the

Bronze Age (1500- 500 B.C.). Nearly all of these remnants were found in the Southern part of the country, yet during the same time period, there were also a few hunter-gatherers in the northern regions (Dagre).

Since the transition from hunter-gatherer to agriculture, farms have been mainly small community-scale operations that were supplemented with other small industries such as fishing, hunting, and timber. A large influence on this is the landscape of the country, and the void of large tracks of arable land. Even today, the average size of a farm in Norway is twelve hectares.

Biodynamic agriculture, which began in the 1930s, formed the foundation for current organic farming. In the 1960s, as was found in many other places, there was a rise in awareness and interest in the environment, thus leading a change towards more organic farms. By the end of the 1960s there were about 30-40 organic farms operating in the country (Johnsen & Mohr 2002). In 1986, Debio Certification was established. This certification is the inspection of organic production in accordance with Norway's "Regulations on the Production and Labeling of Organic Agricultural Products". Today, all organic products in Norway are Debio Certified; this includes aquaculture, agriculture, forestry and all imports (Debio, year).

Agriculture and Horticulture Presently:

Norway is now one of the wealthiest countries in the world monetary-wise; this however is not due to a booming agricultural sector. Most of the countries wealth comes from large amounts of petroleum and natural gas that is mainly derived from offshore drilling. Norway has $276.5 billion U.S. dollars (2009 estimate) in Gross Domestic Product, with only 2.2% of that from agriculture. Agriculture only accounts for 2.9% of

the country's labor force at 2.6 million people. The main agricultural products produced are barley, wheat, potatoes, pork, veal, milk, and fish (Grytten 2008).

As noted, Norway's agriculture remains on a small scale due to national regulations and geographical necessity. The average conventional farm is 12 hectares and the average organic farm is 13 hectares. Most of the farms are still located in the Southern regions of the country.

Table 1: Organic Land Use in Norway in 1999

Crop	Hectares*
Grassland, Meadows, & Green manure	13,592
Grain	861
Seeds	72
Potatoes	147
Vegetables	91
Herbs	36
Fruit	38
Berries	21
Other	87

* Land in transition from conventional to organic not included

Source: Johnsen & Mohr 2002

Organic farming has continued to grow in Norway. There has been a growth in the total number of farms as well as the total number of hectares, yet in 2000, organics only massed 2.0% of the total area of Norway's production (Johnsen & Mohr 2002). Overall, grassland, meadows and green manure take up most of that production area. In comparison, as Table 1 shows, organic fruits and vegetables, etc. encompass a significantly smaller area. This is due to the terrain of the land as well as the country's climate.

The fruit grown the most in Norway consists of apples, pears, plums, and cherries. However these, as with nearly all other crops, are only commercially grown in the South. Even so, smaller fruits such as red and black currants, cloudberries, strawberries, lingonberries and blueberries have proved to hold a substantial importance

for farm incomes in both the Northern and Southern regions of Norway (Gislerød et al, year).

The area's short growing season as well as cool temperatures limits the crops that can be economically grown in field conditions. Therefore, protected growing environments have been an important factor in production of food and ornamental crops. In 1999, there was estimated to be about 200 hectares of greenhouses, nearly half of the total area being utilized for tomato, cucumber and salad crop production. Half of the area of greenhouse space (100 hectares) is used for growing potted plants, bedding plants, and cut flowers. Norway is facing an uphill battle to try and find a way to keep their market for Norwegian-produced horticulture crops. Greenhouse ornamentals once produced 60% of the monetary value of their horticulture industry. In order to keep the market for Norwegian grown greenhouse ornamentals, the industry and the government has invested money to research quality solutions. Norway sees their way of competing with imports as an issue of quality. Therefore they must internally have the highest quality products in order to compete in the market (World Conference 1998).

In 2006 there were 740 establishments in the greenhouse production segment of horticulture throughout the country. This is a decrease in total number from 1999 by 23%; however the total area and level of production has increased during this same time period. Vegetables and berries have had the most notable increase with vegetables up 10% and berries doubling in production (Statistics Norway 2008).

Trends and Innovations:

While presently many historical features of Norwegian agriculture have remained relatively the same, there have been some significant changes as of late. Their production

continues to be small-scale in comparison to the rest of Europe and the United States, focusing on local needs above exports. With the government's emphasis on natural and cultural preservation, there are policies to maintain decentralization and to create prosperous smallholdings. Regulations ensure the protection of natural "settlement patterns" (Heie, year), thus protecting the use and distribution of natural resources as well. The amount of their agricultural production that may be exported is drastically limited due to this emphasis on internal sustainability. Local markets are the main producers of food for each individual community, rather than encouraging an economic reliance on imports. The only exception to this practice is the growth of young flower plants which are usually sent to other Nordic countries (Moe & Askig, year).

Alongside the government's encouragement small-scale production is a trend in the opposite direction. While land use remains relatively the same, the amount of production has increased with a fewer total number of producers. This can be seen in the case of Norway's greenhouse industry. From 1999-2006 there was a 23% decrease in the number of greenhouses while their area remained the same and production increased (Statistics of Norway, 2008).

One such crop that has seen a recent increase in production is strawberries. Grimsby Gartneri designed an off-season strawberry production to capitalize on a year-round strawberry demand within the country. His greenhouse and high-tunnel system utilized artificial light as a photoperiod manipulation to induce flowering three times for 'Korona' berries from September through June (Sønsteby & Hytonen, 2006).

One of the most revolutionary concepts currently in place in Norway is the "climate-controlled greenhouse" using Combined Heat and Power (CHP). CHP is a gas

engine that maximizes the "use of natural gas, as CHP produces heat, carbon dioxide (CO2), and electricity". The heat produced is used to control greenhouse temperatures, the CO2 increases potential plant growth, and the electricity is put into the power grid. It diverts the CO2 in order to reuse those emissions that would otherwise be a negative byproduct. The main benefits of this system are CHP's efficient use of energy, the raised production return, and an economic bonus of that added electricity (Caterpillar 2009).

Integration Over Time:

Starting with the social structure of the hunter-gatherers, we see arguably the most sustainable system. However this type of living is sustainable in a different way from how we now think, for the plants and animals that sustained the hunter-gather's food was in itself sustainable. Their environment was not dependent on their existence, like the modern day food production system has become so dependent on the humans and machines that help them grow.

Norway, from the beginning, has encouraged the vitality of rural communities, which tend to mimic the "natural settlement" of the early human populations in that area. With the decentralization of food production, there generally comes the awareness of preserving the natural ecosystems, as well as an emphasis of the quality of the products.

Norway's population has continued to increased through time. Along with this increase comes the need for higher food production and land use. The climatic conditions and geographical nature within the country demands for innovations in the production patterns of agriculturalists. CHP looks to be a large step in national sustainability. This concept allows for increased production using Norway's natural resources in a dramatically improved manner.

In order for Norway to continue to take steps towards sustainability, they must continue to look for more efficient uses of the natural resources available. Key factors within this progression forward include population control, diversification, and quality and efficiency of products. The most limiting factor of production is the duration of the growing season due to the climatic conditions. Thus protected growing environments such as greenhouses and high tunnels are a necessity. The next step is to continually alter practices to make such protected growing environments as efficient as possible. This does not mean to disregard the arable land, but to instead utilize it for what it can produce and place greenhouses in areas that would not otherwise be able to support such growth.

The natural habitat on the majority of arable land is grassland and meadows for the husbandry of animals. This land is sustainable in this system, the animals continue to provide nutrients for the grasses feed the animals. Therefore in terms of sustainability, this land should not be used for other crops. High tunnels have the ability to extend the season of crops that would otherwise not be part of the nationally produced food system. These structures do use arable land, however they have the ability to produce crops by extending the growing season in an area that was not economically viable before, thus making it a more sustainable practice. Greenhouses can be built in areas that are not capable of supporting crops, when built they increase the production of the area in ways that were not available before.

With the use of CHP and other improved ways of providing the energy needed to use the greenhouse environment there are a multitude of crops that can be grown. Tomatoes, salad crops and cucumbers are the three that have had the largest success in greenhouses in this area. With this in mind, the diversification of crops should be kept as

a higher priority than the economics of producing one high return crop. Diversification has many benefits, from pest and disease management during production to the sustainability of the local markets.

Sustainable Development Strategy:

The future of human existence on Earth depends on the ways that we can get back to using sustainable methods of living. One of the largest areas for integration of sustainability is in the production of food and fiber. When sustainability is woven into the fabrics of both agriculture and horticulture we will take a huge step forward in the sustainability of people on Earth. Although not all countries need the same techniques of sustainability implemented into their society. Norway does not need everything that the United States might need to become sustainable.

Norway has shown that they already place a large amount of their attention and gross national product on supporting their citizens through education and public health care. Norway is also blessed with the natural resources of timber, fossil fuels and natural gas within its borders and along its coast. These resources have provided them jobs and supported their economy for many years now. However these resources are limited, therefore we need to look toward the future to try and find ways to use what we have as efficiently as possible while simultaneously searching for new ways of powering the society.

Due to the climatic conditions of Norway, there is a need for protected growing structures such as greenhouses and high tunnels. I believe that there are places for each of these in the economy and production of food and fiber in Norway. In the southern

regions of Norway where most of the crops are grown, the addition of research with movable high tunnels should be incorporated in order to add to the length of the growing season both earlier and later in the season. High tunnels could become a valuable resource to increase the production of food and fiber as well as reduce the use of pesticides. They could also help with the quality of fruits, vegetables and even ornamental plants which would help to keep Norway's place in the global markets.

The Northern regions of the country where the temperatures become much cooler and the lands are the least fertile should research the use of greenhouses with combined heat and power technology as while as study other alternative power sources.

It is not a sustainable method to take marginal lands and turn them into fields where extra inputs will be needed in order to produce a successful crop. Because of this my recommendations are for an increase in quality, locally produced, and low input food and fiber. This along with the present government attention and support of the rural communities has the ability to sustain the rural citizens while providing food for the urban dwellers.

Norway has the focus on supporting its citizens with their needs and this attention has helped them to become the country with the highest standard of living. Yet the sustainability of society depends greatly on the food and fibers that can be produced within the country. Therefore I believe that is in imperative that further research be done to increase the quality of these products, as they have done with the countries health care and education already.

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