FARMING OF THE FUTURE

The road to climate neutral farming 2050

Report:

Crop cultivation

Lantmännen

Content

All calculations and analyses in Farming of the Future are produced by Lantmännen. The material in the report has been produced by Lantmännen's members and employees, partner organizations, specialists, government authorities and an external reference group consisting of researchers and experts.

Preface

Cooperation and initiatives for future farming

Lantmännen's target is to create conditions for a sustainable primary production, halving the climate impact every decade and achieving climate neutrality by 2050. Primary production comprises the first part of the value chain – what happens on the farm – and this is where the greatest value creation takes place. By reducing the impact on the farms, and the impact from our own production and transport, we create a sustainable food chain – from field to fork.

The earth's growing population needs to be fed, and at the same time the impact of food production on the climate and environment must be reduced. At Lantmännen, we started by asking ourselves the overall question: can production from Swedish farmland increase in the period to 2050, while also achieving international climate targets and contributing to positive environmental development in terms of, for example, biodiversity?

Here we present our calculations, analyses and conclusions for Swedish crop cultivation, using winter wheat as the model crop to quantify the potential going forward. The work and the results can also be applied to other crops and built on for use in other parts of Swedish farming.

Our work is based on material obtained from a unique collaboration between a large number of individuals with different knowledge, skills and starting-points. Employees from different parts of Lantmännen's organization, our members – Swedish farmers – and an external reference group, with experts and researchers, have contributed valuable knowledge. The external reference group has had access to the work, ensuring that the scope, and our assumptions and assessments are reasonable.

Together, we have investigated in depth what is needed to create more sustainable farming now and in the future, which is in line with Lantmännen's overall target for climate neutrality by 2050. Knowledge gathering and simulations in our own model have enabled us to analyze and draw conclusions that pave the way forward. The picture that emerges is clear:

We can increase harvests by 2050 and at the same time achieve the climate targets, but this requires cooperation, extensive research activity, market demand and political will and drive.

Lantmännen has taken a broad approach to future farming, examining the areas that require action. The content extends across national, sectoral and system boundaries and therefore parts of the value chain that are outside Lantmännen's control and outside Sweden's national borders. The approach, which is to strive for a reduction in climate emissions in line with what is required to achieve the Paris Agreement

”We can increase harvests by 2050 and at the same time achieve the climate targets, but this requires cooperation, extensive research activity, market demand and political will and drive.”

target of an increase in temperature well below two degrees, is ambitious. The work has been based on our definition of “sustainable farming” – a definition that takes into account climate, environment, productivity and profitability on the farm. Only when all these criterias are met can we achieve long-term sustainable farming. Sustainable farming is therefore about developing all types of production methods in farming and finding solutions that can be implemented broadly and make a real difference.

Although the farmer is central to the farming, other parts of the value chain must create the conditions for a successful transition. Changes must be made at all levels: farmers, food companies, stores, consumers and society. Our conclusions show the strength of Lantmännen’s role, where activities can be initiated in the research arena as well as through commercialization and implementation in farming. There are problems that do not have any given solutions at present, but for which we have identified prioritized research areas going forward – for example, with regard to carbon sequestration potential and nitrous oxide emissions. However, we are convinced that challenges can be overcome if we tackle them together, in partnership with business and industry, the academic community and politicians.

With the results from Farming of the Future, we show the way forward and take further steps to develop Swedish farming in an even more sustainable direction.

Together we can create farming that contributes to increased resource efficiency and production of food and biomass for energy, follows international climate agreements, reduces environmental impacts and creates the conditions for thriving and profitable Swedish farms. Lantmännen will continue to push the work forward to enable future sustainable farming.

Claes Johansson,
Director Sustainability Lantmännen

Per Arfvidsson,
Executive Vice President, Lantmännen

The importance of sustainable farming for the future

Swedish farming is considered to be among the most sustainable in the world. Nevertheless, many challenges remain, such as reducing the climate impact, increasing environmental benefits and safeguarding biodiversity. At the same time, production must increase in order to meet growing demand for food and fossil-free raw materials. The cultivation method must also enable the cropland's long-term soil fertility to be maintained.

In the food chain, cultivation accounts for a significant part of the total impact on the planet's resources, as the majority of the value, energy and nutrients are created in the first stage.

Global challenges for future farming can be understood from three overall input values to which agriculture and society in general need to relate: the climate issue, sustainability challenges and increasing resource scarcity.

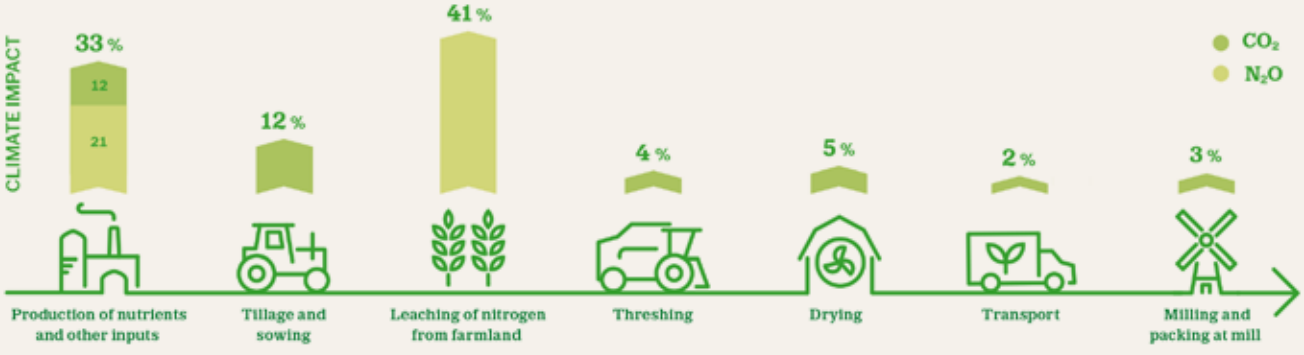
- According to the UN's Intergovernmental Panel on Climate Change (IPCC), there is a chance to limit global warming to 1.5 degrees, but this requires major actions to reduce the climate impact right now. Carbon Law is a scientific model which describes the objectives of the 2015 Paris Agreement. The model indicates that greenhouse gas emissions need to be halved every decade. By working on the basis of this principle, we have the opportunity to keep global warming within an acceptable level.

- The UN has defined 17 global goals "Sustainable Development Goals" (SDG), as part of Agenda 2030. The 17 goals and their 169 associated sub-goals cover environmental, social and economic areas. Several of the goals are directly linked to sustainable farming. These include goal 2: Zero hunger, goal 13: Climate action and goal 15: Life on land.

- According to the FAO, the UN's Food and Agriculture Organization, global production of food, feed and biofuels must increase by about 50 percent by 2050 in order to meet the rising demand from a growing population. It is therefore clear that in the future, arable land will be an increasingly scarce resource that must be used more efficiently.

Diagram 1: From a life cycle perspective, the majority of the climate impact associated with our food products occurs in the cultivation stage. The main contributors are biological conversion of nitrogen in the soil, diesel consumption and drying of grain. Production of plant nutrients (commercial fertilizers) also accounts for a significant proportion. To provide a complete picture of the climate impact of grain cultivation, the carbon sequestration effect should also be included. However, there is currently a lack of methodology for that to be quantified in a life cycle analysis.

Source: Lantmännen's internal figures for 2015, calculated per kilo of wheat flour.


CLIMATE IMPACT
33 %
12
21
12 %
41 %
4 %
5 %
2 %
3 %
CO_2
N_2O
Production of nutrients and other inputs
Tillage and sowing
Leaching of nitrogen from farmland
Threshing
Drying
Transport
Milling and packing at mill

Our work going forward

Lantmännen is driving the development of Swedish farming

Farming is undergoing seismic change as it endeavors to meet the challenges of today and the future – to increase food production while reducing the climate impact. Lantmännen has been working for some time to increase resource efficiency in Swedish farming, and since 2009 has established ambitious goals for reducing the climate impact from its own production. We are already well on the way to achieving our targets of fossil-free production in Sweden and Norway by 2025, in the rest of the Nordic region by 2030 and in the rest of Europe by 2040. Lantmännen also has a target to reduce the climate impact from transports by 70 percent by 2030.

We have also worked actively to reduce the climate impact from the cultivation stage – the first step in our value chain.

At Lantmännen, we have recently defined *a climate goal for farming – to create the conditions for sustainable primary production by halving the climate impact every decade and achieving climate neutrality by 2050*. To achieve this target, we will offer our business partners products with leading climate performance, push the development of new knowledge, technology and cultivation methods, and develop products and services that enable the agricultural companies to produce even more sustainably.

With the work on Farming of the Future, we are continuing to drive and develop the conditions for economically and environmentally sustainable Swedish farming. We have identified significant opportunities to increase production while reducing climate and environmental impacts by scaling up, developing and implementing already known techniques and methods. Significant potential for increasing harvests and reducing the environmental impact can be achieved by 2050. Much of the potential can be realized as early as 2030 with the right conditions in place. A future-proof, sustainable cropping system is possible, but a number of measures are required.

It is about using the potential offered by digitalization and precision farming in parallel with optimal management on the farm, including the introduction of sustainable crop rotation into the cultivation process. Continued investments in plant breeding and intensified development of more sustainable plant protection are required. In parallel, the effects of climate change on soil, water supply, crops and pests need to be monitored and managed. A crucial factor in encouraging the necessary sustainability investments is long-term farm profitability.

Long-term profitability is required to enable the transition to future farming.

Achieving the goals requires more knowledge, innovation and investment for the future and a long-term policy. Above all, more cooperation is required between all value chain participants – farmers, advisors, business partners, food retail and food service players, government authorities, politicians and consumers. The market needs to attach more importance to the sustainability performance of Swedish food production, and other players must contribute to the transition in order for this production to be even more sustainable in the long term. In this way, we take shared responsibility in the process of increasing resource efficiency, and thereby production, while also reducing negative environmental and climate impacts.

In this report, we have summarized the challenges and opportunities for long-term sustainable farming from now until 2050.

About Lantmännen
Lantmännen is an agricultural cooperative founded on the in-depth knowledge built up through generations of our farmers. Based on farmland and operations throughout the value chain, we are there all the way – from sowing and harvest to the food on our table, feed for our animals and climate-smart biofuels. Together we work to make farming thrive. Together we take responsibility from field to fork.

Method, goal and definition of sustainable farming

Lantmännen has identified challenges and opportunities for competitive and highly productive future farming in a climate-smart, resource-efficient and sustainable society. The goal is to clarify Lantmännen's view of sustainable farming and show a possible path forward towards future farming.


Photo: Mårten Svensson

The project has worked on the basis of three main issues:

- **Production perspective:** How much can Swedish agricultural land contribute to a bio-based circular society in which a growing population is to be fed and fossil raw materials are replaced with renewables?
- **Sustainability perspective:** What does a more sustainable farming mean and how can it be achieved?
- **Innovation perspective:** What research and innovation initiatives are needed to enable development towards more resource-efficient and sustainable farming?

The issues have been addressed and answered using a stakeholder-oriented working method involving an external reference group and a group consisting of Lantmännen's members. To understand complex issues and areas of development in farming, knowledge and facts have been obtained from representatives of different organizations. Input, fact-checking and views from these people have been crucial.

The climate impact must be reduced according to the Paris Agreement, the central aim of which is to keep the global temperature increase well below 2 degrees, the ultimate aim being 1.5 degrees. Researchers say that the rate required to achieve this is to halve carbon dioxide emissions every decade from 2020, referred to as the Carbon Law curve.

Definition of sustainable cultivation:

An important result of the work is the definition of sustainable cultivation, which establishes that it must be resource efficient and generate good return per invested unit, stay within the resource space that the planet can provide in the long term, and at the same time be profitable for the person operating the cultivation and also affordable for the person who is buying the raw material.

The climate impact must be reduced according to the Paris Agreement, the central aim of which is to keep the global temperature increase well below 2 degrees, the ultimate aim being 1.5 degrees. Researchers say that the rate required to achieve this is to halve carbon dioxide emissions every decade from 2020, referred to as the Carbon Law curve.

Planet

For farming to be sustainable from the perspective of the planet, a number of principles must be met:

- The climate impact must be reduced according to the Paris Agreement, the central aim of which is to keep the increase in temperature well below two degrees.
- Energy use must be efficient, renewable and sustainable.
- Biodiversity must be ensured and farming must not systematically displace species.
- Soil fertility must be maintained or improved and more carbon sequestered in the soil.
- The plant nutrients need must be met in a sustainable way, with the nutrients fully utilized.
- The plant protection need must be met, with minimal impact on surrounding ecosystems.

Productivity and resource efficiency

More and more people need to get food from the same land area, while farmland is an important resource in society's fossil-free transition. Sustainable farming is therefore high-yielding based on the location-specific conditions. Climate change is making drought, high temperatures or too much rainfall for example increasingly common. Sustainable farming must therefore be resource-efficient and "get more out of less" (in terms of proportion of farmland, per agri-supply unit such as fertilizer, etc.) and be resistant to extreme weather situations.

Profit

A prerequisite for long-term sustainable farming is good profitability for the farmer. This enables new measures and investments to be made in response to the major challenges facing food production. With good profitability, Lantmännen believes that the value that Swedish farmers create now and in the future must be more clearly reflected in the price of the products – and consumers must realize the value of these products to a higher extent. There are already good opportunities for significant environmental and climate measures at farm level, particularly with regard to the transition to fossil-free fuels for machinery and fossil-free electricity. Fossil-free premiums are not paid, and the costs are higher for renewable energy sources than for fossil sources. In a situation where profitability is already squeezed – only about 9 percent of the consumer price spent in the supermarket goes to the farmer – the Swedish farmer cannot alone bear the increased costs associated with the transition to more sustainable food production.

How can we know what the future will look like for Swedish farming?

We have produced a future scenario for how Swedish farming can meet climate and environmental challenges and at the same time produce from farmland. At this stage, we have chosen to focus on crop production in the calculations rather than agriculture as a whole, and more specifically used winter wheat as a model crop to quantify potential.

In order to predict what farming's yield and impact will look like in the future, we have produced a simulation model that describes the theoretical potential for future farming.

Lantmännen's simulation model for calculations of future farming

Lantmännen's calculations and analyses are based on crop cultivation using winter wheat as the model crop.

Lantmännen has used a simulation model that is based on calculations of different production influencing factors and crops. The calculations include farmland as a resource and the climate impact from cultivation's value chain up to and including harvest.

Five influencing factors can be set in the simulation model: climate change, precision farming, irrigation, plant breeding and optimal management. Two additional influencing factors are included for selected crops: cropping systems and measures for increased biodiversity.

It has been necessary to make a number of assumptions in order to describe development going forward. For example, it is assumed that there will be access to fossil-free fuels and renewable energy at competitive prices, availability of water and that plant protection will have the same effect as today regardless of upcoming phase-outs and changes to regulations and supply. However, more knowledge and research is needed in these areas – for example, the issue of future water management, with both supply and drainage being important – and there is also a need for more knowledge about changing cultivation conditions due to climate change.

The simulation model enables us to analyze production potential for Sweden's entire farmland acreage and effects for different environmental parameters.

This provides a current status for farming productivity in terms of area and yield in tonnes, and climate and environmental impacts based on 2015 data and outcomes. The current status forms the basis for the future scenario that has been developed and for analysis of progress towards 2030 and 2050.

It is important to point out that the results and conclusions from our simulation model are not exact. They are based on a number of basic assumptions and further assessments and simplifications have been made. Nevertheless, our results provide new, valuable knowledge and are an important platform for continuing our development work.

Current status (2015)

The result of the current status calculation for Sweden's arable land shows a total yield of 14.5 million tonnes of dry matter on an area of just over 2.5 million hectares, which gives calculated emissions of just over 4.5 million tonnes of CO_2 equivalents (greenhouse gas). This is based on a life cycle analysis for each crop. The calculation does not include biogenic carbon dioxide emissions or nitrous oxide emissions from organic soils.

Crop distribution	Thousand tonnes DM
Spring-sown grain	2,320
Fall-sown grain	2,360
Oilseeds	300
Legumes	130
Other crops	1,140
Ley	8,210
Total	**14,460**

Photo: Mårten Svensson

Results:

Future farming results

Our calculations show that there are good opportunities to increase production while reducing the environmental and climate impact of crop production and favouring biodiversity.

The main way to reduce the climate impact from farming is to replace fossil agri-supply and make resource use more efficient. Replacing fossil agri-supply will be feasible through cutting-edge initiatives within just a few years.

A broader transition by 2030 is also possible with the right conditions, which will have a major effect on the farming's climate performance. Several of the efficiency measures we have envisaged in the 2030 time perspective are also feasible in the near future, and it is our assessment that, for example, precision farming, digitalization and optimal management have good conditions for broad implementation. Technology and knowledge are already largely in place today – but what is lacking is the financial incentive and profitability needed to enable this change. Overall, we have calculated that the climate impact can be reduced by 63 percent per kilo of winter wheat and the yield increased by 38 percent by 2030, provided all potential is utilized, and water and efficient, sustainable plant protection are available.

Our calculations show that in the longer term up to 2050, progress in plant breeding will be the main contributor to a harvest increase of about 48 percent compared with the base year 2015, and a further reduction of the climate impact to about 69 percent.

The remaining climate impact in 2050 – the "innovation gap", estimated at 23 percent in Figure 1 – is almost exclusively linked to biological processes and nitrous oxide emissions from farmland. At present, there is a great deal of uncertainty about the true extent of nitrous oxide emissions, as the calculation method currently used is based on global standard values, which do not take into account local conditions or farming methods. To close the innovation gap that exists after 2030 and follow the curve down to 2050, there is a need to produce more precise quantification of the extent of nitrous oxide emissions from farmland as a first step, followed by more knowledge and innovation with regard to measures that can provide the greatest effect.

By 2050

Production per hectare for winter wheat increases by about 48 percent and the climate impact has the potential to decrease by 69 percent.

Potential for reduced climate impact by 2050

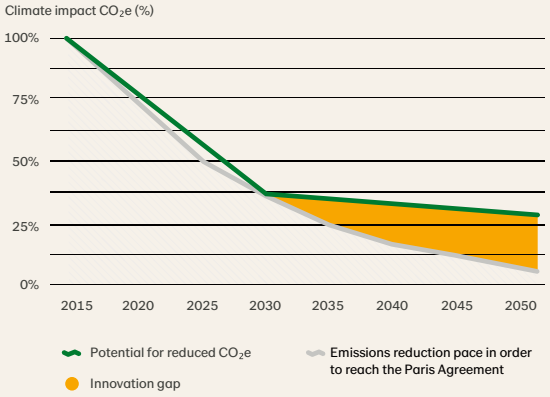


Figure 1. Potential to reduce farming's climate impact, calculated per tonne of winter wheat, and the gap to the Paris Agreement.

Measures for reduced climate impact by 2050

Actions	Potential (%)
Cropping system	-5%
Sustainable plant nutrients	-22%
Fossil free farming	-10%
Precision farming, digitilization, optimal management and plant breeding	-27%
Carbon sequestration	-5%
Total	**-69%**
Innovation gap	23%

Figure 2. The measures contribute to a reduced climate impact of 69% by 2050. To close the gap to the Paris Agreement – calculated at 23% – requires innovation in all measures and management of nitrous oxide emissions from land.

The harvest increases for 2030 and 2050 are based on full implementation of precision farming and digitalization, optimal management, improved crop rotation in cropping systems and continued plant breeding. The calculation requires access to effective plant protection and water management, which with climate change can become a critical factor.

Crop yield 2015–2050

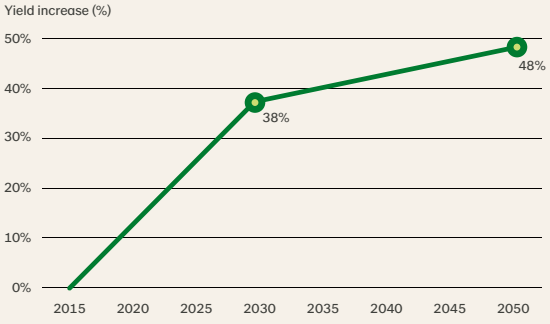


Figure 3. Potential for yield increase 2015-2050, calculated per hectare winter wheat.

Actions for yield increase

Actions	Potential (%)
Cropping system	7%
Precision farming, digitilization, optimal management and plant breeding	41%
Total	**48%**

Figure 4. Actions for increasing yields by 2050, calculated per hectare winter wheat.

Our journey has already begun

Reduced climate impact from Lantmännen's cultivation program Climate & Nature

We have already taken major steps towards more sustainable farming. Our Climate & Nature cultivation program, with up to 20 percent lower climate impact, is commercial proof that it is possible to reduce the climate impact and create environmental benefits in farming while maintaining a good yield. At the same time, the farmer receives an extra premium which finances the measures under the program.

The Climate & Nature cultivation program, launched in 2015, continues to be developed with measures for further climate impact reductions, including fossil-free plant nutrients, and measures to promote biodiversity, such as flower zones in the fields. By 2020, we will have further reduced the climate impact – by up to 30 percent compared with before the program's introduction – from Kungsörnen's wheat and rye flour and from products developed in partnership with other food producers. We are focusing on reducing the impact further by 2022 through several criteria. We will also apply the cultivation program for other grain crops in the future.

Several initiatives for more sustainable production

We have also made important steps towards more sustainable production in other parts of our operations, including the transition to renewable energy sources for Lantmännen's own production and the development of sustainable plant protection.

We have established a recycling facility in Norrköping and another in Kotka, Finland, where waste products from the food industry are collected and converted into sustainable fuel – ethanol with 95 percent lower climate impact than fossil fuels.

Since 2008, we have also developed and updated the climate footprint of our feed raw material. This means we can now offer feed with up to 30 percent less climate impact, which contributes to more sustainable animal production. Swedish meat already has a low climate footprint by international standards, but we continue our efforts to reduce the climate impact of our feed products further. In particular, the results of these efforts, with more knowledge, research and measures on the farm, will be of great significance to the transition of the animal value chain.

The following sections describe the areas where measures are needed to increase harvests, reduce impacts on climate and environment, and promote biodiversity in the period to 2050.

Lantmännen's Climate & Nature cultivation program

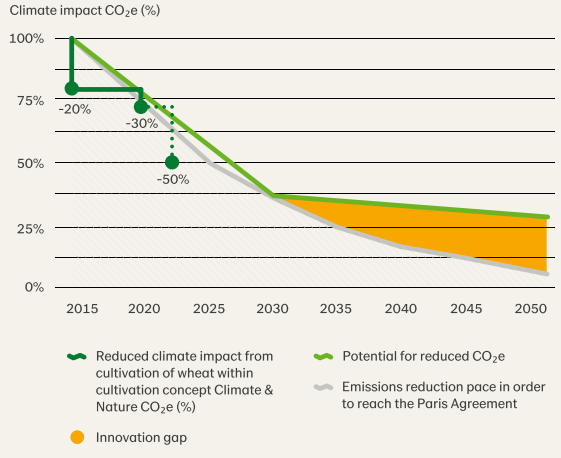


Figure 5. Reduced climate impact from cultivation of winter wheat within Lantmännen's cultivation program tonne Climate & Nature, calculated per tonne winter wheat.

Photo: Mårten Svensson

Eleven crucial areas for future farming

In order for farming to become increasingly climate and environmentally sustainable and at the same time more productive and profitable, a number of initiatives are needed in different areas. Eleven focus areas have been identified as crucial. The following sections describe the current situation, future potential and challenges for development in each area. The potential, expressed as a percentage for each area, applies per tonne of winter wheat. We have quantified each area based on how much they can contribute to a reduced climate impact.

Precision farming, digitalization and optimal management

Sustainable plant nutrients

Plant breeding

Fossil-free farming

Cropping systems

Carbon sequestration and renewable energy from farmland

Reduced nitrogen losses

Reduced leakage of plant nutrients

Sustainable plant protection

Adapting farming to climate change

Biodiversity

Precision farming, digitalization and optimal management

Precision farming, digitalization and optimal management can reduce climate impact by about a quarter by 2050, together with the focus area plant breeding.

Precision farming and digitalization are about using technology to analyze data and information for farming and using it for further improvement measures. Examples of technologies include autonomous driving guided by GPS, advanced mechanical tools, satellite images to analyze and control cultivation, technology that records nitrogen uptake in the crop, drones with cameras linked to a satellite for assessment, and effective plant protection. Optimal management is about taking the right action at the right time to produce the best effects for sowing, plant protection, nitrogen supply, harvests and more.

The methods enable us to achieve more optimized use of resources based on the different needs of the cultivation, crops and soil.

Potential

- Precision farming, digitalization and optimal management are very important in achieving increased productivity and yields with higher profitability. Using these methods provides environmental benefits for water and soil, reduces the impact on the climate through optimized use of agri-supply such as fuel, plant nutrients and plant protection, and promotes biodiversity.

Challenges

- There is already technology with great potential, but it is only used in a limited part of production at present.
- Functionality and usability have not yet been optimized.
- Increased investments require better farm profitability and good pay-back. Broad implementation can make manufacturing cheaper, and increase the accessibility and profitability of technology.
- Standardization of technologies, interfaces and information dissemination is needed, as is support in their use.
- Processing and utilization of data collected from Swedish farming must be clarified in terms of availability, ownership of data and cyber safety.

Lantmännen's role and other important players

Lantmännen's role is to drive the development of digitalization and techniques, and to drive their implementation in farming by means of, among other things, advisory services, products and services. Other key players needed to meet the challenges and achieve full potential going forward are farmers, advisors, machine manufacturers, technology companies and software companies for content services.

Lantmännen is already investing in the future:

Precision farming:

- Lantmännen already has a precision farming center in Skurup, the only one of its kind in Sweden, which brings together leading-edge machinery, equipment and technology.
- Project Svalöv, one of Lantmännen's comprehensive precision farming projects, gathers together the best competences in the area.
- Lantmännen and the technology company Dataväxt, a long-time leader in digital crop production services, have entered into a strategic partnership to drive the digitalization of farming. Better decision data and greater precision create the conditions for higher productivity and profitability in both animal production and plant breeding.
- With the RISE research institute and partners from a number of different sectors, Lantmännen is involved in running a testbed for digitalized farming. The testbed, which was opened at the end of May 2019, is an arena for collaboration on new technology, with data collection from satellites, weather stations and drones, and can be used for testing of, among other things, autonomous and electrified machine systems. The purpose is to develop a digital, standardized infrastructure for how data can be managed and analyzed, which will serve as decision-support for the farmer.

Sustainable plant nutrients

Sustainable plant nutrients and other agri-supply can reduce climate impact by about one-fifth by 2050.

Mineral fertilizer is the most common plant nutrient in farming at present. Mineral fertilizer is a concentrated product, with a composition that provides the crop with the right nutrients for increased yield. Production of mineral fertilizers has a major climate impact.

Increased use of plant nutrients from wastewater may become relevant in the future if it is possible to obtain a quality-assured cycle with wide acceptance in society.

However, Best Available Techniques (BAT) for mineral fertilizer production enable emissions of the greenhouse gas nitrous oxide to be removed from production. The next step is to replace the natural gas in the product. This can be done with existing electrolytic technology where natural gas is replaced with renewable electricity as energy in the process. However, at present this is a more expensive process as natural gas is cheaper as an energy source. If renewable energy were to be available at the right cost, the method could become competitive, enabling fossil-free plant nutrient production.

Organic fertilizers primarily contain organically sequestered nitrogen from plants or animals. This may originate from crop residues or animal manure, for example. Organic fertilization has various benefits, but can be difficult to use in precision farming and can therefore result in greater nutrient leakage into the natural environment. Increased use of plant nutrients from wastewater may become relevant in the future if it is possible to create a quality-assured cycle with wide acceptance in society.

Potential

- Fossil-free production has significant potential to reduce the climate footprint of mineral fertilizers.
- In Sweden, there are significant phosphorus reserves, mainly in the slag heaps from mining, which could provide the opportunity for phosphorus self-sufficiency. The plant nutrients available in wastewater fractions could also be used to a greater extent through the development of new technology and business models. Business development is in progress in the sector to commercialize circulated plant nutrients.

Challenges

- Implementation of the nitrous oxide purification technology in mineral fertilizer production has been carried out by several manufacturers, but is not yet standard in the market.
- Large-scale production of fossil-free mineral fertilizers requires access to renewable energy at a competitive price. More efficient technologies are under development and increased investments are needed to scale up production and broad implementation.
- Creating demand for fossil-free plant nutrients, thereby enabling additional costs to be covered, is an important factor in driving development. Concept development for fossil-free products that drive demand is a possible step to take.
- Commercialization and upscaling of techniques that ensure quality-assured plant nutrient cycles are a future challenge ahead.

Lantmännen's role and other important players

Lantmännen's role is to collaborate with other commercial players, impose requirements for sustainable plant nutrients and drive commercialization of products with added values. Other key players needed to meet the challenges and achieve full potential going forward are plant nutrient producers, the market, academia, recycling companies, government authorities and politicians.

Lantmännen is already investing in the future:

Sustainable plant nutrients

- BAT fertilizers are already used in Lantmännen's Climate & Nature cultivation program. The fertilizers are produced with environmental technology and produce a lower climate impact from the cultivation.
- Lantmännen and the plant nutrient company Yara have launched a pilot project aimed at creating the world's first fossil-free food chain. The launch of mineral fertilizers, produced with renewable energy, is planned for 2022 and is expected to reduce the climate impact from grain cultivation by more than 20 percent. This creates the opportunity for a fossil-free food value chain, where consumers can be offered more sustainable foods with reduced climate impact.
- Lantmännen is a participant in a cooperation project run by Ragn-Sells and EasyMining, the aim of which is to remove the nutrients phosphorus and nitrogen from wastewater and return them to the farmland. These circular solutions reduce the need to produce new fertilizers, while reducing the climate impact of farming.

Plant breeding

Plant breeding can reduce climate impacts by about a quarter by 2050, together with the focus area Precision farming, digitalization and optimal management.

Plant breeding is used to develop and improve crops in many different ways – e.g. increased yield, resistance to disease, stress resistance, better nutrient uptake and end product quality.

Plant breeding also contributes to strengthening the healthy properties of crops – a factor that is becoming increasingly important in line with rising global ill-health. The aim is to introduce as many aspects as possible into plant breeding in order to create profitability on farm and in the industry.

At present, plant breeding is often about yield properties and sector-specific qualities, such as baking quality. In the future, other properties may need to be prioritized in relation to climate change, for example. New plant breeding methods are continuously being developed, which provides opportunities for more efficient, rapid and precise breeding work.

Examples of new plant breeding methods include genomic selection and high-capacity phenotyping. The latter involves measuring the properties of a large number of plants, in the field or laboratory, for a short time using advanced analytical tools. An interesting future area is to develop the root of the plant to produce efficient nutrient uptake, carbon sequestration, better drought resistance, improved soil quality and less need for agri-supply.

Genomic selection is a new technique that will become a tool in all breeding programs. At present, Lantmännen uses the technique for oats and winter wheat. The technology is based on statistical models and genetic mapping. It provides an opportunity for more efficient selection and shorter breeding cycles, creating faster adaptability to external changes, and brings, for example, increased yield, robustness and resilience.

Potential

- Yield and quality can be increased and adaptation to varying environmental and climatic conditions can be improved with the help of plant breeding.
- Plant breeding provides the opportunity for increased carbon sequestration with better root development, improved nutrient quality and robustness to weather and temperature variations.
- Plant breeding also provides resistance to disease and more efficient nutrient uptake. It also reduces the need for plant protection as a result of the increased resistance.

Challenges

- For high-capacity phenotyping, access to analytical equipment is required and for genomic selection, investment in technology and infrastructure for genomic analysis is needed.
- Broad implementation of both methods requires internal skills development and access to a relevant recruitment base.

Lantmännen's role and other important players

Lantmännen's role is to continue to invest in variety production and plant breeding research, and to increase the focus on properties adapted to a changing climate, and reduced climate and environmental impacts in crop cultivation. Other key players needed to meet the challenges and achieve full potential going forward are academia, government authorities and politicians.

Lantmännen is already investing in the future:

Plant breeding

- Lantmännen has for a long time invested heavily in research and innovation in plant breeding, aiming for continued high production, reduced dependency on plant protection products and increased biodiversity. With modern technology, we can produce crops that can withstand and are robust to climate change, have high yields and are profitable at farm level. Other values can also be developed, such as baking and starch qualities.
- Lantmännen contributed to the establishment of SLU Grogrund, a plant breeding competence center for academia and industry, with a planned annual investment of 40 MSEK.
- In 2018, Lantmännen started a collaboration with SLU, which involved transferring knowledge about barley genetics to oats for more healthy fiber.
- The ScanOats research center in Lund, which in 2017 was the first in the world to map the oat's DNA, is working to develop new oat properties for intensified cultivation and better health. The center is run by Lantmännen in collaboration with a number of other participants.

Between 2000 and 2015, plant breeding accounted for 74 percent of the EU's increase in agricultural crop production. In Sweden, Finland and Norway, plant breeding accounts for 50 percent of the total production increase since 1946.

Source: HFFA Research Paper 03/2016

Fossil-free farming

Fossil-free farming can reduce climate emissions by about 10 percent by 2050.

Renewable diesel is currently the main fossil-free alternative for agricultural machinery as the fuel can be used in normal diesel engines without modification.

Biodiesel in the form of FAME/RME (fatty acid methyl ester/rape methyl ester) can normally be used for a maximum of seven percent admixture, while renewable diesel in the form of HVO (hydrogenated vegetable oil) can be used in significantly higher proportions. Both variants can be produced with a variety of vegetable or animal oils and fats, but as HVO is a more advanced biofuel, it is more expensive than FAME/RME. However, HVO may contain palm oil or by-products from palm oil production, which are criticized for the climate and environmental impacts that can arise.

Electrification of vehicles, together with the transition to renewable energy for the farm's operations, is driving demand for farm-produced renewable energy. Solar cells, wind power and biogas production from manure are good alternatives. Fossil-free farms and pilot projects for fossil-free meat and milk production already exist. Demand from farmers to conduct fossil-free farming is increasing.

Potential

- Swedish farming has the potential to produce more raw material for biofuel production.
- The potential for reducing climate impacts depends on the fossil-free alternative used. Fuel used in tillage, operation of machinery and grain drying accounts for a significant proportion of the total climate footprint for grain. A transition to fossil-free farming is therefore important.

Challenges

- Field work often requires a great deal of traction power during long work sessions, which makes it difficult to electrify that part of the farming. Biofuels are therefore important and need to be significantly more available as several sectors of society have the same needs.
- In addition, certain biofuels have not obtained approval from the engine manufacturers.
- A fundamental problem is that renewable fuels are more expensive than fossil fuels and this is expected to continue for a considerable period.
- The transition to new fuel systems and investments in farm electrification are costly and farmers' investments need to be financed.

Lantmännen's role and other important players

Lantmännen's role is to contribute to increased availability of renewable fuels, impose requirements for renewable energy and fuels, and drive commercialization of products with added values. Politics has a key role in supporting the fossil-free transition in a way that strengthens the competitiveness of Swedish farming. Other key players needed to meet the challenges and achieve full potential going forward are other fuel producers, machine manufacturers, farmers and government authorities.

Lantmännen is already investing in the future:

Fossil-free farming

- Lantmännen's Climate & Nature cultivation program, which was introduced in 2015, is constantly being developed and updated with new criteria for sustainable farming. Fossil-free fuels are a new criterion for the 2020 harvest, which means that the climate impact from wheat and rye cultivation will decrease further – by up to 30 percent – compared with before their introduction.
- Lantmännen offers a number of environmentally friendly alternatives that contribute to the conversion of tractors on the farm, including tractors which can be refueled with HVO. HVO is a 100 percent renewable fuel with a climate impact that is 50–90 percent lower than fossil diesel.

Cropping systems

Adapted cropping systems can reduce climate impact by about 5 percent by 2050.

Cropping systems include techniques such as crop rotation, cultivation of perennial crops and new crops, and adapted tillage. The techniques have different degrees of implementation and development.

Different crops are grown in the field according to a crop rotation that forms the basis of the cropping system. The size of the crop's harvest is affected by the previous crop.

Cultivation of ley increases soil organic matter, which is one of several factors that create soil fertility.

Perennial crops do not need to be re-sown, which reduces tillage and energy consumption. In addition, perennial crops can increase carbon sequestration in the soil through a longer growing season and a larger root system. Examples of new crops that can create opportunities include field beans, which can be used as a protein source in feed, and energy crops such as salix. The areas for these are still small, and the potential lies in the future.

Intermediate crops may be grown between main crops to fix nitrogen and cleanse the soil of various plant diseases.

Potential

- Good crop rotation results in larger harvests and reduces the need for chemical plant protection. It can reduce the need for tillage, with reduced climate impact and less need for nitrogen fertilization, as the nutrient is used more efficiently and some crops contribute nitrogen to successive crops.
- In addition, good crop rotation with increased harvest residues and root development in ley, catch crops, intermediate crops and energy crops can also lead to increased carbon sequestration in the soil.
- Soil organic matter can be increased through interventions in the cropping system.
- From a climate adaptation perspective, perennial crops have interesting potential for water robustness and can, for example, prevent erosion.

Challenges

- Developed systems are needed to manage new types of weeds that come with adapted cropping systems, particularly perennial weeds.
- New technology and biology are needed in symbiosis to develop the right tillage at the right time and with the right crop and variety selection.
- Infrastructure and business models are required to create an outlet for more crops in certain regions, enabling optimized crop rotation.
- For new crops, the introduction and commercialization process is long and volumes are small, which means that pricing and yield expectations are important.
- Catch crops and intermediate crops require development of establishment methods, tools for cultivation and plant breeding that develops varieties for the Swedish climate.

Lantmännen's role and other important players

Lantmännen's role is to contribute to further research, provide advice to farmers and work to ensure that raw materials grown with more varied crop rotation reach the market. More research is also needed to investigate the potential of perennial grain. Other key players needed to meet the challenges and achieve full potential going forward are academia, farmers, advisors and other parts of the food sector.

Lantmännen is already investing in the future:

Cropping systems

- Lantmännen, Formas and Mistra support SLU in research on perennial grain within the framework of the AquaAgri project. The research, which is expected to take another 10–15 years, is aimed at helping to make farming better able to cope with the climate of the future. One of the major challenges ahead is to adapt the grain crops to our Nordic climate, so that the crops can be over-wintered and withstand the cold.
- A new plant breeding program for field beans has been initiated at SLU Grogrund, in which Lantmännen is a participant. The field bean's properties need to be developed and improved for both feed and food use.
- Lantmännen is involved in extensive research to improve ley feed and identify new areas of use for ley.

Carbon sequestration and renewable energy from farmland

Carbon sequestration can reduce climate impact by about five percent by 2050, while maintaining a high yield, calculated per tonne of winter wheat. The potential for carbon sequestration increases significantly when ley is also included.

Using farmland as a carbon sink can provide an opportunity to limit increased carbon dioxide in the atmosphere and to increase carbon stores in the soil. In order for it to be a carbon sink, atmospheric carbon must be sequestered into the soil – it is not sufficient for already sequestered carbon to move between different carbon pools. Carbon sequestration potential has a long time horizon.

At present, the main potential for carbon sequestration is through perennial crops, such as ley, catch crops and intermediate crops, which have root systems that contribute to carbon sequestration.

Catch crops are sown between the main crop, and, as with the intermediate crops, the aim is for them to contribute to carbon and possibly nitrogen fixation, which has benefits for the farmland and the successive crop.

Carbon can be sequestered in the soil through the restoration of degraded soils, changed use of organic soils and reduced or changed tillage. Other measures include growing bioenergy crops, using organic fertilizers and bio char, using more harvest residues and root systems, using agro-forestry and adapting grassland and pasture management. An increase in catch crops and intermediate crops offers the most realistic potential for carbon sequestration in grain cultivation.

In addition to carbon sequestration in the soil, bio-based raw materials, for example from what grows on the farmland, can replace fossil raw materials. Green carbon atoms are then circulated and the climate impact is reduced. Agriculture currently contributes agri-supply for renewable fuels that replace fossil fuels.

Potential

- In order to reach full potential, major changes in cropping systems, such as increased cultivation of ley, are required. Root systems from perennial crops such as ley, and catch crops and intermediate crops contribute to carbon sequestration. The most realistic potential comes from an increase in catch crops and intermediate crops.

- Most advantageous from a production perspective is conversion of low-productivity agricultural land to carbon sinks.
- Looking at bio-based energy in the carbon cycle, the biorefinery Lantmännen Agroetanol estimates that 100,000 hectares of grain cultivation enable the climate impact from traffic to be reduced by 430,000 tonnes of CO2 by replacing fossil fuels.

Challenges

- The major potential for carbon sequestration requires a long sequestration time for the carbon – mainly through roots in the soil – of almost 100 years in order to maintain the sequestration effect.
- There is a need for a generally agreed system for calculating future carbon sequestration potential for agricultural land. Verification, agreements and third-party checks may be required.
- Carbon sequestration measures can have a negative impact on production, and displacement effects can occur. Compensation for production losses is needed, both by providing compensation to the farmer and ensuring that the relocation of production does not lead to increased emissions elsewhere.
- There is a need for transition incentives, such as policy instruments. One way is to create a market for carbon sequestration.

Lantmännen's role and other important players

Lantmännen's role is to contribute to further research and provide advice to farmers on the potential of increasing soil organic matter and carbon sequestration, in parallel with producing renewable fuel such as bioethanol. Other key players needed to meet the challenges and achieve full potential going forward are academia, farmers, advisors and government authorities.

Lantmännen is already investing in the future:

Carbon sequestration and renewable energy from farmland

Lantmännen Agroetanol is the Nordic region's largest biorefinery. Based on grain and waste products from the food industry, the biorefinery produces three main products: ethanol, protein and carbon dioxide. These products are further processed into sustainable biofuels, feed raw material and carbonic acid. There are plans to also recycle other residual products in the future, and there is great potential to produce more high-value products and contribute with geological storage (CCS).

Current facility

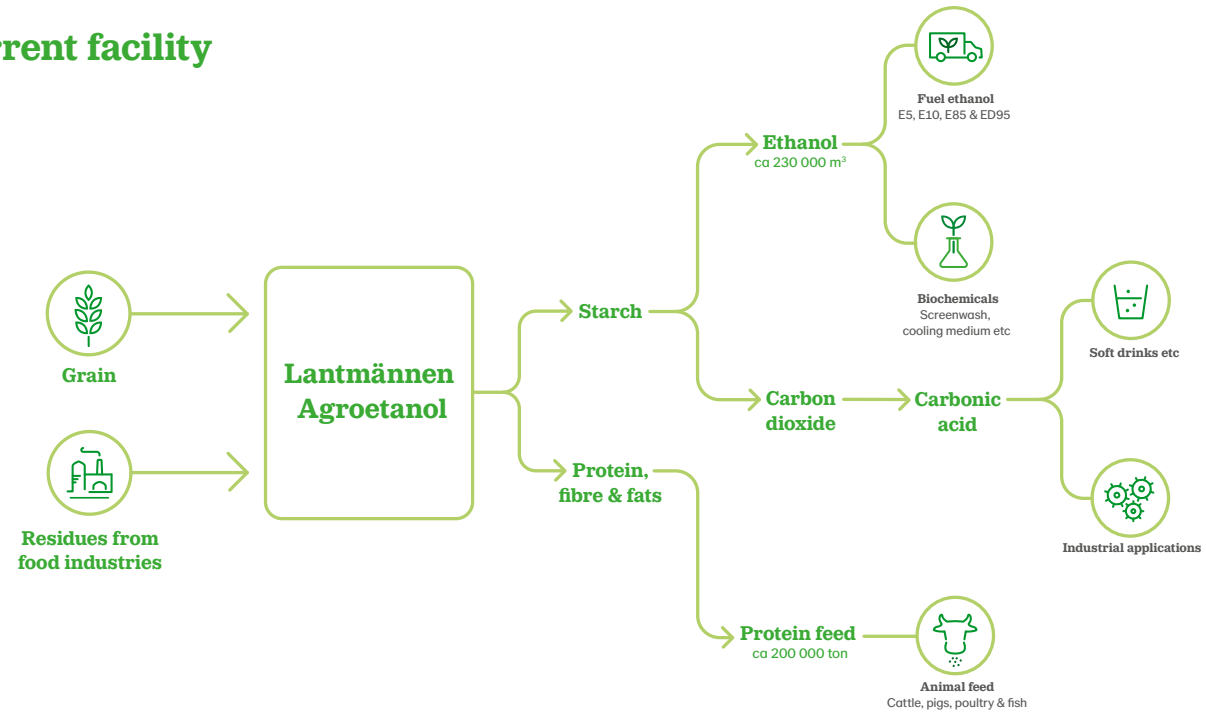


Diagram 2: Lantmännen Agroetanol's sustainable, circular business model.

Reduced nitrogen losses

Nitrogen losses will account for about a quarter of climate impact by 2050 and solutions remain to be found.

Nitrogen losses in the form of nitrous oxide are currently calculated with standard values in climate reporting. More research and knowledge is needed in this area to produce accurate data that will enable a more accurate description of the current situation and a foundation for the right focus in the development work.

It is important that nitrogen is used efficiently in farming to reduce the climate impact.

Nitrogen is important as a nutrient for farming, but if it is not absorbed into the crop it can contribute to nitrous oxide emissions from farmland.

As one kilo of nitrous oxide has the same climate impact as 296 kilos of carbon dioxide, even small amounts of nitrous oxide emissions have a significant impact on the climate. The amount of nitrogen in the soil, pH level, microorganism flora and availability of oxygen in the soil are important factors. Customized fertilization with precision farming, liming and drainage are important measures at present.

Nitrogen is important as a nutrient for farming, but if it is not absorbed into the crop, it can contribute to nitrous oxide emissions from farmland.

Another aspect is that the production of mineral fertilizer nitrogen contributes to significant greenhouse gas emissions and must therefore be absorbed efficiently. With more efficient control and farming practices, well-managed farmland, the right nitrogen supply at the right time and precision farming, a very high utilization rate for mineral fertilizer nitrogen can be achieved – in some cases up to 100 percent.

Potential

- There is great potential to reduce farming's climate impact by increasing the utilization rate for the nitrogen that is supplied to the crop in various ways. This is good for the climate and environment, while the farmer can obtain more harvest per kilo of nitrogen supply.
- High utilization of nitrogen also has positive effects on energy savings in production and reduced leakage to ground and surface water.
- It is crucial to reduce nitrous oxide emissions from farmland if the climate impact of crop cultivation is to move towards zero.

Challenges

- Better opportunities for quantifying and verifying measures are needed. Nitrous oxide and nitrogen leakage are currently calculated with standard values, and there is therefore considerable uncertainty with regard to the climate impact and what measures produce effects. More research is needed in order to better describe and quantify leakage, and to calculate the nitrogen balance for fields and crop rotation.
- Precision fertilization needs to be developed and applied more.
- More investments in soil improvement measures such as drainage and liming are required.
- Increased research and development into nitrous oxide emission reduction is needed.
- There are still gaps in knowledge regarding increased utilization of nitrogen, but to some extent it is also about implementing and applying already known methods and techniques to increase the rate of nitrogen utilization in crop production.

Lantmännen's role and other important players

Lantmännen's role is to contribute to further research, drive the implementation of precision farming and continue to develop advisory services for increased nitrogen efficiency. Other key players needed to meet the challenges and achieve full potential going forward are academia, government authorities and politicians.

Lantmännen is already investing in the future:

Reduced nitrogen losses

- Together with the plant nutrient company Yara, Lantmännen is reviewing knowledge within the field and potential measures to reduce nitrogen losses from farmland.
- Lantmännen's research foundation finances projects aimed at increasing nitrogen utilization, for example by dividing the nitrogen application and by fertilizing at later stages in the crop's development.

Reduced leakage of plant nutrients

Reduced nitrogen and phosphorus leakage can bring resource efficiency and reduce environmental impact.

In Sweden, about 2,500 out of 27,000 lakes, waterways and stretches of coastline are considered eutrophic, which requires measures in several sectors, including farming. However, new calculations from Stockholm University (2019) show that the eutrophication of the Baltic Sea is on course to decrease. This is due to intensive work to reverse the negative development, including in terms of measures on the farms and better treatment of wastewater.

The process of reducing plant nutrient leakage is therefore already well underway, and with measures such as adapted and ordinary protection zones, wetlands, phosphorus dams, liming, lime-filter ditches and two-stage ditches, phosphorus leakage can be reduced even more.

Other measures are reduced tillage, a practice that leaves much of the plant residues on the soil surface to reduce plant nutrient leakage. It is also possible to use intermediate crops and catch crops that capture nitrogen and reduce leakage.

Manure should be handled using methods that reduce leakage in the soil. There is keen interest in direct-seeding systems, where tillage of the soil is minimized, bringing many benefits and potential positive effects for aquatic environments.

Potential

- Eutrophication can be stopped and the balance in Swedish water restored, according to the Swedish Agency for Marine and Water Management (HaV).
- To get there, action is needed in a number of areas mentioned above.
- A cost-effective measure is the creation of wetlands to reduce leakage of phosphorus and nitrogen to the sea.

Challenges

- More work is needed to reduce nutrient leakage on the farms. This can continue to be supported through advisory visits from Greppa Näringen, a collaboration between the Swedish Board of Agriculture, LRF and the county administrative boards.
- There are opportunities to apply for aid for the implementation of phosphorus measures from county administrative boards and at EU level. It is important to investigate how the applications can be increased and the aid used more effectively. HaV is currently working to remove the barriers preventing aid applications.

Lantmännen's role and other important players

Lantmännen's role is to contribute to further research and development of effective methods for reducing plant nutrient leakage, support their implementation by offering advice and commercialize the measures. Other key players needed to meet the challenges and achieve full potential going forward are academia, government authorities, politicians, farmers and advisors.

Lantmännen is already investing in the future:

Reduced leakage of plant nutrients

- Lantmännen is a long-time participant in Greppa Näringen, an initiative that started in 2001 and works to reduce eutrophication and GHG emissions, and ensure safe use of plant protection products. Greppa Näringen offers information and free advice to Swedish farmers.
- Precision farming helps to reduce plant nutrient leakage from farmland. For example, Yara's N-sensor, used in Lantmännen's Climate & Nature cultivation program, can optimize the amount of nitrogen to be supplied to the crop by means of image analysis.
- The SamZon cooperation project, in which Lantmännen participates, is developing a concept for protection zones, which, among other things, minimize the risk of leakage of undesirable substances from farmland.

Photo: Mårten Svensson

Sustainable plant protection

Plant protection is designed to protect crops from fungus attacks, pests and weed competition. Chemical, mechanical and biological methods are currently used, as well as crop rotation, forecasts and variety selection. Regardless of the method, plant protection is very important in obtaining a good harvest, high resource utilization and more sustainable farming. The goal is effective control without environmental risks.

Chemical plant protection products are used to control pests and weeds, but there is a risk of beneficial insects also being adversely affected. Regulations are being developed to limit the use of chemical plant protection products, which means that fewer substances will be available. At the same time, climate change is expected to bring increasing pressure from insects and new species. In the future, mechanical weed control combined with precision application of plant protection will become increasingly important.

In addition to mechanical methods there are also non-chemical methods. Seeds can be treated with heat or biological agents to protect against fungi and bacteria. These treatment methods are already in commercial use.

Other newer methods, which are not as widespread, include use of nematodes, mites or beneficial insects to protect plants from infestation, mainly in vegetable cultivation. Controlled use is important so that the beneficial insects do not disturb the balance in nature.

The effects, costs and impact on nature of the various methods are factors to consider.

Potential

- There are good opportunities to reduce the doses of chemical herbicides by using better technology and new methods without running the risk of insufficient effect. One example is developing target-specific control using a camera that can recognize weeds, combined with inter-row hoeing and spraying.
- Methods of non-chemical treatment are available, and new ones are under development. New products are likely to be used in combination with mechanical treatment. In this way, the potential can be realized in the short term with optimized use of chemicals for plant protection, good disease resistance and increased biodiversity, and the opportunity for equally good yields.

Challenges

- With a warmer climate, more generations of pests will develop during the season and the attacks will come earlier. New diseases may also be established.
- Resistance is a problem for effective plant protection. There is a need to develop sustainable chemical products for insects and weeds that counteract resistance.

- Long decision-making processes for product approval are a challenge, as it is important to rapidly provide new plant protection products adapted to new needs. It is a costly process and it takes time to get the active substances approved.
- There is a need for marketing and education promoting the sustainable added value of non-chemical treatment methods.
- Another challenge is the lower efficiency of some non-chemical preparations and therefore the risk of a reduced harvest.

Lantmännen's role and other important players

Lantmännen's role is to develop and provide sustainable plant protection methods and support their implementation through advice and sales. Other key players needed to meet the challenges and achieve full potential going forward are plant protection companies, government authorities, politicians, farmers and advisors.

Lantmännen is already investing in the future:

Sustainable plant protection

Among other things, Lantmännen BioAgri develops biological plant protection with its environmentally friendly technology, which is not found anywhere else in the world.

- Methods include Thermoseed, which is a proprietary biological method that treats seed, leaving it free from infection. This method leads to a reduced need for pesticides, and brings beneficial effects for flowers and bees in the agricultural landscape.
- The Cedomon and Cederall plant protection treatments are also biological alternatives, and contain a naturally occurring bacterium and environmentally friendly ingredients. When the seed is treated, it becomes resistant to seed-borne diseases.

Untreated seed

Thermoseed treated seed

Photo: Lantmännen Bioagri


Photo: Mårten Svensson

Adapting farming to climate change

The effects of climate change, such as rising average temperatures and more extreme weather with torrential rain and drought, will affect farming going forward. Although this is not a desirable situation, the necessary adaptation may bring some advantages. A longer growing season due to climate change provides the conditions for new crops and different crop rotation. Spring planting will also be done at an earlier date and fall sowing may increase.

Climate change will bring higher temperatures and longer periods of high temperatures: over 20 degrees for 20 consecutive days. With higher temperatures, pests arrive earlier in the season and develop more generations.

New species that spread viruses are also likely to increase. If the soil frost in winter does not break up, clay soils are packed harder, weeds with underground parts can grow throughout the fall and annual weeds can overwinter. In addition, a warmer climate increases the need for irrigation and drainage.

Climate change will also affect rainfall patterns. In Mälardalen (one of the major crop farming regions in Sweden) for example, there may be 15-20 percent higher rainfall, locally up to 40 percent higher near the coast, particularly during the winter. At the same time, it is expected that early summer drought will increase, which will be detrimental to spring crops. Although Lantmännen works actively throughout the value chain to prevent climate change, measures and adaptation for farming will be required in the period ahead.

Potential

- A longer growing season enables two-harvest systems with, for example, feed and energy crops.
- Conditions for growing maize, sunflower and soy in Sweden are improving.
- New winter crops grown in Europe are likely to enter the market and in Sweden the conditions for cultivation further north may increase.
- With an earlier spring, spring planting can start earlier which is essential if the spring crops are to cope with an expected early summer drought.
- Risk diversification using a crop rotation with many different crops will be important in ensuring there is always a crop that can withstand the extreme weather variations and in reducing the system's exposure.

Challenges

- With a changing climate, quick adaptability will be required. This may, for example, involve changes for dealing with new pests and unpredictable weather.
- Grass weeds, which have a very detrimental effect on the harvest, are favored by climate change. New weeds can be established. This requires different chemical plant protection products from those that currently exist.
- Measures to ensure water supply will be necessary and measures will be needed in some areas to deal with heavy rainfall.

Lantmännen's role and other important players

Lantmännen's role is to contribute to increased knowledge about changing cultivation conditions and water management, adapt plant breeding and plant protection to new conditions and provide advisory services. Other key players needed to meet the challenges and achieve full potential going forward are farmers, advisors, plant protection companies, academia and politicians.

Lantmännen is already investing in the future:

Adapting farming to climate change

- With Lantmännen's own extensive plant breeding operations and our involvement in, for example, SLU Grogrund, we work to develop more resilient crops adapted to a changing Nordic climate.
- Lantmännen is looking at the water issue, both in terms of irrigation and drainage, in order to contribute broad solutions and assist members.

Biodiversity

The threat against biodiversity is increasing in line with climate change and the global expansion of farming. Nearly one million species are at risk of extinction, according to a report by IPBES, the UN scientific panel on biodiversity (2019). Measures that promote biodiversity must be taken.

Biodiversity with a functioning ecosystem is a prerequisite for farming. Many crops depend on pollinators such as bees, flies, bumble bees, butterflies, wasps and beetles. Other beneficial livestock include birds, amphibians, shrews and bats, whose diets include insects. Soil-dwelling mammals should also be included in analyses and measures to promote biodiversity. The species are affected by disappearing habitats and use of chemical plant protection.

Various biodiversity-promoting measures have been developed in the area of crop cultivation. Under Lantmännen's Climate & Nature cultivation program, farmers provide skylark plots and flower zones in the fields beneficial to skylarks and pollinators. There is increasing interest in growing plants in protection and buffer zones, thereby promoting biodiversity.

Other biodiversity measures include promoting the conditions for open water bodies such as ditches and dams.

In addition to access to flowers, pollinators can benefit from being offered habitats such as stumps, dead wood, bodies of water, old vole runways and nests.

Potential

- A number of biodiversity-promoting measures are already being implemented in farming, and they should be scaled up for increased benefits. Activities to promote biodiversity strengthen ecosystem services, which in turn are necessary for farming. Location-specific measures are of great importance.

Challenges

- Knowledge and experience of what works in a Swedish context are needed, as well as cost coverage for loss of revenue from allocated land and for the time taken to establish measures.
- Agricultural machines are not adapted for measures such as establishing buffer zones.
- Existing regulations are often set with short time horizons and are not adapted to different landscapes or cultivation zones.
- Location-specific assessments are needed, as the surrounding environment, landscape ecology and needs differ from location to location.
- Training is needed on practical implementation and on how biodiversity is affected by different methods used in farming.

Lantmännen's role and other important players

Lantmännen's role is to contribute to increased knowledge and follow-up of measures, provide products and support their implementation by offering advisory services, and commercialize added values based on biodiversity. Other key players needed to meet the challenges and achieve full potential going forward are farmers, advisors, academia and politicians.

Lantmännen is already investing in the future:

Biodiversity

- Skylark plots, undrilled patches in fields where the threatened skylark can land and find food, are one of the criteria in Lantmännen's Climate & Nature cultivation program. Skylark plots create the variation that the bird needs, and the number of breeding skylarks increases by up to 60 percent in fields with skylark plots compared with fields without. This is the finding of a study conducted by researchers at SLU together with WWF, BirdLife Sweden and Lantmännen.
- Lantmännen's cultivation program also includes flower zones as a new criterion for promoting biodiversity and attracting pollinators.
- Under the SamZon cooperation project, in which Lantmännen participates, plants are grown in special areas of the agricultural landscape, providing food and shelter for birds and encouraging insects such as bumblebees and other bees. The aim of the project is to develop a concept for protection zones which, among other things, minimizes the risk of leakage of undesirable substances from farmland, while promoting biodiversity. The SamZon protection zones are also beneficial to natural enemies of pests, which in turn reduces the need for plant protection.


Photo: Niklas Aronsson/Birdlife Sverige

Under Lantmännen's Climate & Nature cultivation program, farmers provide skylark plots and flower zones in the fields beneficial to skylarks pollinators.

Conclusions and next steps

Our results show the path forward towards Farming of the Future. There is great potential to increase harvests – by about 38 percent by 2030 and about 48 percent by 2050 – and the climate impact can be more than halved every decade, in line with the Paris Agreement targets. The 2050 target requires further measures, research and development and more collaboration.

Our calculations are based on full implementation of precision farming and digitalization, optimal management, effects of changed crop rotation in cropping systems and continued plant breeding. This therefore requires a best-case scenario in terms of technology, with all conditions in place, including optimal supply of nitrogen, availability of water and plant protection methods that keep pace with the pests.

As a major player with operations throughout the grain value chain and as a business partner to farmers, we therefore have important work ahead. The conclusions that lead towards Farming of the Future and more sustainable farming will affect our strategy, objectives and business development in the period ahead.

Lantmännen's role is to drive development from research and innovation to implementation and commercialization of broad solutions for farming. We will make new technology available, offer advice and develop products and services that create the conditions for the transition – together with the other participants in the value chain. It is important for the transition to be broad in order to produce a great effect; niche products are not enough.

Achieving this best-case scenario and the full potential of farming requires the following:

Cooperation throughout the value chain

Increasing production and reducing the impact on climate and the environment requires efforts from many different players throughout the chain. Access to sustainable agri-supply such as fuel, plant nutrients and plant protection, large investments in research and innovation, and profitability, incentives and support for increasing investments on the farms are all needed. Collaboration is the key to achieving a more sustainable food chain.

More research and innovation

The academic community and companies play an important role in the acquisition of knowledge and innovation for more sustainable farming. Further development is needed in the areas of sustainable plant nutrients and plant protection, the fossil-free transition, farming methods for improved harvests with less environmental impact and enhanced biodiversity. There is also a need for more research into, for example, calculation of carbon sequestration

and reduced nitrous oxide emissions from soil. Sweden, as a competitive, innovative food nation with increased food production and exports, requires significantly more resources for research, in particular from the public sector.

Investments on farms

Long-term profitability for the farmer is crucial to making the necessary investments and a successful transition. The challenges of the future place high demands on increased competence, knowledge and availability of services in new areas linked to changing cultivation and farming methods and digitalization. Farmers need the backing of the market, the sector, politicians and society at large.

Good food comes at a cost

Payment models for farmers need to be developed and commercialized in terms of, for example, climate and environmental benefits. This requires the market, both public and private, to place a higher value on sustainability and to price food at a level that enables profitable production, which is not currently the case. Only then can we achieve sustainable farming in the long term.

Policy instruments

Competition conditions for Swedish farming must be improved. Policy instruments need to value sustainable raw materials and create the conditions for a larger proportion of the value to go to primary production. In addition, the arable land must continue to be available. Long-term support and funding needs to be secured in order to enable transition of the entire value chain and the necessary research for the future.

The sustainability and climate aspects of farming have long been, and will continue to be, crucial to Lantmännen's strategy, objectives and business development, in order to make farming thrive. Conclusions and results from this report show the direction ahead and represent an important knowledge contribution in the transition, not only for Swedish crop cultivation, but also for green industries in general.

The real work must begin now and a concerted Swedish effort is required, with all players working together to find solutions in the cultivation stage and throughout the value chain. We have 30 harvests left until 2050.

Thank you for your valuable contribution to the report!

External reference group

The external reference group has had an advisory function, contributing views and assessments from a scientific perspective.

The reference group is composed of:
Göran Bergqvist, SLU
Anders Holmestig, LRF
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Photo: Mårten Svensson

We have 30 harvests left to achieve climate neutrality by 2050

Lantmännen

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