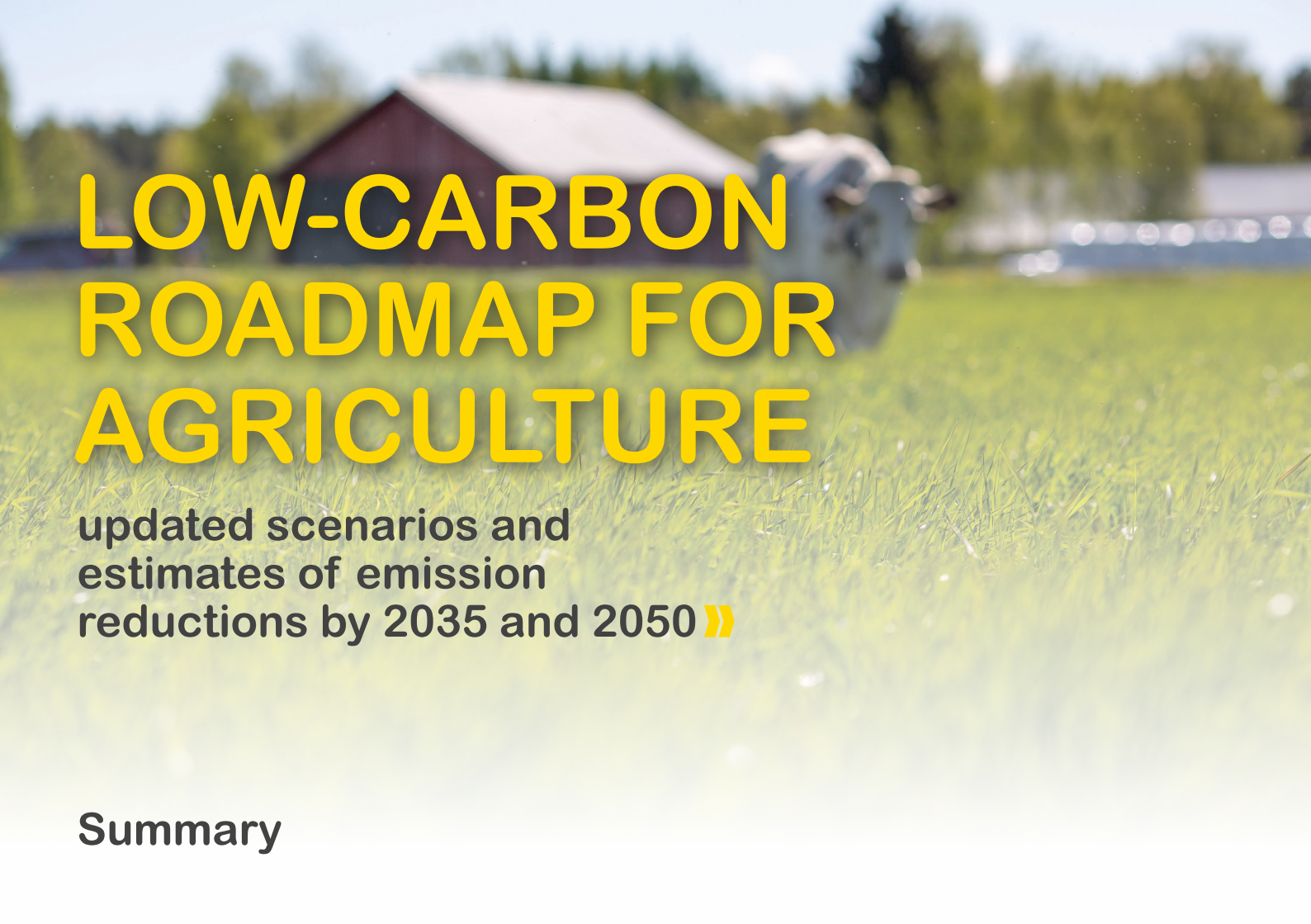


LOW-CARBON ROADMAP FOR AGRICULTURE

updated scenarios and estimates of emission reductions by 2035 and 2050

Summary

Introduction

In 2020, The Central Union of Agricultural Producers and Forest Owners MTK and The Central Union of Swedish-speaking Agricultural Producers in Finland SLC published a Climate Roadmap for Agriculture (Lehtonen et al. 2020) that identified opportunities to reduce greenhouse gas emissions by 2035 and 2050. At that time, the road map stated that carbon neutrality is a challenging goal for Finnish agriculture with current emission factors and carbon sequestration calculations. Despite this, agriculture must aim at reducing emissions as part of Finland's and the EU's climate goals to the extent that is possible without undermining food security and what is reasonable for agricultural producers and with respect to sustainable development. The low-carbon roadmap 2024 discusses the future of climate issues in Finnish agriculture and includes updated scenarios and emission reduction estimates by 2035 and 2050.

The Ministry of Economic Affairs and Employment have given the industries a mandate to update their low-carbon road maps by the summer of 2024. MTK and SLC are responsible for the road map update in the agricultural sector. The Natural Resources Institute Finland (Luke) is responsible for the background work of the low-carbon road map.

The aim is to update MTK's and SLC's low-carbon roadmap from 2020 for selected entities: the EU CAP policy, i.e. the EU's common agricultural policy and any changes in it, the agricultural carbon market, and agriculture as part of energy production.

In the climate road map from 2020, the focus was especially on emissions from drained peatlands, carbon sequestration of mineral soils as well as agricultural energy production. As for agricultural emissions, the low-carbon road map looks not only at the greenhouse emissions of the land use sector, but also at production emissions and the EU's common agricultural policy's (CAP) and land use policy's (LULUCF) opportunities to contribute to low-carbon work in Finnish agriculture.

In the new low-carbon road map, the issues in each main area are approached through scenarios: the basic scenario (WEM) is achieved with current decisions on policy and control measures, the goal-oriented additional action scenario (WAM1) defines additional measures needed to support Finland's carbon neutrality goal, and the ambitious additional action scenario 2 (WAM2) defines policy measures that go even further compared to the two first ones.

Agriculture and climate actions

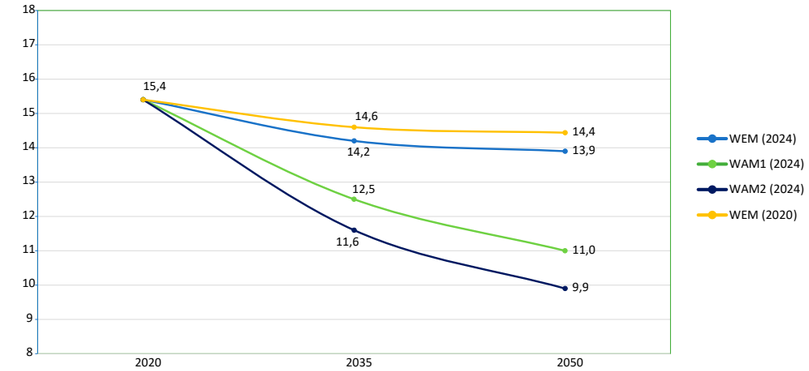
This work analyses the effects of the ongoing programming period (2023-2027) on production control based on the experiences gained during the first implementation year (2023). In addition, potential changes in the priorities of the programme for the remaining years will be analysed. When analysing the effects of agricultural policy, the aim is to create a scenario of the goals for the next programming period (2028-2032), the climate goals of Finnish agriculture and the policy actions needed for reaching them.

A key starting point behind the road map's different future scenarios is maintaining self-sufficiency in food production at its current level and securing a sufficient level of income for farmers despite climate measures. Therefore, when the aim is to reduce emissions through climate measures, we have to make sure that the farmers also benefit from the new measures that shape the production methods within agriculture.

The climate road map is based on three scenarios. The measures between these scenarios are identical and they are used already now, but the scope of the measures varies between scenarios. The scenarios require, among other things, a moderate reduction of decoupled area-based payments and allocating payments more towards climate and environmental measures. These scenarios are also based on the assumption that, in addition to public funding, market-based funding is available for climate measures at farm level. However, as the basis for payments is possibly more focused on climate and environmental measures in the future, maintaining the profitability of farm production must be taken into consideration. Increasing the environmental and climate emphasis substantially in the EU aid scheme may contribute to lower subsidy levels for sales plant crops and thus decreased profitability. The growing of cereal crops, in particular, is often a low-margin business so the subsidy reduction should be compensated by increasing market prices in order to maintain farmers' motivation and the land area in production use. Since cereal crop prices are mainly determined on the world market, compensating any financial losses through market prices may turn out to be ineffective. In grain production, the share of subsidies is substantial or about half of farmers' total income. Significant reductions in subsidy could destroy the economy for many farmers and the conditions for profitable production. Consequently, the fields of poorly profitable farms could be left out of the production of sales plant crops in areas where the demand for fields is non-existent.

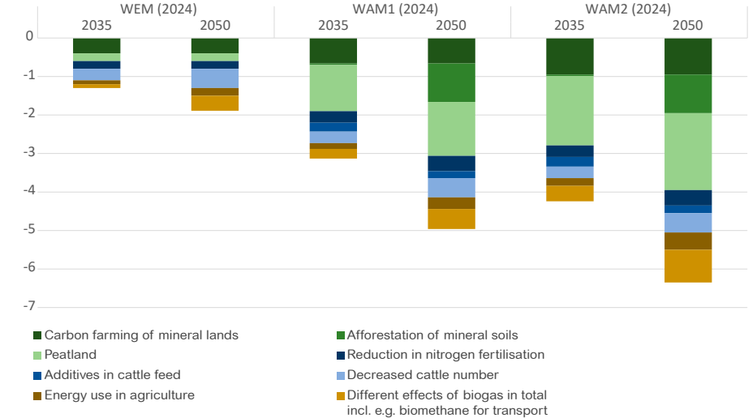
Graph 1.

Different scenarios of GHG emission reductions in agriculture, excluding the different effects of biogas production
(Mt CO2 eq./year)



Graph 2

The reduction of GHG emissions in agriculture (Mt CO2 eq./year) with different measures and in different scenarios from 2020 to 2035 and 2050.



In Finland, a total of some EUR 1.7 billion is paid in agricultural subsidies annually. The most important change compared to the previous CAP programming period is the new eco-system, which forms an integral part of climate measures in agriculture. About 16.4% (EUR 86 million) of the first pillar of CAP's annual funding (a total of EUR 525 million) is paid through it. The measures included in the eco-system include wintertime plant cover, natural grasslands, green manure leys and biodiversity plants. However, the actions taken in the CAP period 2023-2027 will not lead to large emission reductions in agriculture. The Natural Resources Institute Finland has estimated that the total emission reduction effect of the actions in CAP plan 2023-2027 is approximately 0.9 Mt Co2 eq. per year (WEM) while all emissions from agriculture amount to 15 Mt CO2 eq. per year. The effects of changes in agricultural policy are analysed through scenario calculations in the road map for the following sub-areas: climate wetlands, peat land grasses, natural grasslands and biodiversity fallow lands. From the point of view of reducing climate emissions, the measures related to peatland are the most important ones. However, in areas where there is a relatively large area of peatland, removing peat from production use or changing the production method significantly may have an unreasonable effect on the farms in the area and thus on food production. It is easier to achieve the rewetting targets for peat soils in areas where the share of peatland is smaller.

Table 1. Definitions of different scenarios in general terms: Instruments used in agriculture

WEM **basic scenario,** **the situation in April 2024**	**WAM1** **achievable additional incentive (companies, value chains, public authority)**	**WAM2** **ambitious, a strong willingness to pay in society (companies' value chains, public authority)**
The target area for climate wetlands is 3000 ha; no CAP financing, but support for care of wetlands, small budget	The target area for climate wetlands x4 (12 000 ha), larger budget	The target area for climate wetlands of agricultural production 24 000 ha, ambitious policy for low productivity peat lands out from agriculture
Peat land grassland instead of annual crops, target area 40 000 ha	Peat land grassland, target area 50 000 ha	Peat land grassland, target area 60 000 ha annual crops still alternative for minor part of the farmers
Natural grassland, as in 2023-2027	Supplementary premium for drained peat lands as part of the nature restoration law	Supplementary premium for drained peat lands as part of nature restoration law
Biodiversity fallows, as in 2023-2027	Substantial biodiversity premium for permanent grassland on cultivated peatlands, nature restoration regulation (no financing yet)	Substantial biodiversity premium for permanent grassland on any type of soil (no financing yet)
Carbon farming is slowly becoming common, thanks to subsidies for e.g. renovation plants and grasslands for green manuring	Carbon farming is increasingly encouraged	Carbon farming on mineral land becomes the norm, and there is substantial availability of training and financial support for multi-beneficial measures
Decoupled CAP subsidy, as in 2023-2027	Decoupled CAP subsidy decreasing slowly since subsidy is transferred to the above mentioned actions	Decoupled CAP subsidy decreasing quickly
		The share and importance of results-based payments in environmental management of agriculture increases

Carbon market and agriculture

A concrete concept has been formed in the road map for WEM and for WAM1 and WAM2 analysing what kind of possibilities agriculture has in being part of the flexibility mechanism included in the national law of transport fuel blending obligation and in the EU-wide carbon market via CRCF that will take shape in the future. When analysing the emission reduction potential, the cost-effectiveness of various measures in agriculture as an enabler of emission reductions/carbon sequestration/control measures is made clearer, and answers are given to the question on how agriculture can contribute to emission reductions.

The EU carbon certification regulation (CRCF) creates a reference framework for the production, methods and trading of certified climate units on the private market from carbon farming, which can allow agriculture to participate in the carbon market. The requirement for the certification is that the emission reduction has an impact for at least five years. In addition, the criteria regarding accountability, additionality, permanence and sustainability must be met. In the updated version of the climate road map, agriculture has been left out of the carbon market in the WEM scenario which is the current status quo. In the WAM1 and WAM2 scenarios, agriculture has the possibility to be part of the carbon market either moderately or significantly, depending on the scenario.

In the WAM1 and WAM2 scenarios, agriculture has various measures for possible emission reduction that can be utilized with the help of the carbon market. In terms of emission reduction potential, the most important ones are carbon cultivation of mineral soils and rewetting low-yielding peat lands either permanently or nearly permanently by blocking waterways or regulating sub-drainage. Other measures include replacing annual plants with grass in peatlands or wetland cultivation through controlled water regulation or drainage. Afforestation also plays a role in reducing potential emissions, especially when it comes to thin peat flands or low productivity mineral soils. The problem with afforestation is, however, that it takes a long time before carbon sequestration is materialized and initial costs are substantial. This means that afforestation is difficult to implement. The use of the 3NOP additive in cattle feed and the production of biogas are some alternatives, but they are not that cost-effective. Both have, however, at least moderate emission reduction potential. It should be noted that a large part of measures that have great emission reduction potential are not worthwhile for farmers without additional subsidies or other funding that improves profitability. As a whole, emission reductions will focus on things that can be measured through carbon sinks and cost effectiveness. In agriculture, this will primarily mean peatland and low productivity mineral soils.

According to Petteri Orpo's government program, the flexibility mechanism included in the national law of transport fuel blending obligation aims at offering more actions that are applicable for distributors to fill the obligation. With the help of the flexibility mechanism, a fossil fuel distributor can meet the blending obligation by financing additional emission reduction measures from the effort-sharing sector up to the legally defined limit (max. 5,5%). In the case of the land use sector, additional measures could fulfill the flexibility mechanism up to a certain limit (max 1%). This would give agriculture another opportunity to be part of the carbon market through additional funding.

Table 2. Definitions of different scenarios in general terms: Carbon market and the expansion of emissions trading

WEM **No possibility to sell carbon credits from agriculture**	**WAM1** **Gradually increased possibilities to sell carbon credits from verified additional activities.**	**WAM2** **The carbon market is growing rapidly and there is a demand for emission reductions from agriculture – during the 2030s, agricultural emissions trade will be gradually implemented, where many kinds of verified actions are possible.**
	Rewetting of peat lands, water level to be verified, compensation for farmers approx. € 30-40/tCO2 eq., approx. € 300-800/ha (groundwater level 5-30 cm below the surface)	Peat lands as in WAM1
	Increasing carbon input on mineral lands, small compensation EUR 30-40/ha; also water conservation benefits	Mineral soils like WAM1, but the compensation for the farmer is a bit higher because of many benefits
	The 3NOP additive, which reduces methane emissions, is slowly becoming more common in cattle feed	3NOP is widely used in cow and other cattle feed
	Reduced nitrogen fertilization due to e.g. moderate increase in precision farming and leguminous plant rotations	Precision farming, precise and reduced nitrogen fertilization, on a large scale
	Moderate afforestation of low-yielding peat lands and mineral lands that fall out of production	Afforestation of low-yielding and out-of-production peatlands and mineral soils

Energy use and production in agriculture

Since early 2010, energy consumption in agriculture has remained at a level of around 9 TWh, which corresponds to just under 3% of Finland's total energy consumption. About half of the energy use in agriculture is used for heating, a third for driving power for machines and the rest for electrical equipment and lighting. From the point of view of reducing direct GHG emissions in agriculture, the most effective thing would be to focus on developing the energy efficiency of equipment, machines and processes using fossile liquid fuels. Such measures include e.g. increasing light tillage of soil, developing adjustments and technology for warm air drying of grain, using various grain conservation methods, developing farm logistics and modern technology. Structural development, automation, use of data and intelligent production systems will also reduce the use of energy by making current processes more efficient. The use of fossile liquid fuels in agriculture will also decrease as technology develops and other energy sources, such as biogas and solar power, become more widely used. Within the next 10 years, the most significant measures to reduce emissions in arable farming will be the transition from seedbed cultivation to direct sowing on farms that meet the conditions for it. The cultivation of permanent grasslands will also play a significant part in reducing emissions in the next few years.

Many farms have built solar power in the last 10 years. During 2015–2022, farms built more solar power than what was the estimate by 2035 according to the 2020 climate road map. This is partly due to exceptionally high electricity prices. When purchased electricity is replaced with prosumer solar power, the GHG emission reduction effect is, however, relatively small, and in the future it will decrease even more due to fact that electricity consumed in Finland was already 2023 94% fossile free.

The report provides scenarios for the development of energy consumption in agriculture in case the already decided policy guidance (WEM) is implemented and in case the additional action scenarios (WAM1 and WAM2) defining additional measures to ensure the fulfillment of Finland's goal of carbon neutrality by 2035 and the impact of energy consumption in agriculture, are implemented. Based on available data describing the current state, the basic scenario WEM and the development paths WAM1 and WAM2 for biogas production are formed. The report also provides an estimate of energy use and production in agriculture by 2035 and 2050, including an assessment of energy used by agricultural machines in different scenarios. At the same time, the production of solar power in agriculture was updated. The technological development is taken into account in different forms of energy production and usage.

Livestock manure contains most of the recyclable nutrients and serves as an excellent basic input in the biogas process. The grassland area cultivated for biogas production is estimated to be 40,000 ha in the WEM scenario, 80,000 ha in the WAM1 scenario and 150,000 ha in the WAM2 scenario by 2050. It has been estimated that the required arable area will be freed up from feed grain and grassland and agriculture will become more diversified as livestock production decreases in Finland. The change in biogas production is assumed to be the largest by 2035 when significant biogas investments have been completed, assuming that the investments that are in the pipeline at the time of writing are implemented.

Table 3. Definitions of different scenarios in general terms: Energy.

WEM	WAM1	WAM2
Slow but progressing biogas growth with existing intstruments, the use of manure in biogas production becoming more common	Gradually increasing demand for biomethane, sustainability criteria affect the supply of advanced renewable fuels	Strong demand for biomethane for transport and industry, production of grass in order to use agricultural land in a sustainable manner
Biogas production in agriculture will increase to 1 TWh by 2035 and 1.6 TWh by 2050	Biogas production in agriculture will increase to 1.4 TWh by 2035 and 2.2 TWh by 2050	Biogas production in agriculture will increase to 1.7 TWh by 2035 and 3.6 TWh by 2050
Solar energy in agriculture will continue to grow, but slows down by 2030 – the easiest projects have been implemented	Solar energy in agriculture will continue to grow by 2035	Solar energy in agriculture will continue to grow and be more effective, e.g. ownerships in large solar utilities and production areas
Reduced tillage saves fuel – minor impact	Reduced tillage on a large scale – noticeable fuel savings	Reduced tillage and new technology (unmanned machines, intelligent control, electricity) – noticeable fuel savings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