Inland Norway University of Applied Sciences

Faculty of Applied Ecology, Agriculture Sciences and Biotechnology

PRINCE DODOO

Master Thesis

Agrifoodtech in Norway

Master in Applied and Commercial Biotechnology

2023

Consent to lending by University College Library	YES ☒	NO ☐
Consent to accessibility in digital archive Brage	YES ☒	NO ☐

Acknowledgement

My sincere gratitude goes to God Almighty for the gift of life and strength to start and complete the master program.

My heartfelt gratitude goes to my supervisor, Dr. Frank Larsen, for the topic and for his valuable assistance. My profound appreciation goes to the professors and staff of Inland University of Applied Sciences for the warmth and hospitality they offered me during my study period.

I am grateful to the all the people interviewed for their valuable time and insightful information on the topic.

I also thank my families and friends and others for the invaluable support and love.

Thank you so much.

Abbreviations

3D	3 Dimensional
AI	Artificial Intelligence
AMS	Automatic Milking System
CAP	Common Agriculture Policy
CEO	Chief Executive Officer
CFP	Common Fisheries Policy of EU
EC	European Commission
EU	European Union
GCFI	Gross Farm Income
GDP	Gloss Domestic Product
GIS	Geographic Information System
GPS	Global Positioning System
Ha	Hectare
IMF	International Monetary Fund
IoT	Internet of Things
IPR	Intellectual Property Rights
LCA	Life Cycle Analysis
NOK	Norwegian Kroner
PA	Precision Agriculture
PPP	GDP per capital

R&D	Research and Development
ROI	Return on Investment
SDGs	Sustainable Development Goals
SSB	Norwegian Statistics
UAA	Utilized Agriculture Area
UK	United Kingdom
US	United States
US$	United States Dollar

Table of Contents

Abstract

The agrifoodtech industry consists of the agritech sector and the foodtech sector, which uses technology for agriculture and the food industry. The agrifoodtech industry helps farms and businesses to be more efficient, profitable, safer, sustainable, and environmentally friendly. The global industry is close to US$ 9 trillion and dominated by United States (US$21 billion), China (US$7.3 billion), Indian(US$4 billion) and other European countries such as Germany (US$3 billion), France (US$1 billion) in 2021 (AgFunder, 2022a). Norway had US$0.3 billion investment market share in 2021(AgFunder, 2022b). The Norwegian agrifoodtech industry is small but growing rapidly and has the potential to succeed globally. The study aimed at determining how the Norwegian agrifoodtech can succeed internationally with a focus on the agritech sector.

Qualitative research was conducted by interviewing 3 Norwegian farmers and 4 experts with knowledge of Norwegian agrifoodtech companies, industry and farming. A purposive sampling including snowball sampling was used to obtain the participants. Secondary data were collected from published research articles, industrial reports, company and government reports.

An overview of agrifoodtech in Norway shows that there are at least 108 Norwegian companies distributed over the country but most frequent in Innlandet, Trøndelag, Oslo and Akershus Rogaland counties. The Norwegian companies seem to be strong in the biotech-genetic sector, which is important to consider in the exportation of solutions to foreign markets. There are cluster of smart farm and digital solutions companies and circular solutions companies in indoor/vertical farming as well as bioresource solution companies in the country which can also be considered for the international market.

Farmers with large and profitable farms seem to dominate in the use of biotech-genetic solutions and full-time farmers with small farms seem to dominate in the acquisition of smart farm and digital solutions. Moreover, there is a potential market for the use of automated Norwegian solutions by part-time farmers with small farms.

The technology readiness among farmers in Norway seems to be high in some regions such as Innlandet and Akershus counties. Additionally, the use of the agritech solutions by farmers can be found in some countries including Norway, German, and France and the UK. It is

likely that that profitability, sustainability, finance, education and experience are the main factors that affect the readiness of farmers and businesses to use the technologies in Norway. Additionally, farmers with large and profitable farms and full-time farmers with small farms seem to tend to pay and use sustainable technologies. There is a possibility the that marketing of sustainable technology in Norway and abroad can be enhanced with the use of sustainable labels.

1. Introduction

The Agrifoodtech industry is a recent growing technology sector which entails the use of technologies including breeding technology, sensors, devices, machines, robots and information technology in agriculture and food industries. Agriculture technologies are helping farms and businesses to be more efficient, profitable, safer, sustainable and more environmentally friendly. Agrifoodtech is revolutionizing the global food system by offering novel and innovative technology that changes the food system from the production, distribution and consummation of food (Sippel & Dolinga, 2022). The industry is made up of the agritech sector and the foodtech sector (AgFunder, 2022a).

The recent rise in investment activities on agrifoodtech is due to several rapidly emerging technologies that aim to provide better and healthier food options, as well as improve agricultural practices. The agrifoodtech industry is close to US$9 trillion which makes up to 10% of global GDP (Sippel & Dolinga, 2022). The agriculture and food industry have become one of the focal points of tech innovations and financing over the past 10 years. There is a rapid growth in global investment in agri-food tech startups from US$3.1 billion in 2012 to over US$20 billion in 2020 and over US$50 billion in 2021 (AgFunder, 2022a). Currently, United States dominates the global market with the largest investment market share of US$21 billion, followed by China with US$7.3 billion, India with US$4 billion, Germany with US$3 billion and the following countries; United Kingdom, Brazil, Israel and France with over US$ 1.0 billion market share in 2021 (AgFunder, 2022a). Norway has a market share of US$ 0.3 million just below Denmark of US$0.4 million but above Italy and Sweden with US$0.2 million (AgFunder, 2022b). The novel and advancement of agricultural technologies and food solutions coupled with COVID-19 have highlighted the importance of efficient supply chains and improved ways of growing, processing, transporting and selling food to consumers (Fairbairn & Guthman, 2020; Sippel & Dolinga, 2022)

The world population is expected to reach 10 billion by 2050 at a population rate of 77.6 million per year and this will have a high demand for sustainable food (Sippel & Dolinga, 2022). There are many factors affecting the growth of the agrifoodtech industry. Firstly, the growth of agrifoodtech startups is due to increasing availability and use of technologies such as computers, mobile phones and high-speed internet among farmers over the past decades (Fox et al., 2021; Neethirajan, 2020). Currently, more than half of the global population is connected to the internet through computers and mobile phones. This has made it convenient

for farmers to use mobile phones on farms for communication and monitoring of animals and crops. Additionally, there is a rise in the use of data-driven technologies in agriculture including increased speed of data transfer and the development of 4G and 5G on smart phones that offer new opportunities for the agrifoodtech industry. The precision agriculture uses internet of things (IoT), big data, artificial intelligence (IA) and robotics to increase the efficiency of farm activities such as animal feeds, animal movements, crop and animal health, weeds, soil, fertilizer, pest and disease management. However, some technologies must be improved and provided to make agriculture efficient. For example, navigational satellite systems technologies which includes Geographic Information System (GIS), and Global Positioning system (GPS) are used for farmland data collection to effectively map data on soil, farm and wildlife (Liaghat & Balasundram, 2010; Neethirajan, 2020; Rao, 2022). Secondly, there is scarcity of natural resources, particularly land and water. This is followed by a situation in which the demand for agricultural products has exceeded the production capacity of agriculture. Additionally, there are climatic changes with regards to air temperature, atmospheric carbon dioxide and frequent extreme weather which have negatively impacted on agriculture. This has led to the reduction in the quality and quantity of agricultural products, soil degradation, water constraints, increased risk of pests and difficulties faced by farmers in their farming activities (Sundmaeker et al., 2022; Urruty et al., 2016). Thirdly, there is a change in consumer preference regarding how food is produced. Consumers are becoming more concerned about the state of the agriculture and food system and their impact on the environment leading to an increased demand for sustainable, healthy, local, safe and environmentally friendly foods. The new and unmet demands of consumers for such foods have created massive opportunity for investors for the agrifoodtech industry which cannot be achieved currently by the methods used by traditional food system (Sippel & Dolinga, 2022). Fourthly, there is an increase in food waste which has led to an increment in greenhouse gas emissions which can be addressed with agrifoodtech solutions (Dou et al., 2016). Lastly, government policies on sustainability of agriculture and food have aided in the growth of the agrifoodtech industry. An example is from Farm to Fork Strategy which is the core of the European Green Deal and the key to the Implementation of Sustainable Development Goals (SDGs). It aims at building fair, healthy and environmentally friendly food systems and food safety policy in the European Union (Arabska, 2021; Commission, 2020).

Norway is one of the rapid growing start-up ecosystems for agritech in Europe. Agriculture is still prominent in the country's inland and mountains despite its small land mass. Compared

to other western countries, Norway has had less environmental problems which has positively impacted on agriculture. Additionally, farming in Norway is heterogenic with only 3% of the land is cultivated out of the 4% total arable landmass (Daugstad, Rønningen, & Skar, 2006). Despite its small arable farmlands, Norway's entrepreneurs have developed many agritech ideas and solutions that are sustainable and environmentally friendly. Perhaps the relatively small farmland of the country may have led to the optimal use of its available resources. The rapid growing Norwegian's agritech has the propensity to offer modern agriculture solutions to farmers in Europe, America, Asia and the rest of the world.

1.1 Aim and objectives of the study

The aim of the study is to determine how Norwegian Agrifoodtech can succeed internationally, and the focus will be on agritech sector.

The specific objectives are:

1. Overview of the Norwegian Agrifoodtech sector
2. To determine whether size of farms is critical for the company's international success. The technologies or solutions need to fit the needs of the farmers, and the size of the farms may influence several parameters such as the ability to invest, profit increase from automation or better monitoring of the farms.
3. To determine the difference in technology readiness among farmers between regions and countries.
4. To determine the needs and willingness to pay for sustainable agriculture solutions.
5. To determine role of sustainability in the success of an agritech company. There is a lot of focus on sustainability, but are the farmers willing to invest in more sustainable solutions and are the consumers willing to pay for this?

To answer the objectives, an interview was conducted with three Norwegian farmers and four experts with knowledge on Norwegian agrifoodtech industry, companies and farming. The focus was on the agritech companies within biotech-genetic, smart farming, indoor or vertical farming and circular solutions sectors in Innlandet County.

2. Background

2.1 Agritech industry

The improvement of agricultural technology and consumers demands for sustainable and better improved foods among others have contributed to the rise in the global agritech market. Globally, the agritech industry market has grown rapidly over the last ten years from US$1.6 billion dollars in 2013 to US$4.2 billion with 596 funding deals in 2017, US$ 7.6 billion with 1039 funding deals in 2019 and US$19 billion dollars with 1804 funding deals in 2021 (AgFunder, 2022a). The global agritech market is shown in Table 1.

Table 1: Global agritech market for 2021 and 2022 (AgFunder, 2021, 2022a, 2022b, 2022c)

America	Amount in US$ billion	Number of deals (businesses)
United States	10.5	370
China	1.0	48
India	0.9	78
Europe	2.3	408
France	0.472	17
Germany	0.175	12
United Kingdom	0.163	46
Netherland	0.105	14
Finland	0.089	6
Sweden	0.058	8
Australia	0.2	26
Africa	0.032	38
Canada	0.240	53
Brazil	0.067	18
Israel	0.227	29
Japan	0.060	21

The United States, with 41% of the total market of US$10.5 billion dollars and 370 funding deals (businesses), dominates the agritech market and is followed by the Asian countries, China (US$ 1.0 billion dollars with 48 funding deals) and India with US$ 0.9 billion dollars with 78 funding deals in 2021 (AgFunder, 2022a). In Europe, France (US$472 million with 17 funding deals) dominates agritech markets followed by Germany and UK with about US$ 200 million. The agritech market for Australia and Africa are US$0.2 billion with 26 funding deals and US$ 32 million with 38 funding deals respectively for 2021 (AgFunder, 2022c).

The agritech markets for following countries Canada, Brazil, Israel and Japan in 2020 are US$240 million with 53 funding deals, US$67 million with 18 funding deals, US$227 million with 29 funding deals and US$60 million with 21 funding deal respectively (AgFunder, 2021).

The growth of agritech companies in terms of market size and number of funding deals or businesses has been increasing over the decade. The main drivers of growth of the startups are due to growing mobile penetration, increasing in purchasing capability and availability of internet, changing food consumption patterns, upgrades of logistics, improvement of digital infrastructure, reduced cost of components such as mobile devices, data connectivity, sensors and other technologies (Chaudhary & Suri, 2022).

2.1.1 Farming in United States and Europe

[1]In United States, there are over 2 million farms with 98% of farms operated by families including individuals, family partnerships or family corporations. About 86% of the U.S agricultural products are produced by family farms or ranches of which about 25% of the farmers have an average age of 46 years with less than 10 years in business. About 25% of US farm products are exported each year and 36% of the farm operators are women and 56% of all farms have at least one female decision-maker.

[2]In Europe, agriculture is a big employer with about 8.7 million people (4.2%) of total employment in 2020 work in agriculture (crop and animal production). Farming is predominantly a family activity, about nine in every ten (86.1%) people working in agriculture are sole holder farmers. The farm managers are the owners of the farm are typically male and relatively old, about two thirds (68.4%) are male and majority (57.6%) of the farm mangers (both sexes) are at least 55 years of age. About 11.9% are young farmers under the age of 40 years. Three-quarters (76%) of the farm managers of 65 years and older work on small farms. A large share of young farmers manager medium and large-sized farms (31.1%). Few farm managers have full agriculture training, which is about one in ten (10.2%) and the rest (17.5%) have basic training. Young farmers remain scarce.

[1] https://www.fb.org/newsroom/fast-facts

[2] https://ec.europa.eu/eurostat/statistics-explained, Farmers and the agricultural labour force – statistics Nov 2022

The agritech industry encompasses the use of modern technology for plant and animal farming are categories into various sectors based on the combinations of hardware, software, data chains and monitoring. The agritech industry consists of the following subsectors: biotech-genetics (agricultural biotechnology) sector, smart farming, machinery and robotics, Novel farming systems and circular solutions (AgFunder, 2022a; Dhanaraju et al., 2022).

Biotech-genetic sector encompasses on-farm inputs for crops and animals which includes genetics, breeding, microbiome and animal health. The global market for biotech-genetics sector is US$1.6 billion with 173 funding deals in 2020 and US$ 2.6 billion across 209 business deals in 2021. Biotech-genetic solutions potentially increase crop and animal production and improve crop and animal health for global food security. The technologies are less harmful to the environment and human health (AgFunder, 2021). There is increasing demand for animal proteins and high-quality meat, disease-resistant, high reproductive rate livestock breed among farmers for high profitability. North America has the largest market global market share for the biotech-genetic sector. The number of livestock with regards to cattle, pigs, goats and sheep in America and Europe in 2021 is shown in Table 2 below.

Table 2 : Livestock population in America and some European countries for 2021 (FAOSTAT, 2021)

	Livestock (number in millions)			
America	Cattle	Pigs	Goats	Sheep
USA	94	74	3	5
Brazil	225	46	12	21
Europe				
Germany	11	24	0.2	2
Spain	7	35	3	15
France	17	13	1	7
Netherlands	4	11	0.6	0.7
Poland	6	10	0.05	0.3
Sweden	1	1	-	0.3
Finland	0.8	1	0.006	0.1
Norway	0.9	0.8	0.07	2
Belgium	2	6	-	-
Denmark	1	13	-	-

In United States, the number of livestock in 2021 for cattle, pigs, goats and sheep for are 94, 74, 3 and 5 million respectively. In Brazil, the number of livestock for cattle, pigs, goats and sheep are 225, 46, 12, 21 million respectively.

For Europe, France (17 million) has the largest number of cattle followed by Germany (11 million) and Spain (7 million). However, Spain (35 million) has the number of pigs followed by Germany (24 million) and France, Denmark, Netherlands and Poland with 13, 13, 11 and 10 million respectively. The number of goats is high in Spain (15 million) followed by France (7 million) and Germany and Norway with 2 million. The number of cattle, pigs in Norway, Sweden and Finland are about 1 million (FAOSTAT, 2021).

For the fish industry, a total 68,005 metric tons of Atlantic salmon was exported to USA at 74.62 NOK/kg at total value of NOK 5,075 million in 2020. In the same year, 993, 138 metric tons of salmon were exported to Europe at 50.82 NOK/kg at a total value of NOK 50, 469 million. Some of the European countries include France, Denmark, Spain, the Netherlands, Great Britain

[3]The companies in the animal biotech-genetic market include Breed XY, Genus PLC, Viking Genetics, Haystack, RenoOvate Biosciences, Phase Genomics and Danish Genetics. The biotech-genetic animal market competitors in the US include Neogen Corporation, Animal Genetics Inc, Zoetis Inc, and URUS. In Europe the market competitors include Genus plc (U.K), E.W. Group (Germany), Groupe Grimaud (France) Topigs Norsvin (Netherlands), Hendix Genetics B.V (Netherlands), CRV Holdings B.V (Netherlands), DanBre (Denmark), Erogene AI Services (Ireland)

About 70% of wheat is used as food, 20% are used as feed for livestock and 2-3 % for industrial processing (Koop & van Leeuwen, 2017). According to data from the International Grains Council (IGC, 2023) , the estimated wheat production for 2021/2022 was 781 million tons of which more than 545.3 and 147.1 million tons were used as food and feed for livestock respectively. 24.2 million tons were for industrial processing. Wheat production in USA and Europe in 2021/2022 is shown in Table 3.

[3] https://www.pharmiweb.com/press-release/2022-11-15/animal-genetics-market-share-size-worth-usd-1116-billion-at-a-potential-growth-rate-of-925-duri

Table 3: Wheat Production in USA and Europe in 2021/2022 (FAOSTAT, 2021)

	Wheat Production	
	Amount (million tons)	Producer price (USD per tonne)
USA	48.2	268.2
Europe	137.4	
France	36.6	259.5
Germany	21.5	259.7
Romania	10.4	230.7
Spain	8.6	299.1
Bulgaria	7.3	241.8
Sweden	3	237.1
Finland	0.7	255.5
Norway	0.3	422.7

The wheat production for USA and EU for 2021/2022 were 48.2 million tons (at USD268.2 per tonne) and 137.4 million tons respectively. In the Europe, the production and producer price wheat producing countries include France (36.6 million tons at USD259.50 per tonne), Germany (21.5 million tons at USD 259.70 per tonne), Romania (10.4 million tons at USD230.70 per tonne), Spain (8.6 million tons at USD299.10 per tonne), Bulgaria (7.3 million tons at USD241.80 per tonne), Sweden (3 million tons at USD 237.10 per tonne), Finland (0.7 million tons at USD 255.50 per tonne), Norway (0.3 million tons at USD 422.70 per tonne) in 2021 (FAOSTAT, 2021). The production of potato in USA and Europe in 2021 is shown in Table 4.

Table 4: Potato Production in USA and Europe in 2021 (FAOSTAT, 2021)

	Potato Production	
	Amount (million tons)	Producer price (USD per tonne)
USA	18.5	218.7
Germany	11.3	135.4
France	9	218.7
Poland	7	117.8
Netherlands	6.6	159.1
UK and Ireland	5.3	248.7
Belgium	3.9	247.8
Denmark	2.4	236.8
Sweden	0.8	306.7
Finland	0.6	217.6
Norway	0.4	447.3

The production of potatoes in United States in 2021 is 18.5 million tons at USD218.7 per tonne. In Europe the potato production and prices of potato producing countries include Germany (11.3 million tons at USD135.4 per tonne), France (9 million tons at USD218.7 per tonne), Poland (7 million tons at USD117.8 per tonne), Netherlands (6.6 million tons at USD159.1 per tonne), United Kingdom and Northern Ireland (5.3 million tons at USD248.7 per tonne), Belgium (3.9 million tons at USD247.8 per tonne), Denmark (2.4 million tons at USD236.8 per tonne), Sweden (0.8 million tons at USD306.7 per tonne), Finland (0.6 million tons at USD217.6 per tonne) and Norway (0.4 million tons at USD447.3 per tonne)

The global production of fruit and vegetable in 2019 is 2, 010 million tons of which United States produced 55 million tons (25 and 30 million tons for fruits and vegetables respectively). Europe production is 168 million tons (81 and 87 million tons for fruits and vegetables respectively). Spain (31.1 million tons) is the major producer of fruits and vegetables followed Italy (27.5 million tons) and France (20.6 million tons). The production of fruits and vegetables for Norway (0.23 million tons), Sweden (0.34 million tons) and Finland (0.23 million tons) were similar (FAOSTAT, 2019). The main fruits are pome fruits (apples, pears, etc.) at 13.7 million tons, citrus (oranges, lemons etc.) at 10.6 million tons and stone fruit (peaches, nectarines etc.) with 7.3 million tons. With regards to vegetables, production of tomatoes, onions and carrots are 16.5, 6.1 and 4.7 million tons respectively (Eurostat, 2019).

Smart Farming uses sensors, tracking and capturing devices, decision support software, GPS and satellite mapping software for crop and livestock monitoring, precision farming among others. The global market is US$ 890 million with 260 funding deals in 2020. [4]The technologies help farming process to be more efficient and effective and to reduce human effort. Additionally, these technologies improve land fertility and profitability, maximise productivity, reduce cost of farming and facilitate sustainable agriculture. The availability of sensors and concern regarding soil erosion are some of drivers of smart farming growth. United States dominates the smart farming market and some of the companies include Grownetics Inc, Granular Inc, Deere and Company and Conservis. In Europe, the companies include Auroras s.r.l (Italy), GAMAYA (Switzerland) and Aker Solutions (Norway) (AgFunder, 2021; Saiz-Rubio & Rovira-Más, 2020).

[4] https://www.databridgemarketresearch.com/reports/global-smart-farming-market

The farm machinery and robotics sectors involve the use of on-farm machinery, automaton, drone and growth equipment. The global market is $383 million with 105 funding deals 2020.

The novel farming systems entails indoor farms, aquaculture, insects and algae production. The global market for this sector is US$1.5 billion with 116 funding deals as of 2020. The rise in indoor farming is attributed to water efficiency usage, limited land use, decreased labour costs, all year production, and the benefits of controlled farms without climate change. [5]Indoor farming optimizes plant-fertilizing nutrients to provide consumers with fresh and healthy greens. Some of the crops that can grow with indoor farming includes vegetables, herbs, fruits, microgreens and flowers. United States dominates the market with companies including Aerofarms LLC, Agrilution Systems GmbH, BrightFarms Inc and FreshBox Farms. In Europe, the companies dominating the market include Agricool SAS (France), Logiqs B.V (Netherlands) and Urban Crop Solutions BV (Belgium) (AgFunder, 2021; Despommier, 2019).

The circular solution startups address food waste, water waste, plastic alternatives and upcycling. This is a relatively new sector with a global market of US$239 million in 2021. [6]The water and wastewater treatment market are dominated by United States with companies such as Ecolab Inc, American Water, and Aquatech International LLC. In Europe, the market is dominated by companies such as Veolia (France), SUEZ Worldwide (France), Pentair PLC (U.K) and Kemira (Finland). Water is essential natural resource and is used as a critical input in agriculture (AgFunder, 2021; Koop & van Leeuwen, 2017).

2.1.2 Drivers of Growth of Agritech

As explained earlier, the increasing growth in agritech sector is due to the increasing availability of high-speed internet, computers and mobile phones; improvement in technologies to improve the efficiency of agriculture; consumer preference for food that are produced in a safe, sustainable, healthy and environmentally friendly way; the use of

[5] https://www.imarcgroup.com/indoor-farming-companies

[6] https://www.fortunebusinessinsights.com/water-and-wastewater-treatment-market-102632

agrifoodtech solutions to address food waste problems and government policies on sustainability of agriculture and food.

2.1.3 Agritech Solutions and Adoptions by End-Users

The agritech start-ups are growth catalyst and acceleration enablers of the agri-food tech industry. Agritech solutions in agriculture in a sustainable way will offer better, healthier and increment of crop and animal products, crops and animals per hectare, income generation and increase efficiencies (Neethirajan, 2020; Sharma & Mathur, 2018). In agritech, technologies are used to capture and transits real-time data on geo-location using wide range of remote, proximal and contact sensors (Kumar & Ilango, 2018). The data is processed and analysed to determine the soil content, the crop and animal health and the climate. The agritech uses modern information and communication technologies (ICT) which include Internet of things (IoT), geo-positioning systems, big data, automated systems and robots and unmanned aerial vehicles (UAVs, drones) for plant and animal farms (Boursianis et al., 2022; Kamilaris, Kartakoullis, & Prenafeta-Boldú, 2017). The agritech consists of farm management information systems, precision agriculture systems and agriculture automation and robotics.

The adoption of agritech among farmers differ due to economic, environmental, labour impact and adoption readiness by end-users (Balafoutis, Evert, & Fountas, 2020). The impact of the farm size plays a significant role in the investment of farm technology and studies have shown that full-time farmers and farmers with large crops and animal farms are more likely to make investments. The profitability of the technology, farmer's propensity to innovate and regulations of standards of technology use are some of the reasons they are willing to adopt to climate mitigation technologies (Konrad et al., 2019; Moerkerken et al., 2020). As study by (Hu et al., 2022) shows that farmers with large farms in China are more willing to adopt new technologies and spend more time and money on agricultural knowledge. Moreover, many studies show that the adoption rate of the technologies increases significantly from small to large farms (Annosi et al., 2019; Kernecker et al., 2020; Paustian & Theuvsen, 2017). The larger farms are more ready to use the technologies because of higher income generated from the farms and lower investment risks in newer technologies. In addition, large farms have greater access to capital to acquire the technologies (Barnes et al., 2019; Tamirat, Pedersen, &

Lind, 2018). According to (Barnes et al., 2019), cooperative members have better access to investment capital and therefore can investment in the technologies at a lower risk. Additionally, other studies shows that the adoption of agritech among farmers are due to effort expectancy, performance expectancy, facilitating conditions, government support, personal innovativeness hedonic motivation (Shi et al., 2022). Moreover, the need to use and willingness pay for the agriculture solutions among farmers depends on other factors such as land quality, farm size, farmer education and age, farm tenure, risk attitudes and their personal motives (Bishop, Shumway, & Wandschneider, 2010).

The numbers of farmers that uses technology in precision agriculture (PA) varies between countries and regions (Llewellyn & Ouzman, 2014; Lowenberg-DeBoer & Erickson, 2019; Schimmelpfennig & Ebel, 2016). Germany, France, Netherland and UK have high user rates of the PA technologies for crop farming in Europe (Maloku, 2020). For livestock farming, the adoption rate of the technologies such as automatic milking systems (AMS) vary regionally and this depends on their production intensity and operational structure (Eastwood & Renwick, 2020; Gargiulo et al., 2018). Moreover, Nordic countries such as Iceland and Sweden have 30% of AMS adoption rate while Benelux countries such as Belgium, the Netherlands and Luxembourg have 20% of adoption rate. The use of AMS on farms makes work flexible for farmers and improves the animal welfare through better monitoring of the livestock operation (Stræte, Vik, & Hansen, 2017; Vik et al., 2019). Additionally, the use of PA technologies in crop farming is significantly higher United States, Australia, and South America than in Europe (Lowenberg-DeBoer & Erickson, 2019).

2.1.4 Farm Sizes

There are more 608 million farms globally which are mostly (90%) family farms and are mostly (84%) small farms (less than 2 ha). The family farms produce about 80% of the world's food with regards to value. The small farms operate about 12% of the agriculture land of the world and produce about 35% of the world's food. There is a decrease in average size for low and lower-middle-income countries and an increase in farm size for upper-middle-income countries and all high-income countries. The farmland shares increase with increasing income in which 28% of farmland greater than 5 hectares in size are found in low-income countries, 40% in lower-middle-income countries and 85% in the upper-middle-income countries and nearly 99% in the high-income countries. Majority (74%) of the global farms are located in Asia of which China represents 35% and India 24% of the global farms. Nine percent (9%) of

the farms are in Sub-Saharan Africa, 7% in Europe and Central Asia, 4% in Latin America and Caribbean and 3% are located in Middle East and North Africa (Lowder, Sánchez, & Bertini, 2021; Lowder, Skoet, & Raney, 2016)

In Europe, the majority (92%) of the farmers of 10.5 million farmers are family farms. The size of farms varies from country to country. The farm sizes of some selected OECD countries vary among the countries on major agricultural production of crops, dairy, cattle, and pig farming. The countries include Canada, Estonia, France, Germany, Ireland, Italy, Japan, Korea, Latvia, the Netherlands, Sweden, the United Kingdom and the United States. In these countries, the farm sizes have expanded with increasing development of agricultural technologies.

The average farm size of Canada and United States are 493 hectares and 89 hectares respectively. The farm size of Europe is moderate in size with Estonia (132.9 ha), Germany (185.6 ha), England (121 ha), France (84.9 ha) and Sweden (57.8 ha) having relatively high average farm size.

There are more variations in crop production among the countries compared to dairy, cattle, pig farming. North America agricultural productions are mainly associated with large scale production while Europe productions are comparatively moderate in size. The Asian countries such as Japan and South Korea operate relatively very small-scale farms (Bokusheva & Kimura, 2016).

For the EU countries, the physical farm size based on utilized agricultural area (UAA) for small farm, medium-sized and large farms are 2 hectares to <20 hectares, 20 hectares to <100 hectares and > 100 hectares respectively. The standard output of agricultural product (crop or livestock) in euro per hectare or per head of livestock for small farm, medium-sized farms and large farms are EUR 2000 to less than EUR 8000, EUR 8000 to less than EUR 25000 and EUR 25000 to less than 1,00000 respectively. The farms are influenced by economic, structural and social factors. The structure factors include demography such as population growth, urbanization and aging while the socio-economic factors include economic growth, international trades, resource use and competition (Eurostat, 2017; Jacques & François, 2022).

In Africa the farm sizes ranges from less than 5 hectares, 5 to 100 hectares and above 100 hectares for small farms, medium-scaled farms and large farms respectively (Jayne et al., 2016).

In the US, the farm sizes based on annual gross farm income (GCFI) for small, medium-sized and large farms are less than $350,000, $350,000 - $999,999 and $1,000,000 or more respectively. The majority (90%) of the farms are small family farms (1,975,386 farms) contribute to about 15% of the value of the country's agriculture production. Majority (80%) of US agriculture production in value results from agriculture production from mid-size (123,748 farms), large-scale family(43,929 farms) and non-family farms (49,711) (Hoppe & MacDonald, 2013).

The size of the farm may significantly impact on the economic aspects of the farm's operation, which includes profitability. There are changes in farm sizes and specializations over the years in which more small farms are declining in number and the remaining farms are becoming larger and more specialized. The growth and survival of the farms depends on the following factors: age, education and gender of the farm operator, size of the farm, off-farm employment status (Weiss, 1999). Large farms tend to dominate in crop production which is propelled in use of technology to improve efficiency and productivity. Small farms have survived and continue to exist because farm income is supplemented with off-farm income (Hoppe, 2014), The farm sizes, particularly small farms, are important in the growth and sustainability of the agricultural industry. A study of farms in Kansas, USA, illustrates larger farms exhibiting higher productivity and profitability. However, both small and large farms have similar impact on profitability when there is a change in productivity but the impact in terms of trade is much higher for large farm farms (Mugera, Langemeier, & Ojede, 2016). In a study of the dairy sector in USA, the profitability of small and large herds are similar during poor years but in good years, significant higher profit is realized for larger herds (A. Wolf et al., 2016).

Additionally, small farms support high level of biodiversity and promote resilience due to heterogeneity and diversity (Konvicka, Benes, & Polakova, 2016). The small farms also aid to achieve trade-offs in the landscape since they play key role in the prevention of fire and soil erosion by maintain meadows and pastures in mountain areas (Tasser et al., 2007). Additionally, study shows that precision agriculture (PA) technologies in United States are used on farms of all sizes and in all regions. The PA technologies include the use of global position systems (GPS) to direct tractors and other farm equipment, for remote sensing, soil mapping and yield mapping and to guide farm management decisions (Schimmelpfennig & Lowenberg-DeBoer, 2020)

2.1.5 Agtech Solutions for Sustainable Agriculture

The sustainability of a country, community or organisation is commonly conceived as encompassing three interlinked pillars: environmental, economic and social (Purvis, Mao, & Robinson, 2019). This can also apply when characterizing the sustainability of a consumer product or material. Each stage of the life cycle of a product or material (raw materials extraction, materials processing, product manufacture, product use, end-of-life disposal) should be optimised to minimise the impacts within the three pillars and to reach a balance reconciling all aspects in a holistic approach (Eason et al., 2011).

According to Brundtland report (Brundtland, 1987), sustainability is defined as " the ability to meet the needs of the present without comprising the ability of the future generations to meet their own need." In a more pragmatic way, sustainability can be defined as improving a system's productive performance without depleting the resources that it depends for its future performance (Jones, Kemp, & Takahashi, 2011; Turner, Pearce, & Bateman, 1993).

The United Nations promotes the use of sustainable agriculture in support of the Sustainable Development Goal 2, 12 and 13 (SDG 2, 13, 15). The SDG 2 aims at creating a world free of hunger by 2030 while SDG 13 aims at taking urgent actions to combat climate change and its impact. The SDG 15 aims at protecting, restoring and promoting the sustainable use of terrestrial ecosystem and sustainably manage forest, combat densification, and stop and reuse of land degradation and stop biodiversity loss (Kroll, Warchold, & Pradhan, 2019).

Sustainable agriculture ensures that the agricultural system is productive continuously in the future with the aim of using a healthy environment, economic profitability, social and economic equity in the food production process. The demand for sustainable agriculture are rapidly increasing as a result of stress on the environment, water scarcity, soil depletion, insufficient land use and the emissions of greenhouse gases (Santiteerakul et al., 2020). Agritech solutions in agriculture help protect and enhance the natural resource base as well as increase productivity of healthy, safe foods more efficiently and effectively. The agritech innovations such as farm robotics are used in the monitoring farms and application of minimum quantities of input such as water, fertilizers and pesticides to target areas of the farm (Lakshmi & Corbett, 2020).

The European Green Deal aims at offering a sustainable European Union's economy through a fair and inclusive transition process for all citizens (European Commission, 2019). The

Green Deal also aims at a clean and climate friendly economy by means of green investments in environmentally friendly technologies (European Commission, 2020). The Deal also intends to establish a resource and energy efficient economy that is competitive to minimise waste and greenhouse gas emissions and to maintain materials, products and resources in a closed loop as long as possible over time (Stahel, 2016). Apart from being functional and cost efficient, new material or product should also be safe and sustainable. This will ensure compliance with regulations, acceptance by consumers and users and, consequently, a fast and successful access to the market (Anastas & Eghbali, 2010).

2.2 Needs and willingness of farmers to pay for technology

Many startup companies developing sustainable solutions for the economy including agriculture with the aim of achieving economic growth (Hahn, Spieth, & Ince, 2018; Kuckertz, Berger, & Gaudig, 2019). The main determinants of suitable product acquisition decisions are responsibility and perceived consumer value. Although agritech shows significant economic growth, startups fail before reaching the first 5 years due to lack of marketable research to recognize the target end-users. Moreover, entrepreneurs lack necessary knowledge of approved and validated business model. (Velter et al., 2020; Wolfert et al., 2017; Zobnina, 2015). Entrepreneurs need models that present phases to develop innovative products with a clear understanding of customer value (Mansour & Barandas, 2017). There are difficulties in measuring value and market acceptability and the agriculture sector is traditionally conservative which poses barriers to innovative products particularly to farmers ((Lacombe, Couix, & Hazard, 2018; Welo, Olsen, & Gudem, 2012).

For agritech companies to be successful, some approaches that emphasizes on creation of customer value and customer development is required ((Bortolini et al., 2021; Edison et al., 2018). Farmers need to understand the importance of purchasing products that reduce or eliminate impacts on the barriers. Moreover, barriers to awareness change of environmentally friendly technologies can be reduced by providing information to customers to aid them migrate to a more sustainable alternative (Nguyen et al., 2020). A study by Eldesouky et al. (2019), indicated that certified labels promote the buying of sustainable products by consumers. Additionally, most consumers in Italy, Germany and Netherland have preference and willing to pay for sustainable food produced from agritech solutions. Additionally, most

of customers, including environmentally concerned customers, are more likely to pay premium for sustainably produced food products (Ali, Ang, & Van Der Fels-Klerx, 2021)

2.3 International Market Entry Strategy

A company's international business and dependence on the international market for survival and growth is ever increasing and therefore decision-making for internationalization is important. The international or foreign market strategy of a company lies in the selection of markets and the entry mode of each market (Koch, 2001). According to Mintzberg (1978), foreign market entry strategy involves "a pattern in a stream of decisions" that helps a company enter an international market and growth and become profitable (Mintzberg, 1978). The market segment selection process involves stages such as identification, in-depth screening and selection. The market is evaluated based on a range of selection criteria including market size, growth, level of economic development, environment factors, competition, market-based factors, market knowledge and information (Koch, 2001; Sakarya, Eckman, & Hyllegard, 2007). International market entry is an institutional arrangement for the entry of company's products, technology, human skill, management and other resources into the foreign country (Root, 1994). There are several classification of foreign entry modes but broadly classified as either contractual, investment/equity or export modes (Root, 1994). The main generic entry mode includes the following:

- Export: it involves the sales of the firm's products or technologies that are produced in the home market and sold in the foreign market directly or through entity on the foreign country such as sales agents or distributors.
- License and Franchise: This is a formal permission and right offered to a firm or agent located in the foreign market to use the company's proprietary technology or other knowledge resources in return for payment.
- Alliance: This involves an agreement and collaboration between a firm in the home market with another firm in the foreign country to share activities in the foreign country
- Joint Venture: This entails shared ownership of an entity in the home foreign country by the two firm partners in the home market and the foreign market.
- Wholly Owned Subsidiary: This the complete ownership of an acquired or developed entity located in the foreign market by the a firm's location in the home market to

develop or perform value addition to the sale of products or services in the foreign market (Johnson & Tellis, 2008).

2.4 Norwegian Agriculture

In Norway, agricultural land makes up 3.5% of its total land which is equivalent to about 15,869 dekar in 2022. The size of the farms has also increased over the years and more of farms are medium sized farms of 50-300 dekar and large farms above 300 dekar in 2022 as shown in Table 4. Currently there are 37,682 farms and majority (65%) of the farms are animal farms followed by 31% of plant farms (SSB, 2022).

Table 5: Number and sizes of farms (SSB, 2022)

Year	Under 20 dekar	20 - 40 dekar	41 - 81 dekar	81 - 121 dekar	121 - 202 dekar	202 dekar and more
1969	88,481	42,240	17,938	3,922	1,900	496
1979	62,017	32,716	21,632	5,652	2,576	709
1989	37,031	24,969	25,330	7,928	3,266	858
1999	14,517	16,720	22,286	10,367	5,273	1,577
2009	6,273	8,363	13,867	8,797	6,988	3,400
2019	5 404	6,431	9,977	6,326	6 179	4,773
2022	5,598	6 107	9 145	5,806	5,883	5 143

Additionally, majority of the farms are medium sized farms (56%) of 20-99 dekar, followed by large farms (29%) of above 100 dekar and small (15%) below 20 dekar in 2022. The full time farmers have an average income of 236,000 NOK in 2021 (US$ 22,050) (SSB, 2022)

Norway has strengthened its food security by incorporating plans for sustainable food systems. The plans are based on the Sustainable Development Goals, which were formed by the UN in 2015. The Norwegian government aims at using extensive knowledge of sustaining farming within plant, animal and fish farming to increase sustainability, climate adapted food production and increased production from agriculture (Regjeringen, 2019). Moreover, as part of Norwegian governments five-year plan, the government wants to promote sustainable food systems by strengthening institutions relationships and adapting technologies for sustainable and increased production of food in cooperation with farmers and actors locally, nationally and globally. The government will provide assistance in making digital solutions and adapted

technologies available through smart farming that will reduce greenhouse gases, maintain biodiversity, reduce land and soil degradation and deforestation (Regjeringen, 2019c)

The rise of the agritech companies in Norway is associated with the growth in the Norwegian economy leading to increasing entrepreneurship and thriving startup ecosystem (Hub, 2019). Additionally, the growth of Norwegian agritech companies is attributed to support from pro-active government and private actors. For instance, Innovation Norway is a governmental organization that provides funding for new business ideas while innovation companies such as Klosser Innovation, Aggrator, and T-lab promote the expansion of the industry. Moreover, many Norwegian startups have the following key values of transparency, innovation, and sustainability which contribute to their growth. The Norwegian companies also have competitive advantages which includes effective use of resources, healthy animals, low use of antibiotics, low use of pesticides and competent farmers.

The development of new technology in agriculture by tech entrepreneurs has been rising in Norway despite having small agricultural lands (Torud & Iversen, 2018). The green shift entails the restructuring of society towards renewable resources, effective use and re-use of materials, reduction in greenhouse gases, and use of products and services that are less detrimental to the climate and environment (Karlsson & Hovelsrud, 2021; Wiborg & Bjørkhaug, 2011). Norwegian agritech offers solutions that contribute to the green shift economy and Norwegian farms have the potential of leading the agriculture sector with green shift and sustainable practices. The Norwegian agritech companies have competitive advantages of effective use of resources, health animals, less use of antibiotics and pesticides and competent farmers with technological knowledge and skills for the technologies (Landbruk, 2018b;Chaudhary, 2019)

3. Material and Methods

The data and information were collected from primary, secondary, tertiary grey sources that were accessible. The primary sources offered first-hand, reliable and accurate data and information. The secondary sources provided a background and in-depth knowledge of the topic while the tertiary sources provided information about the companies that are understudy, the agritech industry and market trends.

3.1 Data collection

3.1.1 Primary data

Primary data were collected by conducting semi-structure interviews through Zoom using interview guidelines with Norwegian farmers and experts with requisite knowledge and number of years of experience of Norwegian agritech companies, businesses, industry, market and farming. A purposive sampling including snowball sampling was used to obtain the participants. Many of the participants consented to be anonymous, so the names of the participants and organisation are kept anonymous. There were 7 participants consisting of 3 Norwegian farmers and 4 experts (manager or leaders with knowledge on Norwegian farms, Norwegian agritech industry and businesses.

The 3 Norwegian farmers with many years of experience in the use of agritech solutions and are as follows:

- Participant 1 (Farmer with a farm that uses automatic milking and feeding technology to produce milk and poultry)
- Participant 2 (Farmer with a farm that uses GPS solutions for tractors and farm equipment produce grass and grain)
- Participant 3 (The farmer with a farm that produces grass and has once owned and managed livestock farms)

The 4 organisation managers or leaders with knowledge and expertise in Norwegian farms, agritech industry and business are as follows:

- Participant 4 (manager at agritech and foodtech organisation)
- Participant 5 (leader at an academic institution)

- Participant 6 (leader at an academic institution)
- Participant 7 (leader at an academic institution)

3.1.2 Secondary data and Grey literature

Relevant data were collected from published research articles, review articles, company and government websites. The databases and search engines (Oria, ScienceDirect, Springer Link, Google Scholar) were used in the collection of literature using keywords such as "agrifoodtech industry review", "agritech industry review", "agritech in Norway", "global agritech", "farming in Europe", "sustainable agriculture technology", "agritech companies in Norway", "types of farm lands", "adoption of agritech", "needs and willingness to pay for agritech solutions", among others.

Grey literature from company and industrial report, government reports and statistics on agrifoodtech and agritech in America, Asia, Europe and Norway offered information on details of company's technology, competitors, among others.

3.2 Data Analysis

The collected data were analysed, and the following tools were used to support some of the discussion related to the aim and objectives of the studies; market segmentation, SWOT analysis, PESTLE analysis, PORTER's 5 forces, to provide both external environment information (knowledge about the state of international market) and internal environment information (information of the Norwegian agritech companies' and industry's strengths and limitations).

3.2.1 Market Segmentation

Markets have different customers with different needs and behaviour. Market segmentation entails classifying the customers within a market that share related needs and establish related purchasing behavioural patterns. Market segmentation complement the customers with products or technology that satisfy their individual set of needs and behaviour pattern. It allows business to focus on their consumers' behaviour and purchasing pattern effectively to achieve highest return on investment (ROI) in turn of its marketing and sales expenses. Market

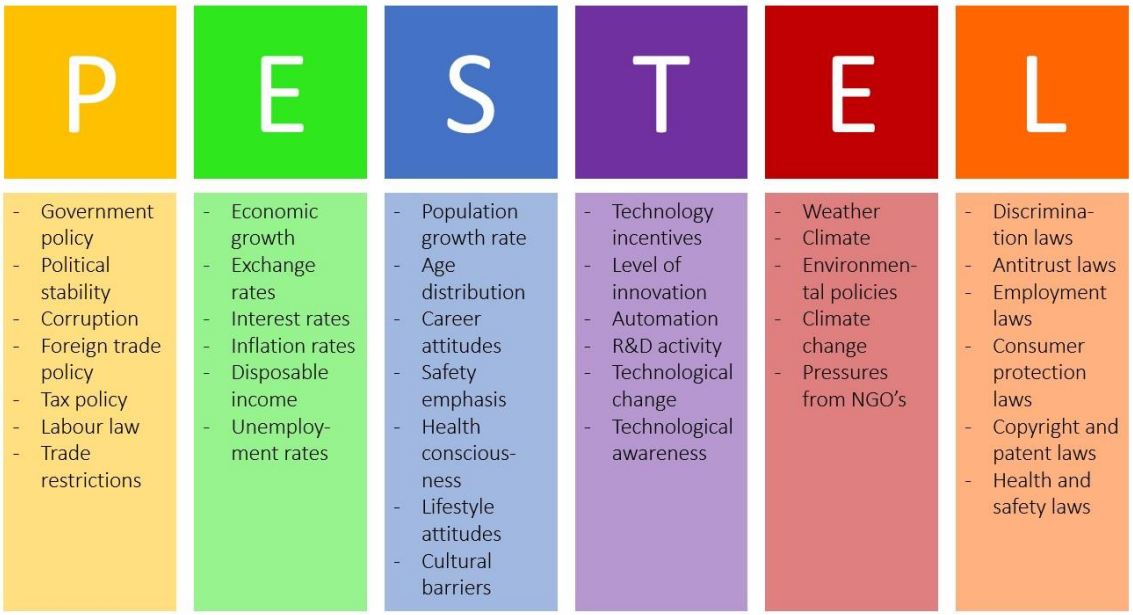
segmentation includes geographical (locations), demographical (age, nationality, occupation, salary etc), behaviour, psychographic (personality, values, interests, lifestyles etc). Market segmentation aid companies to develop market positions, customer commitment and pricing plans in order to strategically succeed in a global market (Kotler, 2001; Martin, 2011).

3.2.2 SWOT Analysis

SWOT analysis is tool for strategic planning. The strength, weaknesses, opportunities and threats (SWOT) analysis is tool that a company uses to evaluate its position in the market by analysing the internal and external environment of the company during time of indecision (Rozmi, 2018). The strengths and weaknesses identify the internal considerations while the opportunities and threats identify the external considerations of the company. The strengths represent the internal elements of the company that facilitates reaching its goals while the weaknesses represent the internal elements that interfere with the success of the company. The Opportunities are external the elements that help the company reach its goals. They also help the company to address gaps and initiate new activities. The threats are the aspect of the company's external environment that are barriers or potential barriers to reaching the goals (Aldehayyat & Anchor, 2008; Benzaghta et al., 2021) A SWOT analysis is one of the tools companies can use to develop marketing strategies in a way that drive optimal business growth and profit (Novicevic et al., 2004).

3.2.3 PESTLE Analysis

PESTLE (PESTEL) analysis is a framework that is used to analyse and monitor how external macro-environmental factors impact the performance of a company. PESTLE is an acronym for Political, Economic, Social, Technological, Legal and Environmental factors that affect a business or a company (Song, Sun, & Jin, 2017). The framework helps companies assess the impact of these external factors on a business when entering foreign market. The framework is used together with SWOT analysis and Porter's 5 forces to clearly understand the status of the foreign market and related internal and external factors.



[7]*Figure 1. PESTLE ANALYSIS*

Political factors – These factors elaborate on how government intervenes in the economy and the factors include tax policy, business policies, political stability or instability, labour law among others. Companies' knowledge of the political factors is important since these factors that impact their business, production and marketing of their products or technologies.

Economic factors – These factors include economic growth, inflation rate, exchange rate and interest rates. These factors affect the purchasing power customers, demands for products and pricing of products or technologies.

Social factors – These factors include lifestyles, population growth rate, health consciousness, age distribution, career attitudes and emphasis on safety, cultural aspects, literacy rate among others. These factors are important in targeting the potential group of customers with products and technologies.

Technological factors – These factors include research and development (R&D) activity, current technological status with regards to data storage, internet, security, automation, robotics, breeding technology, information and technology, technology incentives, and rate of

[7] https://www.business-to-you.com/scanning-the-environment-pestel-analysis/

technological change among others. These factors play an important role in determining whether or not to enter a specific market or launch a product or technology.

Legal factors - These factors include legal aspects such as employment law, consumer protection laws, Copyright/Patent laws, health and safety legislations which differ for regions and countries. Knowledge of the legal aspect of regions and countries is important companies in deciding to enter a specific market or not.

Environmental factors - These factors include sustainability, pollutions, recycling of products which have impact on the growth of a company. Many companies are sustainable products or technologies that reduces the emission of greenhouse gases or causes less damage to the soil and water and the environment as whole.

The knowledge of these factors helps companies to appreciate the status of the market in a specific region or country and align their products to meet the requirements hence saving money and time.

SWOT/PESTLE analysis can be employed in cases where the systems examined are complex and the external parameters has to be analysed extensively (Hill & Westbrook, 1997).

3.2.4 Porter's 5 Forces

The Porter's Five Forces analysis a framework that helps company analyse level of competition in a certain industry and it useful in entering a new industry sector. According to the framework the state of competition is dependent on five forces: the bargaining power of suppliers, bargaining power of buyers, threat of new entrants, threat of substitute products or services and the existing industry rivalry as shown in Figure 2. The profit of an industry and its attractiveness is determined by the collective strengths of these forces (Porter, 2008).

[8]*Figure 2. Porter's 5 forces*

Bargaining power of suppliers

This analyses the power and control a company's supplier to potential raise its prices or reduce its quality of purchased goods or services which will lower the industry's profitability. The supplier power is determined by the concentration of the suppliers and availability of the substitute suppliers. The fewer suppliers there are in an industry, the more power they have. The sources of supplier power also include the switching costs of the companies in the industry, the strength of their distribution channels and the level of differentiation in product or service the supplier delivers (Porter, 2008).

Bargaining power of buyers

This force analyses the extent to which the customers can put company under pressure which affect customer's sensitivity to price changes. The customers have much power when they are few and have alternatives to purchase from other company. However, the buying power of

[8] https://www.business-to-you.com/porters-five-forces/

customer is low when act independently and company's product is very different from its competitors. Companies can reduce buyer power by differentiating their products and services.

Threat of New Entrants

Companies enter new industry or market to gain market share and bring new capacity the industry. The threat depends on the barrier to enter an industry and the higher the barrier to entry the lower the threat to existing companies. Some of the barriers to entry include high customer loyalty for existing brand, large capital requirements, government policies among others.

Threat of Substitute Products

The availability of substitute products increases the propensity of customers to switch to alternative products. Customers may willingly switch to other products that offer similar value but lower price. This ultimately reduces the industry profitability and therefore threat of substitute products should be considered when a company evaluates the industry's attractiveness.

Rivalry Among Existing Competitors

The extent of intensity of competition in an industry is determined by number of existing competitors and what each competitor does. Many competitors that are relatively equal in size and power will lead to a high rivalry, slow industry growth and enable customers to easily switch to competitors offering with little cost. High rivalry causes competitors to engage in advertising and pricing competition which ultimately reduces and limit profitability of an industry (Porter, 2008).

4. Results

4.1 Overview of Norwegian Agrifoodtech Sector

.The agrifoodtech sector of Norway consists of the agritech and the foodtech industry as shown in Table 6. The agritech industry include companies that produces the following:

- Smart farming solutions (Soilmate, Adgir, 7Senses, Findmy, OSID),
- Biotech-genetics solutions (Geno As, Norsvin As, Graminors As)
- Robotics and machinery (Kilters As, Orkel, Saga-Robotics, Soil Steam)
- Indoor/vertical farm (Green Cap Solutions, Avisomo, Lille-Greens)
- Circular solutions (N_2Applied, Hias How2O, Antech Biogas)
- New Bioresources (Artic Biosciences, Invertapro, Norinsect).

The foodtech companies in the country includes Natura, Tine and Hoff .

The agrifoodtech in Norway consist of 108 companies based on information found from the companies' website on the internet, however, there could be more companies. The agritech companies are distributed over the country but most frequent in Innlandet, Trøndelag, Oslo, Akershus and Rogaland counties.

Table 6: An overview of agritech companies in Norway

	Name of Agrifoodtech companies	Purpose	Founder and CEO	No of Employees (2021)	Turnover (million Kr) (2021)	Export	End-Users	Address
SMART FARMIING								
1	Yara Norge (SMB) Akershus County	Fertilizer and chemical company that produces, distributes and sells nitrogen-based fertilizers	Svein Tore Holsether, CEO,	799	16,194	Norway, Europe, Asia, Africa and USA, Brazil	Crop farmers	yara.no/
2	Yara N-sensor (SMB)	Produces sensors and precise fertilization technology to increase crop yield and profitability.	Svein Tore Holsether			Norway, UK	Crop farmers	yara.no
3	Felleskjøpet (Agri) (SMB) Akershus County	Agricultural cooperative that serves as a retailer of agricultural operating equipment including animal food and seeds	Svenn Ivar Fure, CEO	2519	13,231	Norway	Plant and animal farmers	felleskjopet.no
4	OS ID (SMB) Innlandet County	Produces tracking technology for the identity of animals and collecting data on animals' health, welfare and productivity.	Torgeir Svae (CEO)	38	103	Norway, Nodic countries (Denmark, Finland, Sweden)	Animal farmers	osid.com
5	Nofence (SMB) Møre og Romsdal County	Produces world's first commercial virtual fencing solutions for animals, where animals are controlled by GPS-collars and an app	Oscar Hovde, Founder	50	61.4	Norway,	Animal farmers	nofence.no
6	Mimiro (Startup) Akershus County	Develops and produces digital solutions for food growth and production process	Christian Schøyen. (CEO)	29	40	Norway	Crop farmers	mimiro.no
7	Findmy (Startup) Innlandet County	Produces satellite tracking device for animals	Marit Mjøen Solem	10	22	Norway	Animal farmers	findmy.no
8	Farmforce AS (Startup) Vestfold County	Farmers app for the agricultural supply chain (a cloud-based digital platform designed for off-takers and cooperatives to capture and store farmer information)	Anne Joru Aas, (CEO)	22	15	Norway, 4 continents, 32 countries	Plant farmers,	farmforce.com
9	7Sense (Startup) Rogaland County	Delivers smart condition monitoring systems (sensors) to help farmers get more control , higher yield and better time management	Frode Stensaa (CEO)	6	6	Norway, Germany,	Plant farmers	7sense.no
10	Agdir (Startup)	A sensor company that produces technology for watering farms. It provides farming decisions via an online platform.	André Skoog. Bondevik, (General Manager)	5	3	Norway	Plant Farmers	agdir.no
11	Aviant (Startup) Trøndelag County	Deliver end-to-end drone services for transport of logistics	Participant 6 Erik Matsson Fagernæs	22	3	Norway, Sweden	Crop and animal farmers	aviant.no

	Name of Agrifoodtech companies	Purpose	Founder and CEO	No of Employees (2021)	Turnover (million Kr) (2021)	Export	End-Users	Address
			(co-founder and CEO)					
12	Moleda (Startup) Akershus County	Molena sterilises plant material using precise temperature-controlled steam to eradicate pests, diseases and fungi		2	3	Norway	Crop farmers	moleda.nl
13	Digifarm AS (Startup) Innlandet County	An agritech startup that detects the world's most accurate field boundaries through using super-resolution satellite imagery	Nils Helset, (Co-founder & CEO) Konstantin Varik, (Co-founder & CTO)	2	2	Norway, United State, Brazil, Italy, Thailand, Germany, Australia, Canada, Belgium, Poland, France, UK, Mexico, Austria	Animal and plant farmers	digifarm.io
14	Biodrone (Startup) Trøndelag County	Produce drones for various applications in agriculture, pesticides spraying, spreading of fertilisers and seeds	Atilla Haugen (CEO)	6	2	Norway	Plant farmers	biodrone.no
15	Agrodrone (Startup)	Produces multispectral-sensor drones for data collection on plants health and soil conditions on farms for fertilization, spraying etc in efficiently and environmentally friendly way	Erik Løvm (CEO)	1	1	Norway	Crop farmers	agrodrone.no
16	Dimensions Agri Technologies (DAT) (Startup) Akershus County	Advanced sensor company for agri sprayers. The DAT sensors enables the farmer to spray only where needed, reducing herbicide use and environmental impact, costs and at the same time increase yields	Kristian Kaurstad Morthen, (CEO)	11	1	Norway, Spain, Portugal, Denmark, Sweden, Czech Republic, Slovakia	Crop farmers	dimensionsagri.no
17	Agrosense AS (Startup)	Sensor company that monitors fields drones and satellites and use data to optimize irrigation, fertilization and pesticide usage	Einar Vastveit (CEO)	1	0.5	Norway	Fruit and vegetable farmers	agrosense.no
18	Soilmate (Startup) Vestfold County	Sensor company that helps producers to till, sow, set and plant seeds with automation of the work documented	Ole Kind (CEO)	1	0.5	Norway	Plant farmers	soilmate.no
19	Farmable (Startup)	Farm management software for fruits and vegetable crops (vine and orchard)	Participant 6 Petter Blikom, CEO and co-founder	8	0	Norway, Australia, New Zealand, Spain, Germany,	Farmers of greens and fruits	farmable.tech

	Name of Agrifoodtech companies	Purpose	Founder and CEO	No of Employees (2021)	Turnover (million Kr) (2021)	Export	End-Users	Address
20	Sensonomic (Startup) Vestland County	Creates computer simulations of agricultural systems to optimize yield, improve operations and increase resilience	Anders Gundersens (founder)	6	0	Norway, Spain, Portugal, Italy, Latin America	Plant farmers	sensonomic.com
21	Monil AS (Startup) Akershus County	Produces commercial livestock tracking, virtual fencing and grazing solutions for animals and collect data on animals' health, welfare and productivity	Torstein Nesse (CEO)	12	0.54	Norway	Livestock (cattle) farmers	Monil.com
22	Fjøssystemer AS (SMB) Innlandet County	Produces barn systems including Automatic Milking Systems (AMS)	Øivind Skurdal (CEO)	41	135	Norway	Livestock (Cattle, pigs) farmers	fjossystemer.no
23	Greenfarmer AS (Startup) Vestfold County	Produces green energy solutions and Precision Agriculture solutions	Marius Hamid Kristiffersen (CEO)	1	0.05	Norway	Crop (Grass and grain)farmers	Greenfarmer.no
Biotech-Genetics								
24	Geno AS (SMB) Innlandet County	Breeding company that develops and breeds the NRF(Norwegian Red Fe) population in Norway. It distributes cattle genetics in the form of semen and embryos to cattle producers locally and globally	Kristin Malonæs (CEO)	203	395	Norway	Animal (cattle) farmers	geno.no
25	Norsvin AS (SMB) Innlandet County	Specialises in developing and breeding of pigs	Per Inge Egeland	101	203	Norway	Pig farmers	norsvin.no
26	Graminor (SMB) Innlandet County	Develops and breeds an array of plant varieties for the agriculture industry that is proportionate to the Nordic climate	Kristin Borresen (CEO)	39	80	Norway, Sweden, Finland, Baltic countries (Estonia, Latvia, Lithuania)	Farmers that produce greens, potatoes, cereals, fruits, berries	graminor.no
27	Aquagen (SMB) Trøndelag County	Breeding company that produces fish eggs with best genes to ensure efficient, safe and responsible production of fish	Knut Røflo (CEO)	164	672	Norway, Chile, Scotland	Fish farmers	aquagen.no
28	Patogen AS (SMB) Møre og Romsdal County	Specialize fish health and in the prevention of infection and disease of fish for high production and profitability	Jørn Ulheim (CEO)	49	91	Norway	Fish farmers	patogen.no
29	TYR (Startup) Innlandet County	Breeding company for meat breeds of Norwegian suckler cow producers (reindeer breeds and cross breeds)	Per-Sigve Lien (CEO)	14	27.5	Norway	Animal (cattle) farmers	tyr.no

	Name of Agrifoodtech companies	Purpose	Founder and CEO	No of Employees (2021)	Turnover (million Kr) (2021)	Export	End-Users	Address
30	Cryogenetics AS (Startup) Innlandet County	provider of technology and services for the preservation of aquatic genes for research, conservation and the aquaculture industry.	Eli Sætersmoen (CEO)	23	21	Norway, Canada, Chile, USA	Fish farmers	cryogenetics.com
31	Spermvital AS (Startup) Innlandet County	Developed artificial technology for insemination of animals. Developed technology that extends the life spermatozoa after insemination	Nils Christian Steig, Managing Director	14	19	Norway, Spain, Switzerland, Romania, Poland, Israel, Portugal, Italy, Iceland, Holland, UK, Germany, Chile, Belgium, Greece, Croatia	Animal farmer (cattle, pigs etc)	spermvital.com
32	Biobank AS (Startup) Innlandet County	National biobank for fish, livestock and plants	Sigbjørn Gregusson (CEO)	7	13.3	Norway	Animal and plant farmers	biobank.no
33	Aninova (Startup) Innlandet County	Breeding company that specializes in animal genetics	Marte Wetten (General Manager)	2	1.4	Norway	Animal farmers	aninova.no
34	Artic Red (Startup) Innlandet County	Breeding company that specializes in the breeding and commercial production of artic char roe or fry	Frank Larsen (CEO)	3	2	Norway	Fish farmers	
ROBOTICS AND MACHINERY								
35	Kilter AS (Startup) Akershus County	Produces automated agriculture robots for sustainable farming/ precision farming	Anders Brevik (CEO)	18	1	Norway	Farmers of greens	kiltersystems.com
36	Orkel (SMB) Trøndelag County	Manufactures and commercializes innovative agriculture machinery	Jan Olav Fagerholt, CEO	122	229	Norway	Crop farmers	orkel.no
37	Herde Industrier (SMB) Rogaland County	Develops and commercializes innovative agriculture machinery (for fertilizing and tillage etc)	Atle Årsland (General Manger)	37	133	Norway	Plant farmers	herdeindustrier.com
38	Kværnland (SMB) Rogaland County	Company that develops, produces and distributes innovative agricultural machinery and services	Stian Mundal Grøndahl (Managing director)	70	210	Norway Denmark, Germany, France, Netherlands, Italy, Russia and China, USA, UK	Crop farmers	no.kvernelland.com
39	Adigo (startup) Akershus County	Company that Develops agriculture technologies for farms. It has developed robots that take measurement and map the amount of	Øyvind Overskeid (Managing director)	28	36	Norway,	Crop Farmers	adigo.no

	Name of Agrifoodtech companies	Purpose	Founder and CEO	No of Employees (2021)	Turnover (million Kr) (2021)	Export	End-Users	Address
		nitrogen gas released soils of farm fields						
40	Saga Robotics (Startup) Oslo County	Use of technology and robotics to increase agricultural yields and reduce waste, farming-as-a-service (FaaS) model. It develops autonomous robots capable of performing a wide variety of agricultural operations)	Anne Dingstad, (CEO) Pål Johan From, (Co-Founder & CPO)	19	17	Norway, UK, Germany, USA,	Farmers of greens	sagarobotics.com
41	Vepak (Startup) Akershus County	It produces and commercializes and automated firewood packaging technology for production of firewood in bags	Ole (Managing director)	1	13	Norway	Plant and animal farmers	vepak.no
42	Soil Steam (Startup) Vestfold County	Develops technology and equipment for chemical-free treatment of soil	Oddbjørn Bergem, (CEO)	16	4.5	Norway	Farmers	soilsteam.com
43	Autoagri (Startup) Trøndelag County	Develops and manufactures autonomous implement carriers		5	0.9	Norway	Farmers of greens and fruits	autoagri.no
INDOOR / VERTICAL FARMING								
44	Greencap Solutions Rogaland County	Produces technology that removes carbon dioxide and technology for fully closed greenhouse systems, resulting in increased yield, greater resource efficiency and year-round production	Ørjan Aukland (CEO)	8	13.5	Norway	Vertical and indoor farmers	greencap-solutions.com
45	Avisomo (Startup) Innlandet County	Produces vertical farming solutions that reducing costs and increasing flexibility for vertical farmers	Martin Molenaar (CEO)	10	1.2	Norway	Farmers of greens and fruits	avisomo.no
46	Tåsen Microgreen Vestfold County	Produces indoor farm solutions	Shima Shaysteh (General manager)	0	1.5	Norway	Farmers of fruits, vegetables, leafy greens	urbantlandbruk.no
47	Onna Greens (Startup)	It Produces sustainable and transparent food system. It produces plants which are farmed indoors in a fully controlled environment, vertical farming. Technology delivery company for vertical farming	Kristina Løfman	32	0	Norway	Farmers with Vertical farming and greens	weareonna.no
48	Lille Blad (Startup)	Produces indoor farming solutions	Håkon Tillier (Co-founder)	0	0.029	Norway	Vertical and indoor farmers	Lilleblad.com

	Name of Agrifoodtech companies	Purpose	Founder and CEO	No of Employees (2021)	Turnover (million Kr) (2021)	Export	End-Users	Address
49	Biogrid (Startup) Akershus County	Produces intelligent growth modules and solutions for vertical farming industry	Erling Loken Andersen, August Flatby (Founders)	0	0	Norway	Vertical farmers	
50	Byspire (Startup)	Produces high-tech vertical farming systems		0	0.004	Norway	Vertical farmers	facebook.com/byspire/
51	Jor Greentech (Startup) Oslo County	Produces automated indoor/vertical farming solutions	Arne Nicolai Schaanning Larsen (General Manager)	1	1	Norway	Vertical and indoor farmers	Jor.no
52	Biologisk AS (Startup) Vestfold County	Produces solutions for indoor/vertical farms	Silje Stenstad Nilsen (CEO)	1	1.1	Norway	Vertical and Indoor farmers	biologisk.no
Circular Solutions								
53	Biosirk (SMB) Innlandet County	produces protein raw materials for livestock feed and risk raw materials for meat bone meal and fat is	Lars Aashammer (Managing director)	83	446	Norway	Animal farmers	biosirk.no
54	Norilia (SMB) Vestfold County	Produces, refines and sell ingredients for animal health, nutrition, feed and products in sustainable and profitable way from surplus products from meat and egg industry	Morten Sollerud (CEO)	56	370	Norway	Animal farmers	norilia.no
55	Sirkula (SMB) Innlandet County	Sirkula uses technology to manage waste in a sustainable way	Grethe Olsbye (CEO)	127	219	Norway	Animal and fish farmers	sirkula.no
56	Biokraft (SMB) Trøndelag County	Produces biofuel from by-products from plant and from forest mass and waste, and seaweeds	Håvard Wollan (CEO)	20	108	Norway	Animal and plant farmers. Managers of companies	biokraft.no
57	Miljøfôr (SMB) Innlandet County	Produces animal feed from residues from the food industry in a sustainable way	Michel Fjeldstad (managing director)	24	86	Norway	Animal farmers	miljofor.no
58	Ecopro (SMB) Trøndelag County	Produces technology that is environmental-friendly and use organic waste for green energy and biofertilisers products	Tore Fløan (CEO)	10	49	Norway	Plant farmers	ecopro.no
59	N2 Applied (Startup)	Produce technology that reduces emissions from food production and turns organic waste into effective fertiliser	Carl Hansson (CEO)	40	32	Norway, UK	Plant farmers	n2applied.com
60	Hias How2O (Startup) Innlandet County	Produces technology for the treatment of water and wastewater. It removes organic matter, nitrogen and phosphorus biologically	Anders T. Øfsti (managing director)	2	21	Norway	Plant and animal farmers. Managers of food companies	hias.no

	Name of Agrifoodtech companies	Purpose	Founder and CEO	No of Employees (2021)	Turnover (million Kr) (2021)	Export	End-Users	Address
61	Antec Biogas (Startup) Vestfold County	Produces biogas technology that mimics the cow digestive system, combining plug-flow anaerobic digestion with high surface area biofilm	Eirik Gundersen (CEO)	25	20	Norway	Plant and animal farmers. Managers of food processing companies	antecbiogas.com
62	Biovotec (Startup) Vestfold County	Produces wound care products (Dermarep) based on a novel biomaterial derived from hen eggshell membrane	Ralf SCHMIDT (CEO)	1	2	Norway, France, UK	Pharmacists	biovotec.com
63	Agribiotix (Startup) Akershus County	Produces plant protection solutions for treatment of plant diseases	Tage Thorstensen (CEO)	1	0	Norway	Crop farmers,	Agribiotix.com
64	Biosa Norge AS (Startup) Nordland County	Produce animal supplementary feed, organic fertilisers from micro-organism (bacteria)	Helge Nordquist and Berit Bråten Nordquist (Founders)	4	3.5	Norway Denmark Germany Netherland	Crop and livestock farmers	biosanorge.no
65	Hunton Fibergrow (part of a large company) Innlandet County	Produces building materials and solutions from wood and fiber.	Arne Jebsen (CEO)	3	1	Norway Finland Sweden UK Denmark	Farmers, Building contractors and farm carpenters (building of barns and offices)	hunton.no
66	Resourcer (Startup) Nordland County	Produces solutions for the reuse and recycle of waste materials	Håvard Hansgå (CEO)	2	0.4	Norway	Crop and livestock farmers	Resourcer.bio
67	Carrot (Startup) Vestland County	Produces solutions for reuse, recycle or repurpose of waste materials	Tore Totland (CEO)	20	3.4	Norway	Crop and livestock farmers	carrot.tech
68	Glocal Green (Startup) Møre og Romsdal	Produces green fuel (methanol) from residual raw materials	Dag Nikolai Ryste (CEO)	2	0.9	Norway	Crop and livestock farmers	glocalgreen.com
69	Desert Control (Startup) Rogaland County	Produces solutions to combat soil degradation and water scarcity	Ole Kristian Sivertsen (CEO)	12	0.23	Norway United States United Arab Emirates	Crop and livestock farmers,	desertcontrol.com
70	Veas AS (Startup) Akershus County	Produces solution for the treatment of wastewater. Solution for the production of biogas and organic fertiliser	Ragnhild Borchgrevink (CEO)	2	3.5	Norway	Crop, livestock and indoor/vertical farmers	veas.nu
71	Smartsoil Biotech AS (Startup) Akershus County	Produces solutions (using DNA technology and microbiota) to health soils	Erik Norgaard (CEO)	9	1.6	Norway		Smartsoilbiotech.com
72	Vingrip Energy (Startup) Trøndelag County	Produce renewable energy with your own windmill. It develops and produces wind turbines	Nils Magnus Kjenstad (CEO)	2	0.055	Norway	Farmers of animals and plants	vingrip.no

	Name of Agrifoodtech companies	Purpose	Founder and CEO	No of Employees (2021)	Turnover (million Kr) (2021)	Export	End-Users	Address
		adapted to Nordic conditions						
73	Abchar (Startup)	Produces a simple and reliable pyrolysis reactor with a minimal requirement for fuel for sustainable agriculture	Maria Støren Aschjem (CEO)	0	0.05	Norway	Farmers	abchar.no
74	Forestfy (Startup) Innlandet County			0	0	Norway	Farmers	
75	Foodlist (Startup) Akershus County	Foodlist uses technology to ensure that surplus food ends in the hands of people, not in the rubbish bin	Tomas Haug and Pie Haug	0	0	Norway	Plant and animal farmers. Grocery shop owners	foodlist.no
76	Kyoto (Startup) Akershus County	produces a thermal battery, Heatcube, which replaces oil, gas or diesel burners	Anna Camilla Nilsson (CEO)	22	-1	Norway	Animal and plant farmers	kyotogroup.no
NEW BIORESOURCES								
77	Arctic Bioscience (Startup) Møre og Romsdal County	Specialises in developing, manufacturing and marketing pharmaceutical and nutraceutical ingredients based on natural and cultured marine membrane lipids	Christer Valderhaug (CEO)	18	21.5	Norway	Pharmacists and animal health or veterinarians	arctic-bioscience.com
78	Invertapro (Startup) Vestland County	Uses insects yellow mealworm (Tenebrio molitor) to process and upcycle organic waste (industrial, catering and household) sourced from waste management companies into protein rich feed and food ingredients. By-products are used for fertilisers for farms	Alexander Solstad Ringheim (CEO)	11	4	Norway	Plant and animal farmers	invertapro.com
79	Ocean Forest (Startup) Vestland County	Produces technology that uses salt water, algae and CO2 to produce clean food, feed, energy and fuel	Harald Sveier (General manager)	1	2	Norway	Animal and plant farmers	leroyseafood.com
80	Norinsect (Startup) Møre og Romsdal County	developing larvae that can be used as animal feed, and especially for the farming industry	Harald Participant 6en Espeland (General manager)	19	1	Norway	Animal (poultry, fish)farmers	heidner.no
81	Ocean Geoloop (Startup) Trøndelag County	Produces technology that captures point source CO2 emissions, using natural and harmless processes, and transforming the CO2 to a stable, liquid state	Carlos Javier Delgado (CEO)	11	0.3	Norway	Farmers of plants and animals, Managers of food freezing companies	oceangeoloop.com

	Name of Agrifoodtech companies	Purpose	Founder and CEO	No of Employees (2021)	Turnover (million Kr) (2021)	Export	End-Users	Address
82	Flying feed (Startup) Andre County	produce living larvae and larvae protein powder for feed production and as a feed additive	David Tehrani (Founder)	0	0.048	Norway	Fish and animal (poultry) farmers	flyingfeedfredrikstad.com
83	Pronofa (Startup)	Produce black soldier fly larvae and tunicate for animal and fish feed		8	0	Norway	Animal and fish farmers	pronofa.no
84	Montasjen (Startup) Innlandet County	Produces technology for insect (cricket) farming for food and animal feeds	Kine Ariela Egset (General manager)	1	0	Norway	Animal and fish farmers	montasjen.no
85	Nordic Food supplements (Startup) Vestfold County	produces mealworms destined for food industry, animal feeding, plants nutrition	Frederick V. Richard (founder)	2	0	Australia, Austria Canada, China Czech Republic Denmark, Estonia Finland, France Germany	Animal and fish farmers	newnordic.com
86	Hubsect (Startup) Innlandet County	Produces insect farming technology to produce insects for aquaculture and poultry feed	Dr. Jayashankar Das (CEO)	0	0	Norway	Fish and poultry farmers	hubsect.com
87	Bioedel (Startup) Akershus County	Production of food fish and shellfish in sea and coastal fish farming	Trygve Melvin Tamburstuen (CEO)	0	0	Norway	Fish farmers	
88	Co2Bio (Startup) Rogaland County	develop biomass from microalgae, using a supply of CO2 from Technology Centre Mongstad (TCM)	Hans Torstein Kleivdal (CEO)	0	0	Norway	Plant and animal farmers	mongstadindustrialpark.no
89	Folvengaard (Startup) Vestland County	Produce microalgae-based biomass and technology	Rolf Olav Gjørven and Dag Hjelle *(Founders)	0	3.5	Norway	Livestock and fish farmers	
90	Norwegian Mycelium (Startup) Rogaland County	Produce solutions for fungal products	Ingrid Dynna (CEO)	8	1.1	Norway	Livestock and fish farmers	nomy.no
91	Norselab (Startup) Oslo County		Yngve Tvedt (CEO)	9	4.5	Norway		Norselab.com
92	Norse Biotech (Startup) Innlandet County	Produce high value products from biomass	Rune Langerud (CEO)	2	0.16	Norway United States		Norsebiotech.com
Foodtech								
93	Nortura (SMB) Akershus County	Large food producing company owned cooperatively by Norwegian farmers. It facilitates agriculture throughout Norway and ensures that eggs and	Anne Marit Panengstuen, (CEO)	4886	20734	Norway	Food consumers. Managers of Grocery and food shops. Chefs of	nortura.no

	Name of Agrifoodtech companies	Purpose	Founder and CEO	No of Employees (2021)	Turnover (million Kr) (2021)	Export	End-Users	Address
		meat are produced in all parts of the country.					hotels and restaurants	
94	TINE (SMB) Akershus County	Norwegian cooperative company owned by milk producers who supply milk to the company to produce and sell milk, cheese other milk products	Hanne Refsholt (CEO)	4602	19273	Norway	Food consumers, Managers of Grocery and food retail shops	tine.no
95	BaMa AS (SMB) Akershus County	Largest private distributor of fruit and vegetables in Norway	Christian Marius Emil Matthiessen (founder)	478	11146	Norway	Manager of Grocery shops. Chefs of hospitality industry	bama.no
96	Hoff (SMB) Innlandet County	An agricultural cooperative company owned by potato farmers throughout Norway		181	660	Norway	Manager of grocery shop	hoff.no
97	Salsus (Startup) Innlandet County	Produce stock, stock/demi-glace and sauce with unique, environmentally friendly and efficient technology	Tina Lee Vangen (General manager)	34	70	Norway	Professional chefs in restaurant and hotel industry	salsus.no
98	Völur (Startup) Vestfold County	Specializes in meat value chain optimization with the use of Artificial Intelligence (AI).	Robert Ekrem (CEO and Co-founder)	7	3	Norway	Farmers, Manager food storage and grocery shop	volur.no
99	Decon SFS (Startup) Innlandet County	Developed a new slaughter line technology to remove harmful bacteria without the use of additive or chemicals	Vida Julien (General manager)	2	1	Norway	Animal farmers	deconsfs.no
100	Totalctrl (Startup) Vestfold County	A leading food waste prevention software company with a vision to eliminate food waste throughout the entire value chain, from farm to consumer	Charlotte Aschim (Founder)	5	1	Norway	Grocery and Food shop manager. Chefs in hotel and restaurant industry	totalctrl.com
101	Holmen Crisp (Startup) Inn	Produces solution for gluten-free flour	Camilla Rostad (CEO)	7	8	Norway	Grocery and food shop managers, Chefs, and Food and beverage directors of hotels and restaurants	holmen-crisp.no
102	Norske Spirer (SMB) Innlandet County	Produces solutions for the production of sprouts	Carl-Magnus Fjeld Skinstad (CEO)	21	26	Norway	Crop farmers, indoor/vertical farmers	norskespirer.no
Aquaculture								
103	Nofitech (startup)	The company develops, designs and builds RAS	Robert Hundstad (CEO)	3		Norway	Fish farmers	nofitech.com

	Name of Agrifoodtech companies	Purpose	Founder and CEO	No of Employees (2021)	Turnover (million Kr) (2021)	Export	End-Users	Address
	Trøndelag County	facilities for both fresh and seawater						
104	Blue Lice AS (Startup) Rogaland County	Produces solutions for combating Norway's new lakselus (salmon lice)	Karoline Sjødal Olsen (CEO)	6	3	Norway	Fish farmers	bluelice.no
105	Nordic Aquafarms (Startup) Akershus	Produces technology for fish welfare, quality and sustainability in land-based seafood production	Bernt Olav Røttingsnes (CEO)	1	0	Norway	Fish farmers	nordicaquafarms.com
106	Salmon Evolution (Startup) Møre and Romsdal County	Provide technology for optimal growth and health conditions for salmon in the farm	Trond Håkon Schaug-Pettersen, (CEO)	13	0	Norway	Fish farmers	salmonevolution.no
107	Norway Royal Salmon (SMB) Trøndelag County	An arctic offshore farming	Charles Høstlund (CEO)	34		Norway, Europe, Asia	Fish farmers	norwayroyalsalmon.com/no
108	Aquatiq AS (SMB) Innlandet County	Provides technology for aquaculture	Eirik Bugge (CEO)	28.3	13	Norway Sweden UK Belgium Canada Chile Australia	Fish farmers	Aquatiq.com

4.1.1 Agritech in Innlandet

Innlandet County has 30 agrifoodtech companies in the area of biotech-genetics, smart farming, indoor or vertical farming and circular solutions. There are 926 employees in these agritech companies with a turnover of NOK 2,395 million. The study focuses on the agritech sector and companies in Innlandet County within the biotech-genetic (Geno AS, Graminor AS, Spermvital AS, Cryogenetics, AS Aninova, Norsvin AS) smart farming (Findmy, OS ID, Digifarm,) indoor/vertical farming (Avisomo) and circular solutions (Hias How2O). These represents large and small companies that are ready for export.

4.1.2 Geno AS

[9]Geno As is a small and medium size breeding company that develops and breeds the NRF (Norwegian Red Fe) population in Norway. It distributes cattle genetics in the form of semen and embryos to cattle producers locally and globally. Geno's technology improves dairy cattle genetics, and the company breeds more climate-friendly cows that emit less methane gas into the atmosphere. The Norwegian Red cattle have lower emissions than other breeds. The company has 85 years of experience in the success of sustainable breeding solutions and thrives to lower greenhouse gas emissions, breed healthy and sustainable cattle and improve the longevity of individual farms. The dairy cattle bred from Geno's Norwegian Red scores high related to health and animal welfare because the cattle are less susceptible to disease and farmers can reduce the use of antibiotics. This makes Norway one of the lowest rates of antibiotic use in the world. Healthy cattle provide farmers with high feed efficiency and higher yield at a lower cost. The global genetic product market is expected to be US$7 billion by 2026. The company has 203 employees with a turnover of NOK 395 million. The company has a strong market presence in the UK, US and some significant exports to Asia, Europe and South America.

[10]Geno started cattle breeding research and development since 1935 and its global success is due to provision of sustainable and profitable farming by Norwegian dairy farmers. The international success of Norwegian Red genetics is due to breeding the best dairy cattle genetics in accordance with international farmers' needs. Geno's technology and solutions include REDX sexed semen and embryo. The company's continuous reliable data collection of cattle breeding over the years and investment in research and development in genetic improvement and sustainability have given the company a global competitive edge. Additionally, through some projects and solutions such as Feed Efficiency and methane project, Geno has contributed to lowering greenhouse gas emissions. Geno has sustainability projects which include efficient production of milk and meat from the same animal, more healthy and excellent fertility traits and methane monitoring of cows and bulls to reduce global emission. Geno is working with reputable distributors to supply its products and solutions to

[9] https://www.theexplorer.no/solutions/improving-cattle-health-and-fertility-with-innovative-breeding/

[10] https://www.mynewsdesk.com/norwegianred/news/steady-global-growth-for-geno-and-norwegian-red-signals-future-progress-for-norwegian-farmers-and-the-cooperative-members-462292

international farmers interested in Norwegian Red genetics and crossbreeding due to Norwegian Red's superior health and fertility traits. In US, the distributor is ABS Global, whereas in Europe, Bovec SAS (France), Hybrid Genetics e.K. (Germany) and Dovea Genetics Ltd (Ireland) are the distributors. [11]Benefits of REDX include faster production of more high-value heifers, increased relative conception rates and superior health traits. Norwegian Red competes favourably with international Holstein breed,

4.1.3 Graminor AS

[12]Graminor AS is a small and medium size breeding (biotech-genetic) company that specializes in the development and breeding of an array of plant varieties for the agriculture industry. The company's end-users are farmers that produce green, potatoes, cereals, fruits and vegetables. The company supplies farmers both locally in Norway and internationally such as Sweden, Finland and the Baltic countries (Estonia, Latvia, Lithuania). Graminor AS has 39 employees and a turnover of NOK 80 million.

Graminor produces wheat with high and right protein content, increased yields and sustainability and increased resistance to disease and pests. There is collaboration with companies including Boreal Plant Breeding Ltd (Finland), Lantmännen (Sweden) to develop better oat varieties for Nordic farmers. The company has partnerships with research, politics, and industrial players to promote climate, sustainable food supply and security. The company also produces varieties of potatoes including Birkeland and Northen Lights. Some European companies competing with Graminor are AGRICO (Netherlands), Danespo (Denmark) and Norika (Germany).

[11] https://www.norwegianred.com/products--solutions/redx-norwegian-red-sexed-semen/

[12] https://graminor.no/?lang=en

4.1.4 Spermvital AS

[13]Spermvital AS is a breeding (biotech-genetic) startup company that develops artificial technology for insemination of animals especially the dairy industry that boosts pregnancy rates in cows up to 8%. The company has also developed a technology that extends the life of the spermatozoa after insemination to enable dairy farms to increase their efficiency and sustainability. It is estimated that 220 million first inseminations are performed on dairy cows every year, representing 14% of the global herd leaving a large untapped market. The company supplies its technologies to animal farmers locally in Norway and internationally to European countries such as Spain, Germany, UK and Switzerland. The company has 14 employees with a turnover of NOK 19 million.

4.1.5 Cryogenetics AS

[14]Cryogenetics AS is a biotech-genetic startup company that provides technology and services for the preservation of aquatic genes for research, conservation and the aquaculture industry. The technology allows fish farmers to be more productive and sustainable and the technology can be used to protect endangered species. The company has 23 employees and a turnover of NOK 21 million. Cryogenetics provides cryopreservation of high-quality fish milt with the desired gene variety that ensures healthy and robust fish and sustainable production at a fish farm. The company is currently the sole provider of the technology for its cryopreservation services and supplies its technology and services to fish farmers locally in Norway and internationally in Canada, Chile and USA.

[13] https://www.theexplorer.no/solutions/advanced-insemination-solution-improves-herd-fertility-on-dairy-farms/

[14] https://www.theexplorer.no/solutions/cryogenetics--preserving-aquatic-genes/

4.1.6 Aninova

[15]Aninova is a breeding (biotech-genetic) startup company that develops technology for the breeding of animals. The company has 2 employees and a turnover of NOK 2 million. Aninova breeding works include dogs and beef cattle, salmon, char and pigs.

4.1.7 Norsvin AS/Topigs

[16]Norsvin is a small and medium size breeding company that specializes in developing, breeding and sales of pig genetics both nationally and internationally. Some of the pig genetics include Duroc which offers pig farmers production efficiency and meat quality. Duroc, which is purebred, satisfies sustainable food productions through good health and robustness, feed efficiency and good quality of meat. The company has one of the world's semen products including Duroc Basis (for better price, high annual breeding progress and increased efficiency), Duroc Feed (for fattening pigs with lowest feed consumptions) and Duroc Meat (for higher percentage of meat). The company has 101 employees and a turnover of NOK 203 million. The company is owned and managed by Norwegian pig producers with over 70 years of breeding experience with healthy and quality pigs. The company has a high focus on animal welfare, climate and the environment. The pigs have low feed consumption and high growth, high survival rate, good quality meat and less susceptible to diseases to birth defects.

[17]There are over 66,000 pig farms with market value of over US$28 billion in 2021. In United States, some of the pig breeding companies include Fast Genetics Inc., Accelerated Genetics and Pig Improvement. In Europe, some of the pig breeding companies include Hypor BV (The Netherlands), Fuite Mesterijen B.V. (The Netherlands)

[15] https://aninova.no/

[16] https://norsvin.no/

[17] https://nppc.org/the-pork-industry/

4.1.8 Findmy

[18]Findmy is a smart farming startup company that uses satellite tracking technology for animals. The technology allows farmers to locate their grazing livestock without the use of mobile coverage making it easy for farmers to run profitable business, fully utilize grazing lands and achieve high standards of animal welfare and safety. The technology gives farmers control over livestock which improves the use of pasture, soil health and plant life which in turn reduces the use of fertilisers, pesticides and herbicides. The company has 12 employees with a turnover of NOK 22 million.

The company offer three tracking bells (Satellite Model 2 Green, LTE Model blue, and a hybrid LTE and Satellite Model 2 Red) with different features, prices and functionality (stress alert and Geofence, worldwide coverage, good maps, sheep control) to meet the needs of animal farmers. The growth of the livestock monitoring market is attributed growing demand for real-time monitoring and disease detection which is critical for provision of efficient proper care and health maintenance of the animals including heat detection monitoring, feeding management, stress management, milk harvesting management among others. North America is the largest market for livestock monitoring devices.

4.1.9 OS ID

[19]OS ID is a small medium size smart farming company that specializes in GPS tracking technology for the identity of animals and collects data on animals' health, welfare and productivity. The technology gives farmers information to improve farm management and increase sustainability. The company produces E-bells for tracking livestock on open pasture. The company provides intelligent, visual and electronic identification products such as ear tags, collars and bells. The company has 38 employees and a turnover of NOK 103 million. There is high market potential for the technology in Norway and Europe. The EU countries have substantial livestock population of 143 million pigs, 77 million bovine and 74 million

[18] https://www.theexplorer.no/solutions/track-livestock-from-a-smartphone/

[19] https://www.theexplorer.no/solutions/intelligent-livestock-identification-for-better-farm-management/

sheep and goats. Farmers in these countries of high-tech agriculture will need livestock identification solutions.

4.1.10 Digifarm AS

[20]Digifarm AS is a smart farming startup company that produces technology that detects the field boundaries and seeded acres using higher-resolution satellite imagery from remote sensing. The company has an Automatic Field Detection Model which provides data for field analysis and crop monitoring and suitable for small farms as small as 2 hectares. The technology provides farmers with smallest farms with earth observation, high spatial resolution and field boundary. The technology optimizes production on the smallest farms which results in higher crop yields, less use of fertilizers and lower input costs. The company has 2 employees with a turnover of NOK 2 million. The solution is market ready farms in Norway, Germany, Canada, USA and other Asia and EU countries, South America. The company's customer targets are B2B and B2G.

4.1.11 Avisomo

[21]Avisomo is a startup company that specializes in technologies for indoor or vertical farming. The global market for vertical farming is expected to grow from USD 4 billion in 2022 to USD 20 billion by 2029. The technology helps vertical farmers reduce cost and increase flexibility of producing profitable high-quality plants. The system is automated, and the software is updated continuously and optimizes the crops based on the growing data collected over time. The farmers can grow a variety of crops in the same facility which increases flexibility. The system is also scalable, and this will help farmers reduce investment risk. The system's environmental benefits include 99% less use of water and 90% less land compared to normal farming. Additionally, use of pesticides has been eliminated compared to conventional agriculture and plants can be produced indoors 365 days a year ensuring that crops are produced year-round in harsh climates or at places with infertile lands. The system addresses

[20] https://www.theexplorer.no/solutions/deep-neural-networks-and-remote-sensing-for-higher-crop-yields/

[21] https://www.theexplorer.no/solutions/avisomo-vertical-farming-system-gives-crops-a-high-tech-jumpstart/

challenges of food insecurity and environmental degradation. The Avisomo systems is currently used to produce high-value fresh greens, herbs and microgreen. The company has 12 employees, and the turnover is NOK 1.2 million.

4.1.12 Hias How2O

[22]Hias How20 is a circular startup company that specializes in the production of technologies for the treatment of water and wastewater for Innlandet community such as Hamar, Løten, Ringsaker and Stange municipalities. The technology, Hias Process, is a compact biological nutrient removal technology, which is highly advanced, eco-friendly and scalable. The technology involves the use of naturing occurring bacteria in biofilm to clean waste which removes phosphorus, nitrogen and organic substances from the water without use of heavy chemicals. Additionally, the technology makes treatment of water less expensive and more effective compared to mainstream technologies. The recycled phosphorus can be used for high-grade fertilisers and other agricultural products. The company has 2 employees and a turnover of NOK 21 million. The global investment in wastewater treatment is expected to rise 20% in the coming decades and in Norway it is estimated to be US$1.7 billion in 2040.

4.1.13 SWOT ANALYSIS

The Norwegian agritech market is relatively small and majority of Norwegian companies will need a large market to be profitable. For instance, the companies will need to export and grow in a large market such as the European and EU markets.

The table below shows the strengths, weaknesses, opportunities and threats of for Norwegian agritech products for entering Europe (European countries such as Sweden, Denmark, Netherland etc) and the EU markets.

[22] https://www.theexplorer.no/solutions/advanced-insemination-solution-improves-herd-fertility-on-dairy-farms/

Table 7: SWOT Analysis for Norwegian Agritech Products/Solutions

Strength	Opportunities
• Expertise with many years of experience in the production of safe and sustainable agritech products and services. For example, Geno's 85 years of successful sustainable breeding solutions for Norwegian Red dairy cattle • High research and development of agritech products and solutions • Experienced and skilled scientist, developers, producers of agritech products • Experienced and skilled management of agritech products and solutions • Agritech products and solution with Intellectual Property Rights (IPR) and can therefore operate. • Increasing entrepreneurship and thriving startup ecosystem e.g., Klosser Innovation, Aggrator incubator, T-Lab incubator • Support from proactive government and private sector, for example, Innovation Norway (government organisation) and Klosser Innovation (private organisation) • Effective use of resources • Healthy animals and low use of antibiotics and pesticide •	• High demand for sustainable agritech products and services in Norway • Government policy for use of sustainable agricultural products and technology • Customers preference and acceptance of sustainable agritech products and services • Customers in Norway are knowledgeable and experienced in the use of internet, computer and mobile phones. • Norway data protection policy ensure trust and transparency among users. • Norway financial and advisory support for users or farmers • Increasing interest in agritech products and services among farmers
Weakness	**Threat**
• Agritech startups have limited funds. • Weak IPR position of smaller companies and startups. • Lack of national team to collaborate, support startups. • High startup cost and operational cost • Limited business model with sales of products and little or no sales of services and or consumables • Lack of repeat customers to ensure the sustenance and growth of the business. •	• Increasing competition in Norway • The policies on agritech products and solutions may change and approval processes may be lengthy and expensive in Norway. • Future change of Norway data protection policy for users • Difficulty of agritech products differentiation as products increases in Norway. • Inflation rate is [23]4.8% for 2023 and an increment may reduce the purchasing power of customers. • High regulatory demand for from Norwegian government

From the SWOT analysis in table 1, the strength of the agritech products from Norway for Europe and EU market includes expertise and many years of experience in the production of

23

safe and sustainable products, high research and development facilities, skilled scientist, increasing startup ecosystem such as T-lab, Klosser innovation, effective use of resources and collaborative support from proactive government and private sector. However, the weaknesses of the agritech in Norway includes lack of funding for the startups, weak IPR position for smaller companies, lack of national team to collaborate and support the startups, high startup and operational cost, limited business model for products with little or no sales of services or consumables and lack of repeat customers to sustain and grow the business. However, the following are threats to the Norwegian agritech industry including increasing competition, changes in Norwegian government policies on agritech products, low product differentiation, high inflation rate of 4.8% and high regulatory demand. Nevertheless, there are many opportunities for the success of the products which includes high demand for sustainable products and services, customers' preference and acceptance for sustainable products and services, high customers' access to internet, computer and electricity, Government financial and advisory supports for farmers.

4.1.14 PESTEL ANALYSIS

Majority of the Norwegian companies need large market to be profitable. For instance, the Norwegian companies can be profitable by exporting and growing in the EU market and therefore the need to perform PESTLE analysis of the EU market.

The European and EU market is an important market for the exportation of Norwegian agritech solutions. The success of Norwegian agritech companies in EU markets dependents on the political, economic, social, technological, environmental and legal situation of the EU market as shown in Table 2 below.

Table 8:PESTLE Analysis of EU market

P	E	S	T	E	L
Good and strong political stability in Europe governed by EU. EU's CAP paid farmers €38.2 billion and supported agricultural market with €2.46 billion in 2019. EU legislation to ensure food produced and sold is safe. EU's farm to folk strategy (announced in 2020) ensures food is produced more sustainably. EU has good trade policy that support and defend EU industry and business. [24]EU work countries and World Trade Organisation (WTO) to remove trade barriers for European exporters to gain fair condition and access market. EU offer industrial tariff reduction, rule of matter such as intellectual property and sustainable development	High economic growth with GDP of about US$16.6 trillion in 2022 Free market economy including internal single market and free movement of goods, services, capital and labours. Largest trading partners include United States, UK, Canada and Norway Employment rate of 5.9% in 2023 Inflation rate of EU is 7.7% in 2022 with service (64.6% of GDP), manufacturing (23.5% of GDP and agriculture (1.7% of GDP)	EU's agriculture provides farmers, their families and sustain society. The EU society is conscious of safe, healthy food produced in a sustainably and eco-friendly way. Farmers are encouraged to provide food and services in a sustainable way to protect natural resources and biodiversity	Europe and EU member countries have access widely available internet and data (93% of EU households have internet access in 2022) EU has increasing availability of digital technology such as Internet-of-Things, artificial intelligence, digital market and platforms. Level of innovation in Europe and EU agritech industry is advanced such as robotics, industrial data, advanced manufacturing that support the shift to greener economy.	EU citizen benefits from high environmental standards EU legislation on the environment including protection of air from pollution, water quality, waste management. EU environment policy on resource-efficiency, green growth to ensure Europe economy is environmentally sustainable (greenhouse gas emission reduction by 55% in 2030 and become climate neutral by 2050) and low carbon energy	The EU employment law offers EU workers' rights to health and safety at work, equal opportunities for women and men, protection against discrimination and labour law. Conservation of marine biological resources under common fisheries policy (CFP) EU offers consumer protection law, copyright and patent laws to ensure that consumers and producers are protected.

Politics - Europe has a good and strong political stability governed by the EU. The EU also has a Common Agriculture Policy (CAP), which implements a system of agricultural subsidies such as agricultural production support and common organisation of markets. The EU farm policy covers several areas including food quality, traceability and trade. The EU also supports farmers financially and encourages sustainable and environmentally friendly farm practices. Its objectives include increase in food production, stabilise markets and secure availability of supplies (Parliament, 2018). CAP also encourages farmers to respect the environment, food safety, and animal welfare standards (Parliament, 2018). [25]CAP's agriculture subsidies to

[2424] https://european-union.europa.eu/priorities-and-actions/actions-topic/trade_en

[25] https://www.europarl.europa.eu/news/en/headlines/society/20211118STO17609/eu-agriculture-statistics-subsidies-jobs-production-infographic

farmers were €38.2 billion and supported the agricultural market with €2.46 billion in 2019. CAP price intervention covers agricultural products such as cereal, potatoes, flour, animal feed and dried fodder, milk and milk products, fruits and vegetables, animal meat, animal semen, egg cells and embryos among others. The EU's Farm to Fork strategy which was announced in 2020 ensures that food is produced more sustainably. Additionally, the EU has good trade policy that support and defend EU industry and business. The EU's common commercial policy (CCP) or EU's trade policy ensures that European Commission negotiate the internal and external trade relations for member countries by removing trade barriers, reducing industry tariff and ensuring rule of matter such as intellectual property and sustainable development.

Economic - The European Union (EU) has high economic growth with gross domestic product (GDP) of about US$16.6 trillion in 2022 which constitutes about one sixth of the global economy. Germany has the biggest national GDP followed by France and Italy of all EU countries (International Monetary Fund, 2022). With regards to the labour market, the EU has a low unemployment rate of 5.9% in 2023 for which the unemployment rate for men and women are 5.7% and 6.2% respectively (Eurostat, 2023). The EU's euro is the second most traded and second largest reserve currency in the world after United States dollar (Boesler, 2013). The EU economy is based on free market and advanced social models including internal single market with free movement of goods, service, capital and labours. The GDP per capita (PPP) is $43,188 compared to $62,869 in the United States in 2018. The European Unions' largest trading partners include United States, the United Kingdom, Canada, and Norway (International Monetary Fund, 2019). The inflation rate of the EU is 7.7% in 2022 and the services sector makes up 64.6% of GDP compared to manufacturing industry with 23.5% of GDP and agricultures with 1.7% of GDP (Eurostat, 2022; Urmersbach, 2023)

Social - [26]Agriculture provides for famers, their families and the sustains society through the provision of food and essential materials in EU. The EU society prefer safe and healthy

[26] https://agriculture.ec.europa.eu/sustainability/socially-sustainable-cap_en

product that is produced in a sustainably and eco-friendly way. Farmers are encouraged to provide food and services in a sustainable way that protects the natural resources and the environment. Consumers are also educated by CAP on EU agriculture as safe and sustainable source of food (Glogoveț an et al., 2022).

Technology – [27]Europe and the EU member countries have access to widely available internet and about 93% of EU households had internet access in 2022. [28]There is increasing availability of digital technology such as Internet-of-Things, artificial intelligence, digital markets and platforms for agricultural industry and businesses. Additionally, there is high level of innovation and the agritech industry uses technologies such as robotics, artificial intelligence and advanced manufacturing that support green economy (Bellon-Maurel et al., 2023; Musa & Basir, 2021).

Environment - The EU has legislations include the protection of the environment such as air pollution, water quality, waste management, nature conservation, the control the chemicals and biotechnology. EU citizens benefit from high environmental standards and EU policy ensures resource-efficiency, green economy that is environmentally sustainable with reduction of greenhouse gas emission by 50-55% by 2030 compared to the 1990s, climate neutral by 2050 and low carbon energy. The policy also offer protection for EU citizens from environment-related pressures and risks, health and wellbeing. The EU environmental policy affect both Europe and the rest of the world. The EU also ensures that there is conservation of marine biological resources under the common fisheries policy (CFP) (Hermoso et al., 2022; Pauleit et al., 2019)

Legal - The EU employment law offers workers' rights to health and safety, equal opportunity for women and men, protection against discrimination and labour law. Additionally, EU

[27]https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Digital_economy_and_society_statistics_-_households_and_individuals#Use_of_internet

[28] https://single-market-economy.ec.europa.eu/industry/strategy/advanced-technologies_en

coordinates consumer protection laws, copyright and patent laws in Europe and the EU. [29]The EU's copyright rules ensure that the works of authors, artists and other creators are recognized, paid for and protected. The EU actions help protect rightsholders and lower transaction costs. Moreover, EU's policy on safety and sustainability ensures that material or product at the early stage of the design process instead of relying on control and measures to retroactively mitigate their impact on human health and the environment. As a legal requirement, safety is fulfilled by companies to obtain access to the market for their substances and products (European Commission Regulation, 1999)

4.1.15 PORTER'S FIVE FORCES

It establishes the relationship between competitive forces and profit potential in which high intensification of the competitive forces leads to a decrease in profit potential. However, low intensification of the competitive forces leads to an increase in profit potential. The Porter's 5 forces affect the agritech startups externally.

A) Rivalry among existing competitors

Globally, agritech startups have been growing rapidly. In Europe and particularly among the EU member countries, there are agritech products and services ranging from precision farming, genetic and breeding, robotics (Bellon-Maurel et al., 2023)

The following factors influence rivalry among competitors:

1. Growth rate of the industry. Agritech market has been growing rapidly over the last 10 year in Europe to US$2.3 billion with 408 funding deals in 2021(AgFunder, 2022b). France (US$472 million with 17 funding deals) dominates the industry in Europe followed by Germany (US$175 million with 12 funding deals), UK (US$163 million with 46 funding deals), Netherland (US$105 million with 14 funding deals), Finland (US$89 million with 6 funding deals) and Sweden (US$58 million and 8 funding deals) in 2020 (AgFunder, 2021) . For example, the animal biotech-genetic companies competing in Europe include Genus plc of U.K, E.W. Group of Germany, Groupe Grimaud of France, and Topigs Norsvin of

[29] https://digital-strategy.ec.europa.eu/en/policies/copyright

Netherland. Therefore, there is increasing rivalry among competitors with low product differentiation. The Norwegian company, Geno AS has the potential to succeed in Europe with its Norwegian Red Fe that differentiates from its competitors with the breeding of more climate-friendly cows that emit less methane gas into the atmosphere compared to other cows. Secondly, the company has long experience of over 85 years of success in the breeding of sustainable cattle that are less susceptible to diseases and thus the lowest use of antibiotics by farmers.

The major drivers of growth include increasing availability of high-speed internet, computers and mobile phones (Fox et al., 2021; Neethirajan, 2020); consumers preference for food produced in a safe, sustainable, health and eco-friendly way (Sippel & Dolinga, 2022); government policies on safe, healthy and sustainability of agriculture and food (Arabska, 2021; Commission, 2020).

2. Loyalty of customers

New companies in the EU agritech market encounter many challenges since customers using existing brands and products may be reluctant to change to other brands and products. However, customers will change to new a brand and product if such brand and products offer better and higher value to the existing ones in the market. The Norwegian agritech companies offer high value of sustainable and climate friendly agritech products and services that satisfy the EU's CAP and Green deal on safety, sustainability and eco-friendliness for Europe and the EU market.

3) The number of competitors. The agritech market in Europe and EU offers many patented agritech products and solutions. The competition with Norwegian agritech products also includes agritech services offered by the competing companies. For example, in the smart farming sector which involves the use of data capturing devices, decision support software, mapping software, satellite and GPS, data analytics for livestock monitoring, there are few companies competing in the market in Europe. Some of the companies include Auroras s.r.l (Italy), GAMAYA (Switzerland) and Aker Solutions (Norway)(AgFunder, 2021; Saiz-Rubio & Rovira-Más, 2020). Therefore, the size of the competitors is moderately low.

4) Switching cost. The agritech products and solutions in Europe and the EU countries that do not satisfy the sustainability and climate friendly standards set by the EC will have a low switching cost. However, the agritech products that satisfy the EU standard of sustainability and are climate friendly will be expensive and will therefore have a high switching cost.

B) Threat of new entrants

There are many companies entering the Europe and the EU agritech market that pose a threat to existing companies. The threat of new entrants of the Norwegian agritech products and services to the EU agritech market is relatively low.

The factors that affect the degree of threat of the new entrant include the following:

- Time and cost of entry. The agritech products needs regulatory, IPR approval and a lengthy research and development (R&D) process in Europe and the EU which can be expensive and time consuming. Additionally, there are other costs such as marketing which requires large capital for products to enter and succeed in the EU market and this can be challenging for small business and startup agritech businesses. However, the Norwegian agritech companies when working as a team and receive government and private sector support in the area of finance, knowledge sharing, marketing, IPR will help reduce the cost and time of entry into the Europe and the EU market.
- Barrier to entry. The barrier to entry to Europe and EU agritech market is high because it requires high regulatory approval which can be time consuming. Moreover, large investment in R&D is required in addition to IPR challenges. However, barrier to entry can be minimised when the Norwegian agritech companies work a national team and offer support to resources such as finance, R&D knowledge and IPR.
- Economy of scale. The size of a company affects its economy of scale; the large companies can produce large number of products and solutions which results in less cost of the products. However, small and startup companies will produce small volume of products and solutions which are expensive and therefore difficult to compete alone with established large agritech businesses in Europe and the EU market. However, as a team, the agritech startups in Norway can receive technical and financial support to produce products and services that can enter and compete favourable in the EU market.

C) Threat of substitute products.

The existing of several products in a market that serve the similar purpose can affect the profitability of existing products. The threat of substitution for Norwegian agritech products and services in Europe and EU market will be relatively low since the products satisfy the EU sustainability and climate friendly standards which are expensive and difficult to substitute. Additionally, there are few numbers of substitute products that satisfy the EU sustainability and climate friendly standards since agritech is a relatively new and growing industry. Moreover, with regards to prices, quality and performance of products, the agritech products and solutions from Norway are considerable good and can perform well internationally. The Norwegian agritech products offer good sustainability and climate values that are affordable to farmers in Europe and in the EU countries. In addition, the Norwegian agritech product differentiation in terms of effective use of natural resources, provision of healthy animals with low use of antibiotics, low use of pesticides, as well as value of transparency, innovation and sustainability will facilitate the reduction of threat of substitute products in the Europe and EU.

D) Bargaining power of supplier.

The bargaining power of supplier of agritech products in Europe and the EU is relatively low because the resources needed for the products are not scarce. Additionally, the number of suppliers is many, and this make it easy for companies to get resources from suppliers. Therefore, the cost of changing of supplier in Europe and EU is relatively low which potentially favours agritech products from Norway.

E) Bargaining power of customers

The bargaining power of customers who are mainly farmers and farming companies is relatively low since there are not so many agritech products and solutions with similar functions and purpose. This is because the agritech industry is a new and growing industry with technologies that are relatively new. Additionally, the switching cost for customers from one agritech product to another is relatively high since there are not many products of similar functions and purpose. Moreover, Norwegian agritech products and solutions are safe, sustainable and climate friendly and will satisfy farmers and companies in Europe and EU.

Additionally, the number of farmers with potential economic strength and capital to adopt and use the technology is high. However, farmers with inadequate capital can by the EU through CAP to patronise the agritech products and services for their farms. Concerning customers interest in the agritech products, the main customers are family and business farmers who have access to data, internet, smart phones and laptops among other facilities in Europe and the EU. Therefore, there is high readiness for the adoption of agritech products and services which Norwegian agritech companies can offer and deliver.

4.2 Size of farm and international success of agritech solutions or technology

According to Participant4[30] , agriculture is a large industry that consist of several player including farmers that produce the crops, supplying companies that provide good and services to production finished products on farm. She asserted that the size of farm is critical for international success of Norwegian agritech solutions and as such farms should be of a given size to in order to have sufficient capital to make investment and benefit from the use of new agritech technologies. Moreover, [31]Participant 1 and [32]Participant 2 also said that farm sizes are important for international success of agritech solutions. They also added that the economic status of the farmers and foreign countries should be considered for the successful internationalization of agritech solutions and technologies. In their view, the technologies will be successful for farmers and countries with strong economic status. Additionally, according to [33]Participant 6, technology is needed despite the age and size of the barns. He added that farmers with indoor mechanism with large herds and high-cost farms will usually invest in new technologies to improve the activities and production of the farm. He said that for small farms, farmers will usually manage to milk and feed the animals without depending on new

[30] Interview with Participant 4 (Manager at agritech and foodtech organisation)

[31] Interview with Participant 1 (Farmer with a farm that uses automatic milking and feeding technology to produce milk and poultry).

[32] Interview with Participant 2 (Farmer with a farm that uses GPS solutions for tractors and farm equipment to produce grass and grain).

[33] Interview with Participant 6 (leader at an academic institution)

technology. He added that smaller farms will have better or increase income when farmers have knowledge of the technology and are able to use it correctly. He also said for the large farms, the technology is more useful to the farmers since it helps reduce the use workload on the farmer and gives the farmer more time and flexibility to do other things on the farm. According to Participant 7, farm size is important for the foreign success of technology since the farm size is considered when the agritech solutions are made. He added that the farm system and structure in Norway are also considered to provide appropriate technology that meet the needs of the farmer. He said that small farms often invest in smaller and simpler systems and that larger farms often can select more advanced models and often use new and advanced technologies or solutions. Participant 7 said that the size of the farm towards the international success of the technology has more to do with the market segmentation of the solutions. According to him, companies produce and sell varieties of products or different families of equipment with different capacity and level of features depending on the market and customer demands or needs.

On the contrary, according to [34]Participant 5, the size of farm is not necessarily important for the international success of agritech solutions, although the purchase of very expensive equipment can easily be acquired by farms with large production. He added that even small farms can use sensors, GPS equipment and less expensive technologies for their farms and therefore the size of farm is not necessarily critical for foreign success of Norwegian agritech solutions. He also said that many of the farmers have other sources of income beside farming and that they use various technologies for precision agriculture such as spraying and fertilization and other farming methods including the use of digital maps on their farms. He added that the technologies for precision livestock farming uses artificial intelligence (AI) for feeding and management of livestock. According to Participant 5, savings from using less pesticides can also be justified as investments for farmers with relatively small farms.

Additionally, Participant 7 said the size of the farm and international success of the agritech products relates to the market segmentation for the technology. According to him, the companies produce and sell varieties of products or different families of equipment to different markets with different pricing according to the needs of the farmers and companies. He also said that some companies in Norway have representatives in other countries in Europe and

[34] Interview with Participant 5 (leader at an academic institution)

rest of the world that ensure that their products or technology have features tailored for the farmer's needs in these countries.

4.3 Readiness of farmers to use agritech solutions

According to Participant 5, most of the farms in Norway are owned and managed by one person and his or her family. He added that farms are relatively small and specialized for few productions such as dairies and cereals compared to those in other European countries. According to him, the Norwegian farms are similar to European and EU farms but relatively smaller and produces few dairies and cereals.

Participant 4 said that farmers in Norway are far ahead in the use of new technologies because there is extensive access to the internet and use of smart phones, and this has facilitated the acquisition of agritech solutions by farming companies in the country. She also added that however in other countries and western part of the world, there might be some challenges in accessing the internet and use of smart phones. Moreover, Participant 1and Participant 2 stated that they use technologies on their farms that meet the requirement for efficiency and the environment. They added that they are ready to use new agritech technologies and equipment. Additionally, Participant 2 added that he has been distributing farm equipment for many years and is therefore interested in new technologies. Moreover, according to Participant 6, technology readiness is quite high in among farmers in Norway. According to Participant 3, he is technology ready to use the solutions on his farm. He added that he has a farm on hilly land and so he uses heavy and expensive machinery and tractors. Moreover, Participant 5 said Norwegian farmers and companies are generally ready to us new technologies and they will make careful assessment of technologies for procurement because these technologies are often expensive. He also added that adoption of technology is influenced by success of the economy; where the economy is good, the companies are ready to adopt and use the technologies.

With regard to factors that affect their readiness to use the technology, Participant 1and Participant 2 said the economic status; education age and experience; and facilitating conditions are the key factors that affect the readiness for the use of the agritech products and solutions. According to Participant 6 and Participant 7, financial factors are very important

for farmers to invest and use advanced milking and feeding technologies , and heavy high-capacity machinery and tractors respectively. Moreover, Participant 4, said that the financial status of farming companies is crucial and that farmers must have funds to invest in new technology and the size of their farm to be profitable. Participant 4 elaborates that farming companies invest in agritech solutions because it is profitable regarding increasing income and efficiency of their farms.

Participant 6 also stated that facilitating conditions such as access to internet is very high in Norway and close to 100% access by farmers in cities and at the countryside and that farmers are familiar with the use of digital tools, and this has contributed to high adoption rate of the technologies. Moreover, Participant 4 stated that Norwegian farmers are well advanced in use of technological equipment and use of smart phones. She added that farmers prefer to use safe smart phone applications with desired common interface for the agritech solution on their farms. In addition, Participant 4 indicates that facilitating conditions such as available infrastructure and resources favour farmers with flat and large farms in the use of the agritech solutions. She added that other technologies however are made for Norwegian conditions and environment such as open field grazing and barren soil and as such these solutions have lower initial costs for farmers to use on their farms. Participant 7 said that education and experience are the most important factors that affect farmers' readiness to use the technologies. He elaborated that some of the Norwegian farmers take short courses and educate themselves gradually throughout the year. He stated that the more educated and experienced farmers tend to adopt the technology readily. Moreover, Participant 6 said that Norwegian farmers are highly educated compared to other European countries such as Poland and Italy and that knowledge of programming is part of the education for farmers since last 2 or 3 years.

4.4 Needs and willingness to pay for sustainable agriculture solutions

Participant 1 and Participant 2 said that they are satisfied with the agritech solutions they have using on their farms because the solutions satisfy their farm needs. They added that they are willing to invest on the equipment over the years to improve efficiency, increase profit and reduce their workload thereby satisfying their farm needs. They added that by running a profitable farm business, the farmers can pay for the technologies and would highly

recommend such technologies to other farmers. According to Participant 6 and Participant 7, most full-time farmer whose main income are derived from the farms are willing to invest in the new technology. Participant 6 said farmers are willing to invest in automated milking systems since they make farmers' work flexible and help the farmers to save money, time and earn money. Participant 7 said for farms on hilly landscape, farmers will need technology such as high-capacity combined compressors with bale wrapper machines and tractors because they will increase farm production quality, make farm production faster and efficient. Participant 4 states that agriculture is constantly faced with new challenges such as climate change with leads to drought and much rain which must be resolved with sustainable agritech solutions that satisfy needs of farmers and companies. For expensive technologies, Participant 1 and Participant 2 recommended that farmers could cooperate and purchase the technologies for their farms. Additionally, they suggested farmers can engage a contractor to lease the technologies to them at prescribed monthly fee. According to Participant 6, farmers with financial difficulties usually depend on the government funds. Moreover, Participant 4 said that for average farms that finds it challenging to make large one-off investment on the technologies can choose subsidy payments to help them acquire the technologies. She also added that farming companies' ability and willingness to acquire the technologies for their farms varies between countries and based on their investment's strengths. In addition, she recommended rental of expensive technologies to enable farmers and companies acquire and use the technologies. She also suggested joint purchasing of the technologies by farmers so that many farmers can share in the investment and use of the technologies. She added that the selling of the service rather than the product will help more farming companies patronise the use of the technologies. Participant 6 and Participant 7 also said for expensive technologies, the small farmers can rent, use contractors or cooperatively buy and use the technologies on their farms. According to Participant 5, the technologies often satisfy the farmers and companies' needs. He added that the farmers and companies' willingness and ability to acquire the technologies depends on their financial status and competence. He also added that the companies will need trained and educated staff in order to make maximum use of the technology. Participant 5 also stated that the acquisition of the technology must be useful for sustainable and economic reasons. He added customer service and support are crucial in the acquisition of the technology by farmers and companies.

4.5 Sustainability for the success of an agritech company

According to Participant 1 and Participant 2, the sustainability of their farms is very important to them because they are concerned about the climate and the society when they operate their farms. According to Participant 6 and Participant 7, sustainability of farms is very important and rapidly growing in the country and that many farmers want to operate their farms more sustainably they are concerned about climate change and impact on society. Participant 4 stated that the sustainability of the technologies and agriculture is and will be much important in years to come because it has always been the mainstay of agriculture. Moreover, Participant 5 said that sustainability of technology is always important to companies because soil health and animal welfare among others are important for modern agriculture. Additionally, Participant 4 said that farmers are income-driven, and it is profitable to operate sustainable and invest in sustainable technology.

Concerning the sustainability of the agritech solutions in Norway, Participant 1and Participant 2 said that most of the agritech solutions are sustainable and elaborated that sustainability is important for profit, for people and the planet. They added that, however, there are few technologies that still use diesel and petrol, and this make them unsustainable. According to Participant 5, most Norwegian agritech solutions are sustainable and that there are many types of these technologies. Participant 7 also said that agritech solutions are sustainable to some extent and there might be some variation of solutions that offer more sustainability than others. He suggested that the technologies must be completely sustainable and that this can be achieved by performing the Life Cycle Analysis (LCA) of the product by determining the material and energy use from making, producing, transporting the product to the farm and its effect on the environment during its usage on the farm as well as the recycling of it on the environment.

Participant 6 said that one has to consider the economy, climate and the environment when focussing on the sustainability of the solutions. Participant 1 and Participant 2 said the Norwegian agritech companies help farmers and companies to be sustainable with the use of less pesticides and water as well as use of genetic method that help increase food production. Participant 4 added that for the agritech companies to be profitable, their solutions or technologies must be sustainable so that the farm and everything on it can be managed in a way they do not deplete and can be used year after year. She said also said that sustainability of the agritech solutions on farms is important for the success of the agritech companies.

Moreover, Participant 5 said the agritech solutions can help farmers and farming companies to be sustainable.

Concerning the marketing of the sustainability of agritech products by the companies, Participant 4 said the Norwegian agritech companies market the sustainability of their agritech solutions to a very high extent particularly, the Norwegian companies abroad. She added that sustainability of agritech solutions is important in the international success of the Norwegian agritech companies and there are constant new guidelines among others that the European Union is furthering. Moreover, Participant 5 said most Norwegian agritech companies market the sustainability of their technologies to companies by pointing out the value of saving inputs such as pesticides, fodder among others. He added that sustainability of the agritech solutions will be more and more important because of the value of saving inputs such as pesticides and fodder as well as the protection and improvement of soil health and animal welfare among others which are important for agriculture. Participant 6 said that although some agritech companies market the sustainability of their product to farmers, there is little no focus on sustainability measures such as energy consumption among others. On the contrary, Participant 7 said companies do not adequately market the sustainability of their products although their products may be sustainable.

With regards to the importance of sustainability of agritech solutions for international success of the companies, Participant 6 and Participant 7 said that the sustainability of the agritech solution is important for the international success of the Norwegian agritech companies and they suggested that it is important for the companies to have a modern profile of the sustainability of their products. Moreover, Participant 7 recommended that the agritech products should have LCA labels that show the sustainability of the products for farmers and companies to purchase them.

According to Participant 6, Norwegian sustainable agritech solutions can be successful in Europe and international markets. He said that most companies that supply farmers with equipment look to Norway as a stressed country and therefore technologies that work in Norway, will succeed anywhere in the world. He added that technologies produced in Norway are expensive due to the high level of cost in the country and that this is a challenge with the exportation of Norwegian agritech solution. He recommended a scalable system to solve the cost challenge by starting with the basic solutions and then scaling them up to bigger systems or more advanced systems. He said that it is important to focus on different countries with

specific customer needs by mapping these countries with the appropriate technologies. He also said the Norwegian companies can start with countries closer to Norway with similar farming characteristics such as Sweden, Denmark, Germany, Switzerland, Austria, France, Netherlands and Finland and move to bigger markets such as California in United States of America with bigger systems or solutions. He also added one need to focus on the markets closer to Norway that are willing to pay for more expensive products and later increase the volume of the products for markets interested in low-cost products from Norway.

5. Discussion

Agritech solutions help farmers to increase and improves their crops and animals in a more profitable, efficient, sustainable and safe way. It also helps protect the natural ecosystem through the efficient use of less water, pesticide and fertilisers on farms (De Clercq, Vats, & Biel, 2018). The Norwegian agritech products and services have a great potential to contribute meeting the farming needs of farmers and companies in Norway, Europe and the rest of the world.

5.1 Overview of Norwegian Agrifoodtech Sector

As indicated in the results, it seems there is a cluster of biotech-genetic companies mainly in Innlandet County that dominate the Agrifoodtech industry in country. The strength of the biotech-genetic solution companies might be important and can be considered for the international markets. Additionally, there seems to be many clusters of smart farming and digital solutions companies in Innlandet and Akershus County as indicated from the results. Moreover, there are the possibility of new cluster of circular solution companies particularly indoor or vertical farming companies and some cluster of bioresource companies mainly in Innlandet County and Akershus County. In Trøndelag there is a mix of agritech and aquatech companies. This trend of increment in the number of Norwegian companies might be as result of the growth of the country's economy. According to Hub (2019), the rise in the number of companies in the country is due to the growth in the country's economy, increasing entrepreneurship and flourishing startup ecosystem. Additionally, The Norwegian agritech companies have competitive advantages of effective use of resources, production of healthy animals, less use of antibiotics and pesticides and competent farmers with technological knowledge and skills for the technologies (Landbruk, 2018b;Chaudhary, 2019)

5.2 Size of farms for the international success

As indicated by the results from Participant 4 and Participant 5, it seems that profitable large farms are more likely to dominate in the purchase and use of the technology and the small farms might fall behind. Similarly, a study by Hoppe (2014) showed that large farms tend to dominate in the use of technology to improve efficiency and productivity of crops. Additionally, farmers with large farms are more ready to use the technologies because of

higher income generated from the farms and lower investment risks in using newer technologies. The large farms have greater access to capital to acquire the technologies (Barnes et al., 2019; Tamirat, Pedersen, & Lind, 2018).

However, as indicated from the results by Participant 5, it appears that farmers with small farms are also likely to acquire smart farming and digital solutions for their crop and livestock farms. Additionally, as stated by interviewing objects, it seems full-time farmers are more likely to acquire the technology and part-time farmers with small farms are more likely to rent the technology. There is also a possibility that the acquisition of smart farm technology might increase among small farms which might dominate the market and therefore the smart farm solutions may be successful in foreign market. This is supported by a study by Mugera et al. (2016) that showed small farms are important in the growth and sustainability of agriculture and have similar impact on profitability. From the SWOT analysis of the Norwegian agritech companies, and from the PESTLE analysis of the European and EU market, there is a possibility of a success of the exportation of Norwegian agritech solutions to EU market because of good political stability, relatively high economy, social acceptance for sustainable products, technological advancement and legal support for sustainable and environmentally friendly technologies.

5.3 Technology readiness among farmers between regions and countries

As indicated from the results by the Participants, it seems that Norwegian farmers in Innlandet County, Trøndelag County, Akershus County and Rogaland County are technology-ready and are willing to purchase and use the agritech solutions. Moreover, farmers in other European countries also appears to be advanced in the use of technology. For instance, a study by Maloku (2020), showed that there is high user rate of PA for crop farming by farmers in Germany, France, the Netherlands and the UK. It appears that economic, profitability, education and experience, and facilitating conditions are the main factors that influence farmers' readiness to use the technology as stated by Participants. There are supporting studies that show that these factors influence the use of technology by farmers. (Balafoutis, Evert, & Fountas, 2020; Bishop, Shumway, & Wandschneider, 2010; Moerkerken et al., 2020). As indicated by the results from Participants, large profitable farms and full-time farmers with small farms seem to be willing to acquire the expensive sustainable biotech-genetic solutions

and less expensive smart farming and digital technology respectively. The automation of the technology on farms is likely to make Norwegian companies competitive concerning quality and pricing. Moreover, there is a possibility that part-time small farmers might acquire the smart farm and digital solutions and automate them on their farms for economic, sustainable and, profitability reasons. This might also reduce workload on their farms and offer them flexibility to do other jobs. This is supported by a study by Stræte, Vik, & Hansen (2017) which showed that AMS makes farmwork flexible for farmers and improves animal welfare.

5.4 The role of sustainability in the success of an agritech company

The results from Participants indicate that the sustainability of their farms is important because they are concerned about the climate and its impact on society. As stated by Participants, Norwegian technology is likely to be sustainable and marketing of sustainability of the solutions can be improved by using sustainability labels. Moreover, there is a likelihood of a high demand for sustainable products by farmers in Norway because of the economic, environmental and social benefits the products offer. Similarly, a study indicated that most consumers in Italy, Germany and, the Netherlands prefer sustainable food produced by agritech solutions and are willing to pay for it. These customers are also more likely to pay premium for the sustainable food products (Ali, Ang, & Van Der Fels-Klerx, 2021). From the results as indicated by Participants, it clearly seems that the sustainability of the technology is important for the success of the Norwegian agritech companies both in the country and abroad. The initiation and the development of businesses of the Norwegian agrifoodtech companies by private companies such as Klosser Innovation appears to be important in the building of the agrifoodtech industry in the country. Additionally, the company clearly seems to be helping the Norwegian companies to advance and grow both nationally and internationally. In addition, the company seems to facilitate the formation of a national team of Norwegian companies to receive government support and to scale up and export sustainable solutions to foreign markets.

6. Conclusion

The agrifoodtech industry, consisting of agritech and foodtech sectors, offers new and innovative technology for the production, distribution and consumption of food (Sippel & Dolinga, 2022). The rapid growth and investment in the agrifoodtech industry is associated with increased access and use of internet, computers and mobile phones; reduction in quality and quantity of food products due to soil degration, water contraints and increased risks of pest; customer preference for safe and healthy sustainable food production, the need for reduction of greenhouse gas emissions from food waste, and government policies on sustainability of agriculture and food.

In Norway, the agrifoodtech industry may consist of over 108 companies with a strong cluster of biotech-genetic solutions companies mainly in Innlandet County. There are also cluster of new smart farm and digital solution companies mainly in Innlandet County and Akershus County. Additionally, there are cluster of circular solution companies particular indoor/vertical farming and some clusters of bioresource solution companies in Innlandet County and Akershus County. For the Norwegian agritech companies to compete effectively both nationally and internationally, there should be a focus on the biotech-genetic companies, the smart farm and digital companies, and circular solutions such as indoor/vertical farming solutions as well as bioresource solutions.

In Norway, large and profitable farms are likely to dominate in the use of biotech-genetic solutions in and full-time farmers with small farms may dominate in the use of smart farm and digital solutions. In addition, there is a possibility that part-time small farms might increase in the use of automated smart farm and digital solutions on their farms. In Norway, large and profitable farms and full-time farmers with small farms are important for the international success of Norwegian agritech solutions because they are willing to purchase and use the sustainable solutions.

Additionally, Norwegian farmers in Innlandet County, Trøndelag County, Akershus County and Rogaland County are technology-ready and are willing to pay for the use of the technology. There is high user rate of the technology by farmers in some European countries such as Germany, France, the Netherland and the UK.

There is a possibility of rich farmers with large farms are willing to pay and use sustainable biotech-genetic solutions. Additionally, full-time and part-time farmers with small farms seems to be willing to acquire smart farm and digital solutions.

The sustainability of the agritech solutions is important to farmers because of the environmental, economic and social benefits the solutions offer. The Norwegian technology has the potential of being sustainable and might help farms to be environmentally friendly. Additionally, it seems the agritech companies in Norway and abroad market the sustainability of their technology to their customers and therefore there is a likelihood of high demand for sustainable technology by farmers. The automation of the technology has the possibility of making the Norwegian solutions competitive in terms of quality and pricing. The SWOT analysis of Norwegian companies indicate that the companies are more likely to export the sustainable solutions the European and EU market based on the PESTLE analysis of the market. The Norwegian companies may improve the marketing of the sustainable solutions with the use of sustainable labels such as LCA labels on their solutions.

7. Recommendation

A further study to determine how the marketing of the sustainability of the Norwegian agritech solutions which includes the use sustainable labels may provide useful information to companies, academicians and stakeholders in the country.

A study to determine the international success of the Norwegian solution companies with focus on the foodtech sector may be important and useful to companies, researchers and stakeholders in the country.

A study on how customers acquisition of technology be influenced by the provision of customer service by the Norwegian companies might offer valuable information to companies, researchers and stakeholders.

A further study on the scalability and exportation of the Norwegian solutions to foreign markets may offer new knowledge to businesses, researchers and stakeholders.

8. References

A. Wolf, C., Stephenson, M. W., Knoblauch, W. A., & Novakovic, A. M. (2016). Dairy farm financial performance: Firm, year, and size effects. *Agricultural Finance Review*, *76*(4), 532-543.

AgFunder. (2021). *Agfunder Farm Tech Investment Report*. https://www.agfunder.com/research Accessed February 19, 2023

AgFunder. (2022a). *AgFunder AgriFoodTech Investment Report*. https://www.agfunder.com/research Accessed January 25, 2023

AgFunder. (2022b). *AgFunder European Investment Report*. https://www.agfunder.com/research Accessed January 29, 2023

AgFunder. (2022c). *Asia-Pacific AgriFoodTech Investment Report 2022*. https://www.agfunder.com/research Accessed February19, 2023

Aldehayyat, J. S., & Anchor, J. R. (2008). Strategic planning tools and techniques in Jordan: awareness and use. *Strategic Change*, *17*(7-8), 281-293.

Ali, B. M., Ang, F., & Van Der Fels-Klerx, H. (2021). Consumer willingness to pay for plant-based foods produced using microbial applications to replace synthetic chemical inputs. *PloS one*, *16*(12), e0260488.

Anastas, P., & Eghbali, N. (2010). Green chemistry: principles and practice. *Chemical Society Reviews*, *39*(1), 301-312.

Annosi, M. C., Brunetta, F., Monti, A., & Nati, F. (2019). Is the trend your friend? An analysis of technology 4.0 investment decisions in agricultural SMEs. *Computers in Industry*, *109*, 59-71.

Balafoutis, A. T., Evert, F. K. V., & Fountas, S. (2020). Smart farming technology trends: economic and environmental effects, labor impact, and adoption readiness. *Agronomy*, *10*(5), 743.

Barnes, A. P., Soto, I., Eory, V., Beck, B., Balafoutis, A., Sánchez, B., Vangeyte, J., Fountas, S., van der Wal, T., & Gómez-Barbero, M. (2019). Exploring the adoption of precision agricultural technologies: A cross regional study of EU farmers. *Land use policy*, *80*, 163-174.

Bellon-Maurel, V., Piot-Lepetit, I., Lachia, N., & Tisseyre, B. (2023). Digital agriculture in Europe and in France: which organisations can boost adoption levels? *Crop and Pasture Science*.

Benzaghta, M. A., Elwalda, A., Mousa, M. M., Erkan, I., & Rahman, M. (2021). SWOT analysis applications: An integrative literature review. *Journal of Global Business Insights*, *6*(1), 55-73.

Bishop, C. P., Shumway, C. R., & Wandschneider, P. R. (2010). Agent heterogeneity in adoption of anaerobic digestion technology: Integrating economic, diffusion, and behavioral innovation theories. *Land Economics*, *86*(3), 585-608.

Boesler, M. (2013). There Are Only Two Real Threats To The US Dollar's Status As The International Reserve Currency. *Business Insider*.

Bokusheva, R., & Kimura, S. (2016). Cross-country comparison of farm size distribution.

Bortolini, R. F., Nogueira Cortimiglia, M., Danilevicz, A. d. M. F., & Ghezzi, A. (2021). Lean Startup: a comprehensive historical review. *Management decision*, *59*(8), 1765-1783.

Boursianis, A. D., Papadopoulou, M. S., Diamantoulakis, P., Liopa-Tsakalidi, A., Barouchas, P., Salahas, G., Karagiannidis, G., Wan, S., & Goudos, S. K. (2022). Internet of things (IoT) and agricultural unmanned aerial vehicles (UAVs) in smart farming: a comprehensive review. *Internet of Things*, *18*, 100187.

Brundtland, G. (1987). Our Common Future: Report of the World Commission on Environment and Development. Geneva. .

Chaudhary, S., & Suri, P. (2022). Agri-tech: experiential learning from the Agri-tech growth leaders. *Technology Analysis & Strategic Management*, 1-14.

Daugstad, K., Rønningen, K., & Skar, B. (2006). Agriculture as an upholder of cultural heritage? Conceptualizations and value judgements—A Norwegian perspective in international context. *Journal of Rural Studies*, *22*(1), 67-81.

De Clercq, M., Vats, A., & Biel, A. (2018). Agriculture 4.0: The future of farming technology. *Proceedings of the world government summit, Dubai, UAE*, 11-13.

Despommier, D. (2019). Vertical farms, building a viable indoor farming model for cities. *Field Actions Science Reports. The Journal of Field Actions*(Special Issue 20), 68-73.

Dhanaraju, M., Chenniappan, P., Ramalingam, K., Pazhanivelan, S., & Kaliaperumal, R. (2022). Smart Farming: Internet of Things (IoT)-Based Sustainable Agriculture. *Agriculture*, *12*(10), 1745.

Eason, T., Meyer, D. E., Curran, M. A., & Upadhyayula, V. (2011). Guidance to facilitate decisions for sustainable nanotechnology. *US Environmental Protection Agency, Washington, DC*.

Eastwood, C. R., & Renwick, A. (2020). Innovation uncertainty impacts the adoption of smarter farming approaches. *Frontiers in Sustainable Food Systems*, *4*, 24.

Edison, H., Smørsgård, N. M., Wang, X., & Abrahamsson, P. (2018). Lean internal startups for software product innovation in large companies: enablers and inhibitors. *Journal of Systems and Software*, *135*, 69-87.

European Commission. (2019). The European green deal.

European Commission. (2020). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions, A new circular economy action plan for a cleaner and more competitive Europe COM 98 Final.

European Commission Regulation. (1999). No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration. *Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive*, *45*, 1-849.

Eurostat. (2017). Archive: Small and Large Farms in the EU—Statistics from the Farm Structure Survey. In. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Small_and_large_farms_in_the_EU_-_statistics_from_the_farm_structure_survey&oldid=406560#Economic_size_of_farms Accessed February 5, 2023

Eurostat. (2022). World Econonic Outlook Database. In: Eurostat Press Office.

Eurostat. (2023). Umemployment statistics. In: Eurostat.

Fairbairn, M., & Guthman, J. (2020). Agri-food tech discovers silver linings in the pandemic. *Agriculture and Human Values*, *37*, 587-588.

FAOSTAT. (2019). Production. Crop. https://www.fao.org/faostat/en/#compare Accessed 14.04.2023

FAOSTAT. (2021). Production and Price . Crop and Livestock. https://www.fao.org/faostat/en/#data Accessed on 12.04.2023

Gargiulo, J. I., Eastwood, C. R., Garcia, S. C., & Lyons, N. A. (2018). Dairy farmers with larger herd sizes adopt more precision dairy technologies. *Journal of dairy science*, *101*(6), 5466-5473.

Glogoveţan, A.-I., Dabija, D.-C., Fiore, M., & Pocol, C. B. (2022). Consumer perception and understanding of European Union quality schemes: A systematic literature review. *Sustainability*, *14*(3), 1667.

Hahn, R., Spieth, P., & Ince, I. (2018). Business model design in sustainable entrepreneurship: Illuminating the commercial logic of hybrid businesses. *Journal of cleaner production*, *176*, 439-451.

Hermoso, V., Carvalho, S., Giakoumi, S., Goldsborough, D., Katsanevakis, S., Leontiou, S., Markantonatou, V., Rumes, B., Vogiatzakis, I., & Yates, K. (2022). The EU Biodiversity Strategy for 2030: Opportunities and challenges on the path towards biodiversity recovery. *Environmental Science & Policy*, *127*, 263-271.

Hill, T., & Westbrook, R. (1997). SWOT analysis: it's time for a product recall. *Long range planning*, *30*(1), 46-52.

Hoppe, R. A. (2014). Structure and finances of US farms: Family farm report, 2014 edition.

Hoppe, R. A., & MacDonald, J. M. (2013). Updating the ERS farm typology. *USDA-ERS Economic Information Bulletin*(110).

Hu, Y., Li, B., Zhang, Z., & Wang, J. (2022). Farm size and agricultural technology progress: Evidence from China. *Journal of Rural Studies*, *93*, 417-429.

IGC. (2023). Supply and Demand. Wheat. *International Grains Council*. https://www.igc.int/en/markets/marketinfo-sd.aspx Accessed on 12.04.2023

International Monetary Fund. (2019). World Economic Outlook Database. In: International Monetary Fund.

International Monetary Fund. (2022). World Economic Outlook database. In: International Monetary Fund.

Jacques, L., & François, N. (2022). Research for AGRI Committee-The Future of the European Farming Model: Socio-economic and territorial implications of the decline in the number of farms and farmers in the EU. https://www.europarl.europa.eu/RegData/etudes/STUD/2022/699620/IPOL_STU(2022)699620_EN.pdf Accessed February 5, 2023

Jayne, T. S., Chamberlin, J., Traub, L., Sitko, N., Muyanga, M., Yeboah, F. K., Anseeuw, W., Chapoto, A., Wineman, A., & Nkonde, C. (2016). Africa's changing farm size distribution patterns: the rise of medium-scale farms. *Agricultural Economics*, *47*(S1), 197-214.

Johnson, J., & Tellis, G. J. (2008). Drivers of success for market entry into China and India. *Journal of marketing*, *72*(3), 1-13.

Jones, R., Kemp, D., & Takahashi, T. (2011). Dynamic modelling of sustainable livestock production systems. XXI International Grassland Congress and VIII International Rangeland Congress,

Kamilaris, A., Kartakoullis, A., & Prenafeta-Boldú, F. X. (2017). A review on the practice of big data analysis in agriculture. *Computers and Electronics in Agriculture*, *143*, 23-37.

Karlsson, M., & Hovelsrud, G. K. (2021). "Everyone comes with their own shade of green": Negotiating the meaning of transformation in Norway's agriculture and fisheries sectors. *Journal of Rural Studies*, *81*, 259-268.

Kernecker, M., Knierim, A., Wurbs, A., Kraus, T., & Borges, F. (2020). Experience versus expectation: Farmers' perceptions of smart farming technologies for cropping systems across Europe. *Precision Agriculture*, *21*, 34-50.

Kobayashi-Solomon, E. (2018). AgTech: A Great Investment For The Future. https://www.forbes.com/sites/erikkobayashisolomon/2018/10/31/agtech-a-great-investment-for-the-future/?sh=43a6625f1a09 Accessed on 21.03.2023

Koch, A. J. (2001). Selecting overseas markets and entry modes: two decision processes or one? *Marketing Intelligence & Planning*, *19*(1), 65-75.

Konrad, M. T., Nielsen, H. Ø., Pedersen, A. B., & Elofsson, K. (2019). Drivers of farmers' investments in nutrient abatement technologies in five Baltic Sea countries. *Ecological economics*, *159*, 91-100.

Konvicka, M., Benes, J., & Polakova, S. (2016). Smaller fields support more butterflies: comparing two neighbouring European countries with different socioeconomic heritage. *Journal of Insect Conservation*, *20*, 1113-1118.

Koop, S. H., & van Leeuwen, C. J. (2017). The challenges of water, waste and climate change in cities. *Environment, development and sustainability*, *19*(2), 385-418.

Kotler, P. (2001). *Marketing management, millenium edition*. Prentice-Hall, Inc.

Kroll, C., Warchold, A., & Pradhan, P. (2019). Sustainable Development Goals (SDGs): Are we successful in turning trade-offs into synergies? *Palgrave Communications*, *5*(1).

Kuckertz, A., Berger, E. S., & Gaudig, A. (2019). Responding to the greatest challenges? Value creation in ecological startups. *Journal of cleaner production*, *230*, 1138-1147.

Kumar, S. A., & Ilango, P. (2018). The impact of wireless sensor network in the field of precision agriculture: A review. *Wireless Personal Communications*, *98*, 685-698.

Lacombe, C., Couix, N., & Hazard, L. (2018). Designing agroecological farming systems with farmers: A review. *Agricultural systems*, *165*, 208-220.

Lakshmi, V., & Corbett, J. (2020). How artificial intelligence improves agricultural productivity and sustainability: A global thematic analysis.

Llewellyn, R., & Ouzman, J. (2014). Adoption of precision agriculture-related practices: status, opportunities and the role of farm advisers. *Canberra, Australia: CSIRO*.

Lowder, S. K., Sánchez, M. V., & Bertini, R. (2021). Which farms feed the world and has farmland become more concentrated? *World Development*, *142*, 105455.

Lowder, S. K., Skoet, J., & Raney, T. (2016). The number, size, and distribution of farms, smallholder farms, and family farms worldwide. *World Development*, *87*, 16-29.

Lowenberg-DeBoer, J., & Erickson, B. (2019). Setting the record straight on precision agriculture adoption. *Agronomy Journal*, *111*(4), 1552-1569.

Maloku, D. (2020). Adoption of precision farming technologies: USA and EU situation. *SEA–Practical Application of Science*, *8*(22), 7-14.

Mansour, D., & Barandas, H. (2017). High-tech entrepreneurial content marketing for business model innovation: A conceptual framework. *Journal of Research in Interactive Marketing*.

Martin, G. (2011). The importance of marketing segmentation. *American journal of business education (AJBE)*, *4*(6), 15-18.

Mintzberg, H. (1978). Patterns in strategy formation. *Management Science*, *24*(9), 934-948.

Moerkerken, A., Blasch, J., Van Beukering, P., & Van Well, E. (2020). A new approach to explain farmers' adoption of climate change mitigation measures. *Climatic Change*, *159*, 141-161.

Mugera, A. W., Langemeier, M. R., & Ojede, A. (2016). Contributions of productivity and relative price changes to farm-level profitability change. *American Journal of Agricultural Economics*, *98*(4), 1210-1229.

Musa, S. F. P. D., & Basir, K. H. (2021). Smart farming: towards a sustainable agri-food system. *British Food Journal*, *123*(9), 3085-3099.

Neethirajan, S. (2020). The role of sensors, big data and machine learning in modern animal farming. *Sensing and Bio-Sensing Research*, *29*, 100367.

Nguyen, A. T., Parker, L., Brennan, L., & Lockrey, S. (2020). A consumer definition of eco-friendly packaging. *Journal of cleaner production*, *252*, 119792.

Novicevic, M. M., Harvey, M., Autry, C. W., & Bond III, E. U. (2004). Dual-perspective SWOT: a synthesis of marketing intelligence and planning. *Marketing Intelligence & Planning*, *22*(1), 84-94.

Parliament, P. B. O. P. o. t. H. o. t. O. I. (2018). An Overview of the Common Agricultural Policy

(CAP) in Ireland and potential regional andsectoral implications of future reforms. https://data.oireachtas.ie/ie/oireachtas/parliamentaryBudgetOffice/2018/2018-08-17_an-overview-of-the-common-agricultural-policy-cap-in-ireland-and-potential-regional-and-sectoral-implications-of-future-reforms_en.pdf Accessed: 07.08.2023

Pauleit, S., Ambrose-Oji, B., Andersson, E., Anton, B., Buijs, A., Haase, D., Elands, B., Hansen, R., Kowarik, I., & Kronenberg, J. (2019). Advancing urban green infrastructure in Europe: Outcomes and reflections from the GREEN SURGE project. *Urban forestry & urban greening*, *40*, 4-16.

Paustian, M., & Theuvsen, L. (2017). Adoption of precision agriculture technologies by German crop farmers. *Precision Agriculture*, *18*, 701-716.

Porter, M. E. (2008). The five competitive forces that shape strategy. *Harvard business review*, *86*(1), 78.

Purvis, B., Mao, Y., & Robinson, D. (2019). Three pillars of sustainability: in search of conceptual origins. *Sustainability science*, *14*, 681-695.

Regjeringen. (2019). Agreement on climate agreement between the government and agriculture. https://www.regjeringen.no/no/dokumentarkiv/regjeringen-solberg/aktuelt-regjeringen-solberg/lmd/nyheter/2019/juni-19/enighet-om-klimaavtale-mellom-regjeringen-og-jordbruket/id2661309/ Accessed on 21.03.2023

Root, F. R. (1994). Entry strategies for international markets. *New york*.

Rozmi, A. N. A. (2018). The perception of ICT adoption in small medium enterprise: A SWOT analysis. *International Journal of Innovation and Business Strategy (IJIBS)*, *9*(1).

Saiz-Rubio, V., & Rovira-Más, F. (2020). From smart farming towards agriculture 5.0: A review on crop data management. *Agronomy*, *10*(2), 207.

Sakarya, S., Eckman, M., & Hyllegard, K. H. (2007). Market selection for international expansion: Assessing opportunities in emerging markets. *International Marketing Review*, *24*(2), 208-238.

Santiteerakul, S., Sopadang, A., Yaibuathet Tippayawong, K., & Tamvimol, K. (2020). The role of smart technology in sustainable agriculture: A case study of wangree plant factory. *Sustainability*, *12*(11), 4640.

Schimmelpfennig, D., & Ebel, R. (2016). Sequential adoption and cost savings from precision agriculture. *Journal of Agricultural and Resource Economics*, 97-115.

Schimmelpfennig, D., & Lowenberg-DeBoer, J. (2020). Farm types and precision agriculture adoption: crops, regions, soil variability, and farm size. *Global Institute for Agri-Tech Economics Working Paper*, 01-20.

Sharma, K., & Mathur, H. (2018). A Step Towards Digital Agronomy by Startups. *International Journal of Business Insights & Transformation*, *12*(1).

Shi, Y., Siddik, A. B., Masukujjaman, M., Zheng, G., Hamayun, M., & Ibrahim, A. M. (2022). The antecedents of willingness to adopt and pay for the IoT in the agricultural industry: An application of the UTAUT 2 theory. *Sustainability*, *14*(11), 6640.

Sippel, S. R., & Dolinga, M. (2022). Constructing agri-food for finance: startups, venture capital and food future imaginaries. *Agriculture and Human Values*, 1-14.

Song, J., Sun, Y., & Jin, L. (2017). PESTEL analysis of the development of the waste-to-energy incineration industry in China. *Renewable and Sustainable Energy Reviews*, *80*, 276-289.

SSB. (2022). Facts about Agriculture. https://www.ssb.no/jord-skog-jakt-og-fiskeri/faktaside/jordbruk Accessed on 21.03.2023

Stahel, W. R. (2016). The circular economy. *Nature*, *531*(7595), 435-438.

Stræte, E. P., Vik, J., & Hansen, B. G. (2017). The social robot: a study of the social and political aspects of automatic milking systems.

Tamirat, T. W., Pedersen, S. M., & Lind, K. M. (2018). Farm and operator characteristics affecting adoption of precision agriculture in Denmark and Germany. *Acta Agriculturae Scandinavica, Section B—Soil & Plant Science*, *68*(4), 349-357.

Tasser, E., Walde, J., Tappeiner, U., Teutsch, A., & Noggler, W. (2007). Land-use changes and natural reforestation in the Eastern Central Alps. *Agriculture, Ecosystems & Environment*, *118*(1-4), 115-129.

Torud, A., & Iversen, E. B. (2018). Norway AgriTech: Punching Above its Weight. https://agfundernews.com/norway-agritech-punching-above-its-weight Accessed on 26.03.2023

Turner, R. K., Pearce, D. W., & Bateman, I. (1993). *Environmental economics: an elementary introduction*. Johns Hopkins University Press.

Urmersbach, B. (2023). European Union: Share of economic sectors in gross domestic product (GDP) from 2012 to 2022. In: Statista.com.

Velter, M., Bitzer, V., Bocken, N., & Kemp, R. (2020). Sustainable business model innovation: The role of boundary work for multi-stakeholder alignment. *Journal of cleaner production*, *247*, 119497.

Vik, J., Stræte, E. P., Hansen, B. G., & Nærland, T. (2019). The political robot–The structural consequences of automated milking systems (AMS) in Norway. *NJAS-Wageningen Journal of Life Sciences*, *90*, 100305.

Weiss, C. R. (1999). Farm growth and survival: econometric evidence for individual farms in Upper Austria. *American Journal of Agricultural Economics*, *81*(1), 103-116.

Welo, T., Olsen, T. O., & Gudem, M. (2012). Enhancing product innovation through a customer-centered, Lean framework. *International Journal of Innovation and Technology Management*, *9*(06), 1250041.

Wiborg, A., & Bjørkhaug, H. (2011). Challenges for future farming in Norway: The role of place for farm succession. https://ruralis.no/wp-content/uploads/2017/05/14e97f7cc24fd9-1.pdf Accessed on 26.03.2023

Wolfert, S., Ge, L., Verdouw, C., & Bogaardt, M.-J. (2017). Big data in smart farming–a review. *Agricultural systems*, *153*, 69-80.

Zobnina, M. (2015). Startup development, investments, and growth barriers. In *Emerging markets and the future of the BRIC nations* (pp. 111-124). Edward Elgar Publishing.