SWISS FUTURE FARM

Annual Report 2024

AGCO
Your Agriculture Company

arenenberg

GVS Agrar

The Farm

Farm size

81 ha agricultural land

55 ha arable crops

20 ha permanent grassland

6 ha biodiversity area

Dairy barn

Cattle herd Tänikon:

65 dairy cows

2/3 Brown Swiss, 1/3 Red Holstein and Holstein Frisian

Cow husbandry:

The farm makes the trial barns available for trials by Agroscope and the Swiss Future Farm.

Two sites with dairy cattle barns: Emission research barn Waldegg & dairy barn Tänikon

Cows are milked with an automatic milking system (milking robot)

Free stall barn with permanently accessible outdoor paddock

Calf rearing:

Individual housing in igloos with run

Milk for free disposal

Rearing calves leave the farm after 3 weeks and spend the time until 4 weeks before the first calving on two partnership farms and on the alpine pasture

Pigpen

Number of animals:

60 breeding hogs

1 boar

Number of places:

120 fattening places

200 rearing places

18 farrowing pens

The Aim

The Swiss Future Farm makes modern Precision Farming technologies for sustainable and competitive agriculture visible, tangible and understandable:

- Highlight the benefits and opportunities of digitalization, connectivity, data acquisition and documentation, and as a decision-making aid in everyday life.
- Demonstrate how Smart Farming technologies can be used to redesign farming processes and thus significantly improve Sustainability (ecological and economic) of food production.
- Support and implement research and development activities of the partners as well as Agroscope and other third parties.
- Set an example in the innovative interaction between companies in the agricultural sector and public research, education and advisory services.
- Permanent experimental farm with visiting opportunities and further training opportunities for employees as well as knowledge transfer to farmers, the public and other stakeholders. To establish Tänikon as an agricultural meeting point.
- Continuously implement innovations and developments in production processes on a farm. The Swiss Future Farm offers a platform for the use and testing of new technologies. In order to continuously stay up to date, Swiss Future Farm conducts targeted re-search on new solutions (Innovation Survey and Scouting) and integrates them into operational processes.

The Partners

AGCO International GmbH

Leading manufacturer of high-tech solutions for farmers. Brands: Fendt, Valtra, Massey Ferguson, Precision Planting.

Arenenberg

Agricultural education and extension center of the Canton of Thurgau with three school and experimental farms.

GVS Agrar AG

Market-leading importer of agricultural machinery in Switzerland. Import, sales and service for all AGCO brands.

Swiss Future Farm: Strategy 2030

MISSION: Driving a future-proof and sustainable agriculture and food industry

VISION 2030: Swiss Future Farm is a Swiss leader in the testing, evaluation and communication of new processes and the use of technologies that support ecological, economical and robust food production.

The agricultural and food industry is facing a major challenge as a result of climate change: rising temperatures, changing precipitation patterns and extreme weather events are putting agricultural production under increasing pressure. This is why the Swiss Future Farm is committed to economically, ecologically and socially sustainable food production. It focuses on farming methods that represent potential solutions to future agricultural challenges such as climate change, scarce resources, soil fertility, soil biology, water balance and yield capacity. The feasibility of these methods in Tänikon and in the Cantons of Thurgau and Schaffhausen is examined impartially and critically. The Swiss Future Farm is not committing itself to one label. The aim is hybrid management that adapts to the situation, true to the principle of “less is more”.

Modern technology is and remains a pillar of Swiss Future Farm's strategy, with the technology following the methods. Swiss Future Farm fosters exchange and utilizes synergies with Agroscope and University of Applied Sciences OST at the Tänikon site and provides the infrastructure and know-how. Acquired knowledge is passed on and made accessible in line with customer requirements.

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1 Field Trials

1.1 Short Stature Corn – Initial Pilot Trial 2024

STUDY CONTACT:

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BACKGROUND

Due to climate change and the goal of developing more sustainable farming systems, nutrient and especially water efficiency of plants will become increasingly important in the future. Plants that can cope better with less nutrients or water, or that generate the same output with less input, are at an advantage.

In this trial, newly bred corn varieties with reduced plant height were compared to conventional varieties. Due to differences in plant height, both plant density and row spacing were varied, which can also influence ground cover, weed suppression, and soil erosion.

How do these factors affect cob-plant proportion and forage quality? Do these varieties actually provide an advantage over established varieties, and can they demonstrate their benefits under practical farming conditions?

This pilot trial is being used to develop the methodology for potential research projects or more extensive future trials.

OBJECTIVE

The aim of the trial was to evaluate the suitability of the new SSC (Short Stature Corn) varieties compared to conventional varieties under Swiss farming conditions. Particular attention was paid to:

- Adjustment of seeding rate,
- Yield (fresh mass and dry matter),
- Forage quality (NEL, crude protein, crude fiber, crude fat),
- Plant and cob characteristics,
- Disease susceptibility (e.g., corn smut, helminthosporium),
- Overall productivity depending on population density.

TRIAL DESIGN AND METHODS

Corn:

- A new short-statured variety from Bayer (Dekalb) was compared to the variety LG 31.207 as a control. LG 31.207 was used on most fields of the farm.
- Different seeding rates were tested: SSC: 7, 10.5, and 14 seeds/m²; LG 31.207: 7, 9, and 10.5 seeds/m²
- Two strips of 6 meters width were established per seeding rate

Figure 1. Trial design for Short Stature Corn 2024

Soil Preparation:

- Previous crop: temporary grassland
- May 3: Shallow tillage with Horsch Terrano 3 FX
- May 10: Rotary harrow and Horsch Terrano 3 FX (with altered steering angle A+)
- May 11: Seeding with Precision Planter, row spacing 75 cm

Fertilization:

- May 10: 37 kg N/ha as pig manure
- May 14: 55 kg N/ha as pig slurry
- June 25: 55 kg N/ha as urea

Plant Protection:

- June 7: Application of Banvel 4S + Equip Power

Assessments:

- July 18: Internode distance, cob height
- September 12: Plant height, cob height, fresh and dry mass separately for cobs and plants, disease inspection, tillering assessment

Harvest:

- October 25
- Fresh and dry mass samples, as well as analysis of crude nutrients and energy estimation

RESULTS

All tested variants delivered yields and quality as expected.

Population density and variety influenced productivity (yield per hectare) and agronomic traits such as plant height, ear height, and ripening behaviour.

Higher seeding rates resulted in higher yields but tended to lead to slightly lower dry matter contents.

The overall height of SSC corn was significantly lower than that of the control variety.

No significant negative effects regarding disease infestation (corn smut, helminthosporium) or tillering were observed.

Cob proportion and forage quality (NEL, crude protein, crude fiber, crude fat) were within the expected range.

Figure 2. Left: SSC corn, right: LG 31.207, photo taken July 17

Figure 3. Drone image of the trial field; the different varieties are clearly visible

DISCUSSION

Since it is important to us to present robust and reliable data, the trials will be repeated in 2025. Numerical results will only be published after evaluation of multi-year trials. Based on the current observations, we can state that productivity, yield, nutritional values, and disease resistance are satisfactory, and we are fundamentally pleased with the results and intend to continue testing the seed material. No negative points were identified. Unfortunately, in one replicate, 7 seeds/m² were mistakenly sown instead of 14 seeds/m², resulting in only one valid replicate at the highest seeding rate.

The seeding rate of 14 seeds/m² at a row spacing of 75 cm was borderline. In 2025, the trial will be repeated with a 50 cm row spacing, which should allow better use of available space, and SSC corn may better exploit its advantages.

Furthermore, a 50 cm row spacing could offer benefits for mechanization across various crops due to standardized row spacing.

The control variety LG 31.207 was not ideally matched in terms of maturity to the SSC variety. LG 31.207 matured somewhat earlier (as indicated by dry matter values), and the overall farm's silage corn harvest was scheduled according to the predominantly used LG 31.207. A more carefully selected control variety will be used in 2025.

Potential advantages of SSC in challenging weather conditions (drought, storms) could not be assessed during this trial.

ACKNOWLEDGEMENTS

We would like to thank Kevin Brändli and Bayer for providing the opportunity to test this new seed material, and Jürg Hiltbrunner from Agroscope for his support and advice in planning and implementing the trial.

1.2 Herbicide Reduction and Reduced Tillage Study in Sugar Beets

CONTACT

Nils Zehner – AGCO Agronomy and Farm Solutions, Swiss Future Farm
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OBJECTIVE

The objective of this study was to evaluate yield in sugar beets grown with different weed control regimes. These are comprised of herbicide broadcast spraying and band spraying in combination with mechanical weeding in two different reduced tillage systems (Deep ripping vs. Strip-Till).

STUDY DESIGN

The trial was carried out at the Swiss Future Farm in 2024 as a side-by-side strip trial. The planting date was within the usual timeframe on April 14, 2024. The treatments that were compared are shown in Table 1. As for band spraying, the target area for application was only 50% of the broadcast application. (Only crop rows sprayed, inter-row weed control via mechanical weeding.) It was therefore possible to reduce the applied herbicide amount by 50%.

Table 1. Treatments of the herbicide reduction and reduced tillage study in sugar beets.

Trial strip	Tillage	Weed Control Treatment	Weed Control Field Operations
1	Deep ripping + disc harrow	Broadcast spraying (2 Splits, Bayer Conviso One, 2x 0.5 l/ha)	– Chemical weeding w/ broadcast spraying 2x (= 100% herbicide amount)
2	Deep ripping + disc harrow	Band spraying (50% target area, 2 Splits Bayer Conviso One, 2x 0.25 l/ha) + Mechanical Weeding	– Chemical weeding w/ band spraying 2x (= 50% herbicide amount) – Mechanical weeding w/ camera-steered hoe 1x
3	Strip-Till	Broadcast spraying (2 Splits, Bayer Conviso One, 2x 0.5 l/ha)	– Chemical weeding w/ broadcast spraying 2x (= 100% herbicide amount)
4	Strip-Till	Band spraying (50% target area, 2 Splits Bayer Conviso One, 2x 0.25 l/ha) + Mechanical Weeding	– Chemical weeding w/ band spraying 2x (= 50% herbicide amount) – Mechanical weeding w/ camera-steered hoe 1x

RESULTS

Field emergence measurements were taken 44 days after planting and show a low emergence rate, averaging 60%, which did not differ significantly in the field section with deep ripping tillage, but had a 5% difference between treatments after Strip-Till (Figure 4).

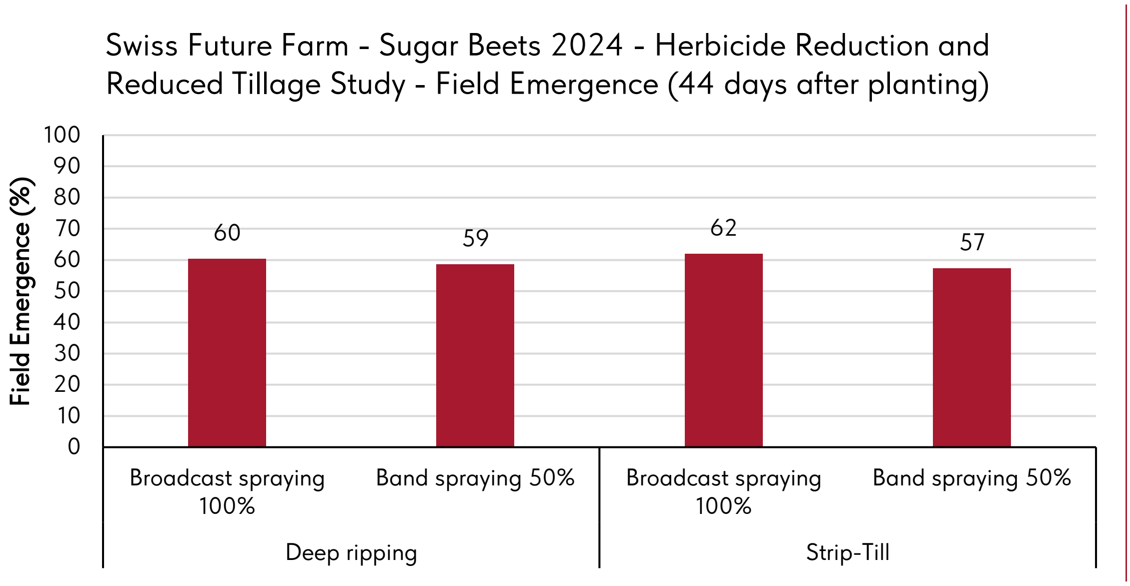

Figure 4. Field emergence results of the herbicide reduction and reduced tillage study in sugar beets.

The trial was harvested on October 7, 2024. The average beet yield across all treatments was 71.1 t/ha (Figure 5).

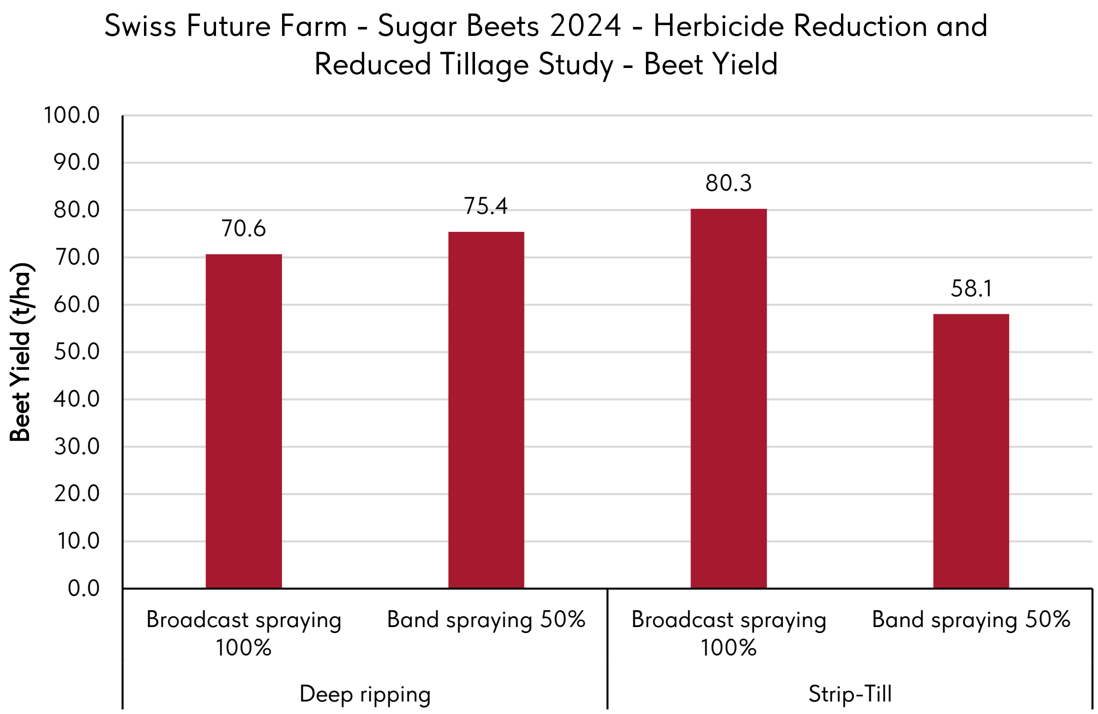

Figure 5. Beet yield results of the herbicide reduction and reduced tillage study in sugar beets.

A detailed results comparison is contained in Table 2. These findings show contrary results for beet yield in the two tillage regimes. While obtaining a 6.8% yield increase for the band spraying treatment in the deep ripping field section, beet yield for the band spraying treatment after Strip-Till was significantly lower (-28%), which may be partially explained by the 5% lower field emergence rate found in this trial strip (cf. Figure 4). As a further observation, we found significantly higher late season weed infestation in a section of the trial strip with band spraying after Strip-Till, which may be a field effect from previous trials and is the cause for nutrient and water competition resulting in lower yield and sugar content (Figure 6). Sugar content was consistently lower for the band spraying treatments. Results for sugar yield are equivalent to the trend found for beet yield with a 4% higher sugar yield for band spraying after deep ripping, and 35% lower yield for the band spraying treatment after Strip-Till.

Table 2. Results overview of the herbicide reduction and reduced tillage study in sugar beets.

	Deep ripping + Broadcast spraying 100% (Control 1)	Deep ripping + Band spraying 50%	Strip-Till + Broadcast spraying 100% (Control 2)	Strip-Till + Band spraying 50%
Beet yield (t/ha)	**70.6**	**75.4**	**80.3**	**58.1**
Difference to control (%)	0	6.8	0	-27.7
Sugar content (%)	**16.2**	**15.8**	**15.7**	**14.6**
Difference to control (%)	0	-0.4	0	-1.1
Sugar yield (t/ha)	**10.0**	**10.4**	**11.1**	**7.2**
Difference to control (%)	0	4.0	0	-35.1

Figure 6. Late season weed infestation patch in trial strip with Strip-Till and band spraying treatment (drone image taken 08/16/2024).

ADDITIONAL OBSERVATIONS

Crop measurements taken in mid-June showed differences in sugar beet weight, root length, and root diameter between the different trial treatments. These results are closely correlated to the results found for beet and sugar yield after harvest, with the highest yielding treatment of Strip-Till and broadcast spraying (trial strip 3) also showing the best developed beets during the crop measurements (Table 3).

Table 3. Crop measurement results (average of 40 beets per treatment) obtained via random sampling on 18 June 2024.

	Deep ripping + Broadcast spraying 100%	Deep ripping + Band spraying 50%	Strip-Till + Broadcast spraying 100%	Strip-Till + Band spraying 50%
Beet weight with leaves (g)	51.6	58.8	103.8	37.4
Beet weight without leaves (g)	8.3	10.2	23.8	6.3
Root length (mm)	65.9	80.8	114.6	59.6
Root diameter (mm)	16.8	20.5	29.7	15.7

FINANCIALS

Table 4 shows a comparison of the financial results. Revenue is based on paid out sugar beet price as an index of beet yield, soil contamination, sugar content and extractability according to lab analysis after delivery to sugar factory. Operating costs include all machine, labor, and inputs costs. Results show that the revenue differences between treatments matched the trend found with yield measurements. There was a cost level for the deep ripping treatments due to the deep ripper pass and two disc harrow passes for seedbed preparation that were conducted. Higher operating costs in the band spraying treatments are due to the mechanical weeding pass, which could not be mitigated by 50% savings in herbicide costs.

Table 4. Financial results of the herbicide reduction and reduced tillage study in sugar beets.

	Deep ripping + Broadcast spraying 100%	Deep ripping + Band spraying 50%	Strip-Till + Broadcast spraying 100%	Strip-Till + Band spraying 50%
Revenue (CHF/ha)	4373	4607	4961	3449
Operating Costs (CHF/ha)	3771	3912	3487	3628
Gross Margin (CHF/ha)	602	695	1474	-179
Gross Margin + Subsidies (CHF/ha)	2952	3295	3824	2421

Including subsidies, which comprise bonus payments for reduced tillage for both tillage treatments in this study, and herbicide reduction bonus payments for band spraying application, the treatment with Strip-Till and broadcast herbicide application remained the most profitable treatment. This is due to the highest yield level and lowest operating costs in the comparison, which could not be compensated to an equivalent profitability level via subsidies for the other treatments (**Figure** 5Figure 7). Based on a national subsidy scheme, Swiss sugar beet growers are compensated with 2100 CHF/ha crop-specific subsidies, which is independent on the tillage or weed control regime applied, which is additionally supporting profitability of sugar beet production.

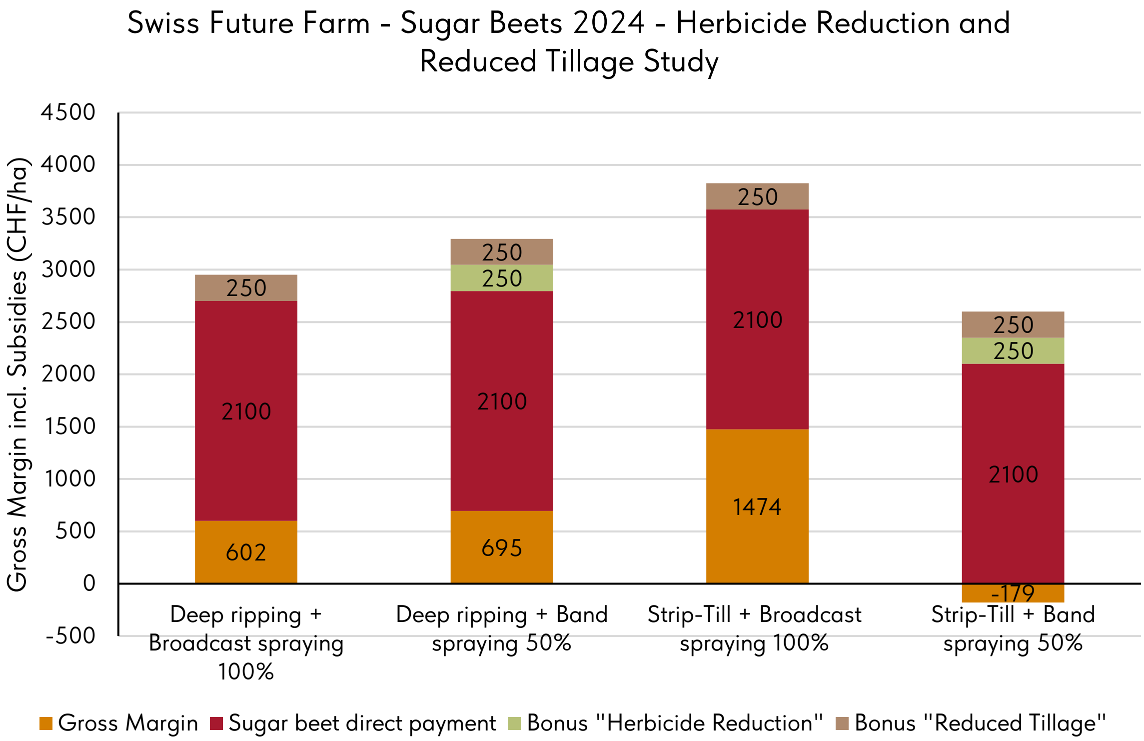

Figure 7. Gross margin including subsidies for the treatments of the herbicide reduction and reduced tillage study in sugar beets.

CONCLUSIONS

- Results of this study show that competitive yield levels can also be achieved in herbicide reduced weed control regimes.
- Although 50% savings for herbicide costs can be realized with band spraying, the addition of mechanical weeding still represents a disadvantageous solution from a profitability standpoint due to higher operating and labor costs (higher fuel and wear costs, higher work time requirements due to lower field efficiency) in comparison to conventional broadcast herbicide application.

1.3 Biostimulant and Water Application at planting in Sugar Beets

CONTACT

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OBJECTIVE

The objective of this study was to investigate the impact of water and biostimulant applications at planting on beet yield and sugar content, and the resulting sugar yield under two different tillage regimes. The underlying hypothesis was that water application improves seed-to-soil contact, resulting in faster more uniform field emergence, and that biostimulants may promote root development to enable yield increase.

STUDY DESIGN

The trial was carried out at the Swiss Future Farm in 2024 as a side-by-side strip trial. Water application (100 l/ha) and biostimulant product application at planting (Timac Agro Irys 7-9-13, 5 l/ha, applied with 95 l/ha water) was done with Precision Planting FlowSense system in a comparative trial with no water or biostimulant application as the control treatment following two different tillage regimes (deep ripping + disc harrow vs. Strip-Till). The planting date was April 14, 2024. Weed control was identical across all trial strips with Bayer Conviso ONE two split herbicide application (2x0.5 l/ha). The treatments compared are shown in Table 5.

Table 5. Treatments of the Biostimulant and Water Application Study in sugar beets.

Trial Strip	Tillage	Liquid application
1	Deep ripping + disc harrow	No liquid application (Control 1)
2	Deep ripping + disc harrow	Water application (100 l/ha)
3	Deep ripping + disc harrow	Biostimulant Timac Agro Irys 7-9-13 (5 l/ha), applied with water (95 l/ha)
4	Strip-Till	No liquid application (Control 2)
5	Strip-Till	Water application (100 l/ha)
6	Strip-Till	Biostimulant Timac Agro Irys 7-9-13 (5 l/ha), applied with water (95 l/ha)

RESULTS

Field emergence measurements taken 44 days after planting show a significantly higher emergence rate for sugar beets planted with water application after deep ripping tillage, and for both water and biostimulant applications after Strip-Till tillage (Figure 8).

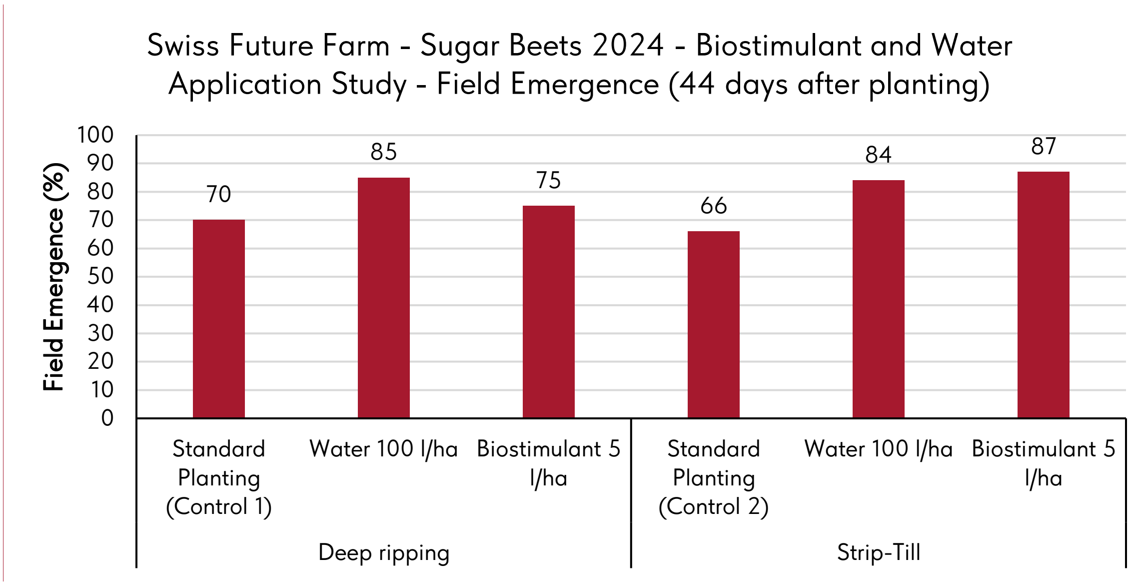

Figure 8. Field emergence results of Biostimulant and Water Application Study in sugar beets.

The trial was harvested on October 7, 2024. The average beet yield across all treatments was 78.4 t/ha (Figure 9).

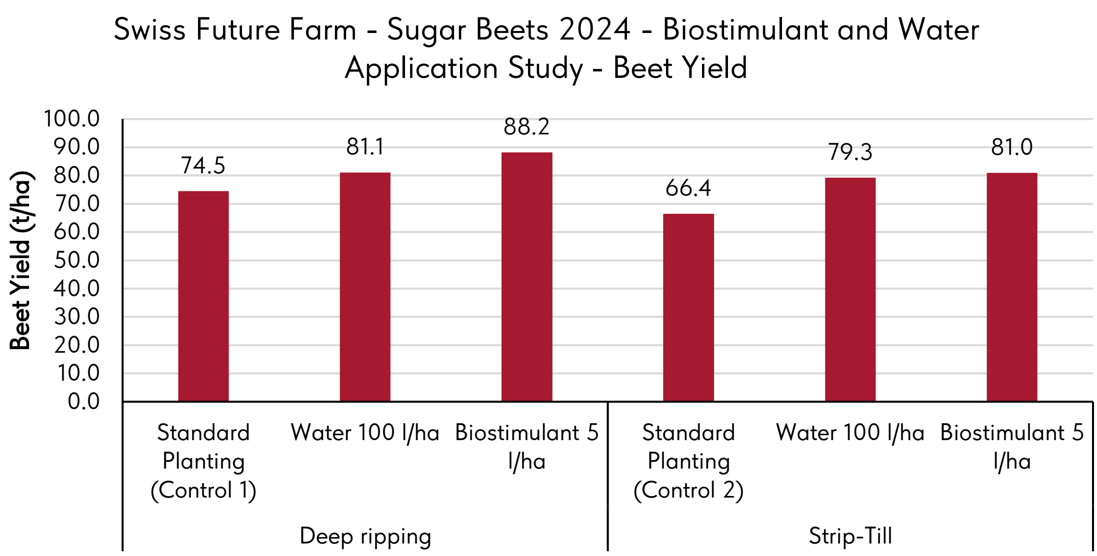

Figure 9. Beet yield results of Biostimulant and Water Application Study in sugar beets.

A detailed results comparison is contained in Table 6. These results show that both water and biostimulant applications at planting resulted in significant beet and sugar yield increases, whereas changes in sugar content were less evident. The yield advantage also needs to be interpreted as an impact of the significantly higher field emergence rates in trial strips with water and biostimulant applications. The increase in sugar yield per hectare is majorly resulting from the increase in beet yield (biomass), while differences in sugar content had a minor influence between the treatments of this study.

Table 6. Results overview of the Biostimulant and Water Application Study in sugar beets.

	Deep ripping / disc harrow + No liquid application (Control 1)	Deep ripping / disc harrow + Water application (100 l/ha)	Deep ripping / disc harrow + Biostimulant application 7-9-13 (5 l/ha)	Strip-Till + No liquid application (Control 2)	Strip-Till + Water application (100 l/ha)	Strip-Till + Biostimulant application 7-9-13 (5 l/ha)
Beet yield (t/ha)	**74.5**	**81.1**	**88.2**	**66.4**	**79.3**	**81.0**
Difference to control (%)	0	8.9	18.4	0	19.4	22.0
Sugar content (%)	**15.1**	**14.7**	**15.3**	**15.3**	**16.8**	**16.1**
Difference to control (%)	0	-0.4	0.2	0	1.5	0.8
Sugar yield (t/ha)	**9.7**	**10.4**	**11.7**	**8.9**	**11.8**	**11.5**
Difference to control (%)	0	7.2	20.6	0	32.6	29.2

ADDITIONAL OBSERVATIONS

Crop measurements in late June showed significantly higher beet weight, root length, and root diameter in sugar beets with water and biostimulant application under both tillage systems investigated. This also reflects the yield differences found at harvest (Table 7).

Table 7. Crop measurements results (average of 40 beets per treatment) obtained 18 June 2024.

	Deep ripping / disc harrow + No liquid application (Control 1)	Deep ripping / disc harrow + Water application (100 l/ha)	Deep ripping / disc harrow + Biostimulant application 7-9-13 (5 l/ha)	Strip-Till + No liquid application (Control 2)	Strip-Till + Water application (100 l/ha)	Strip-Till + Biostimulant application 7-9-13 (5 l/ha)
Beet weight with leaves (g)	81.6	135.7	136.0	48.7	70.9	48.5
Beet weight without leaves (g)	16.8	32.6	30.7	9.4	15.3	9.2
Root length (mm)	84.7	121.4	100.3	88.3	110.1	86.2
Root diameter (mm)	25.8	32.8	31.4	20.2	23.3	19.5

FINANCIALS

Table 8 shows a comparison of the financial results. Revenue is based on paid out sugar beet price as an index of beet yield, soil contamination, sugar content and extractability according to lab analysis after delivery to sugar factory. Operating costs include all machine, labor, and input costs including the purchase price of the biostimulant product of 25.70 CHF/l and water costs of 0.002 CHF/l. Results show that the increase in gross margin when using water or biostimulant application was 318 CHF/ha and 710 CHF/ha (Deep ripping), or 1163 CHF/ha and 825 CHF/ha (Strip-Till) in comparison to the respective control treatments. Including subsidies, which are comprised of crop-specific direct payments for sugar beets (2100 CHF/ha) and bonus payments for reduced tillage for all treatments (250 CHF/ha), the highest gross margin was obtained for biostimulant application after deep ripping + disc harrow tillage, and water application after Strip-Till tillage**Figure 5**.

Table 8. Financial results of the Biostimulant and Water Application Study in sugar beets.

	Deep ripping / disc harrow + No liquid application (Control 1)	Deep ripping / disc harrow + Water application (100 l/ha)	Deep ripping / disc harrow + Biostimulant application 7-9-13 (5 l/ha)	Strip-Till + No liquid application (Control 2)	Strip-Till + Water application (100 l/ha)	Strip-Till + Biostimulant application 7-9-13 (5 l/ha)
Revenue (CHF/ha)	4545	4863	5383	4053	5216	5006
Operating Costs (CHF/ha)	3686	3686	3815	3643	3643	3771
Gross Margin (CHF/ha)	858	1176	1568	410	1573	1235
Gross Margin + Subsidies (CHF/ha)	3208	3526	3918	2760	3923	3585

CONCLUSIONS

- Biostimulant and water applications at planting have both shown to be a promising approach to improve yields in sugar beet production.
- Water application at planting enabled the increase of beet yield (8.9-19.4%) and sugar yield (7.2-32.6%) in comparison to the control treatment with standard planting.
- Biostimulant application at planting enabled the increase of beet yield (18.4-22.0%), sugar content (0.2-0.8%), and sugar yield (20.6-29.2%) in comparison to the control treatment with standard planting.
- These positive effects of water and biostimulant application were found both under deep ripping and Strip-Till tillage systems.
- Water application represents a favorable option on profitability level due to lower input costs and at the same time significant yield increase.

1.4 Reduced Tillage Study in Silage Corn

CONTACT

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OBJECTIVE

The objective of this study was to evaluate yield in silage corn grown with different approaches for timing, number of tillage passes, and fertilizer application at planting in a Strip-Till tillage system.

STUDY DESIGN

The trial was carried out at the Swiss Future Farm in 2024 as a side-by-side strip trial. Strip-Tillage was done with a Horizon Ag SPX Strip-Till toolbar (https://www.horizonagriculture.com/spx) equipped with dry fertilizer system for banded application (placed 2 inches to the side and 2 inches below the seed) at planting. The cover crop was terminated using Roundup Powermax 3 weeks before planting. The planting date was 30th April 2024 with 90,000 seeds/ha in 50 cm row spacing. Weed control and fertilization was identical across all trial strips with one herbicide application (EquipPower, 1.0 l/ha) and one fertilizer application (58 kg N/ha, applied as Urea 46% with 126 kg/ha). The treatments that were compared are shown in Table 9.

Table 9. Treatments of the reduced tillage study in silage corn.

Trial strip	Tillage Field Operations	Fertilizer Application at planting
1	- Strip-Till pass 2 weeks before planting (15 cm depth) - Strip-Till pass on the day of planting (15 cm depth)	- No banded fertilizer at planting
2	- Strip-Till pass 2 weeks before planting (15 cm depth) - Strip-Till pass on the day of planting (15 cm depth)	- Banded NP fertilizer at planting (Landor Notill 20-20, 80 kg/ha)
3	- Strip-Till pass on the day of planting (15 cm depth)	- Banded NP fertilizer at planting (Landor Notill 20-20, 80 kg/ha)

RESULTS

The trial was harvested on September 20, 2024. Cold and wet weather conditions in the weeks after planting provided very unfavorable growth conditions during the juvenile phase. Hence, the average yield level across all treatments was very low compared to the historic average of the location with an average dry matter yield of 12.1 t/ha (Figure 10).

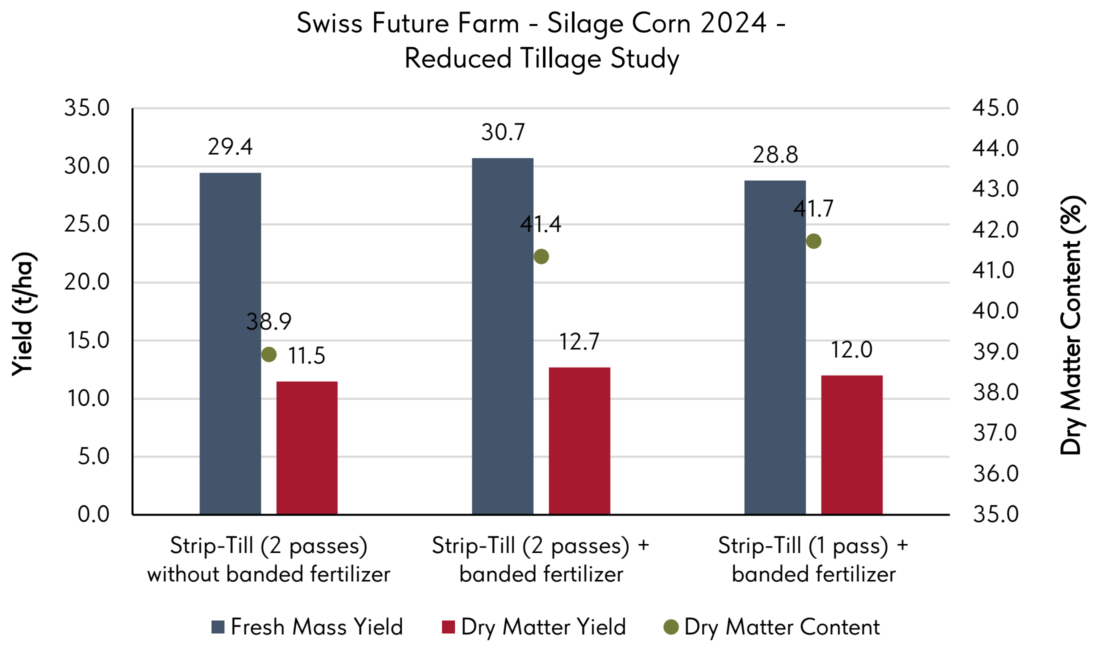

Figure 10. Yield and dry matter results of the Reduced Tillage Study in silage corn.

These results show that banded fertilizer applications at planting resulted in higher dry matter content and dry matter yield. Hence, the dry matter yield increase with banded fertilizer application in comparison to the control treatment without banded fertilizer was 10.4% for the Strip-Till 2 passes and 4.4% for the Strip-Till 1 pass treatment, respectively.

FINANCIALS

Table 10 shows the revenue obtained from the different trial strips, assuming a silage corn price of 60 CHF/ton fresh mass for silage corn harvested with ≥40% DM content and 58.50 CHF/ton with <40% DM content. The revenue obtained was limited by the low yield levels at this location in 2024 (11.5-12.7 t/ha vs. 19.0-21.0 t/ha historic average). Factoring in operating costs (incl. all machine, labor, and input costs) resulted in a low gross margin level for all treatments, with the Strip-Till 2 passes + banded fertilizer treatment being the most beneficial treatment from a profitability standpoint. Gross margins increased by 33 CHF/ha or 11 CHF/ha with the application of banded fertilizer compared to no fertilizer application at planting, respectively. Subsidies, which comprise bonus payments for Strip-Till as a reduced tillage practice amount to 250 CHF/ha for all treatments compared.

Table 10. Financial results of the reduced tillage study in silage corn.

	Strip-Till (2 passes) without banded fertilizer	Strip-Till (2 passes) + banded fertilizer	Strip-Till (1 pass) + banded fertilizer
Revenue (CHF/ha)	1723	1842	1726
Operating Costs* (CHF/ha)	1658	1745	1651
Gross Margin (CHF/ha)	64	97	75
Gross Margin + Subsidies (CHF/ha)	314	347	325

*excl. harvest costs to account for silage corn prices as stated by Agridea (2024)

CONCLUSIONS

- Strip-Till with two passes before planting has shown as a preferential reduced tillage practice to enable higher yield level under the conditions of the study location, where additional operating costs for a second Strip-Till pass do not outweigh the higher revenue from yield.
- Banded fertilizer application at planting enabled the increase of silage corn dry matter yield by 4.4% to 10.4% in comparison to the control treatment without banded fertilizer.

1.5 Biostimulant and Water Application at planting in Silage Corn

CONTACT

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OBJECTIVE

The objective of this study was to investigate the impact of water and biostimulant applications at planting, on silage corn yield. The underlying hypothesis was that water application improves seed-to-soil contact, resulting in faster more uniform field emergence, and that biostimulants may provide plant health benefits and more stress resistance to enable yield increase.

STUDY DESIGN

The trial was carried out at the Swiss Future Farm in 2024 as a side-by-side strip trial. Water application (100 l/ha) and biostimulant product application at planting (Timac Agro Irys 7-9-13, 5 l/ha, applied with 95 l/ha water) was done with Precision Planting FlowSense system in a comparative trial with no water or biostimulant application as the control treatment in an intensive tillage system (moldboard plow). The planting date was 1st May 2024. Weed control and fertilization was identical across all trial strips with one herbicide application (EquipPower, 1.5 l/ha) and one fertilizer application (55.2 kg N/ha, applied as Urea 46% with 120 kg/ha). The treatments compared are shown in Table 11.

Table 11. Treatments of the Biostimulant and Water Application Study in silage corn.

Trial Strip	Liquid application
1	No liquid application (Control)
2	Water application (100 l/ha)
3	Biostimulant application Timac Agro Irys 7-9-13 (5 l/ha), applied with water (95 l/ha)

RESULTS

The trial was harvested on September 20, 2024. The average yield level across all treatments was comparably low for the historic average of the location with an average dry matter yield of 16.3 t/ha (Figure 11).

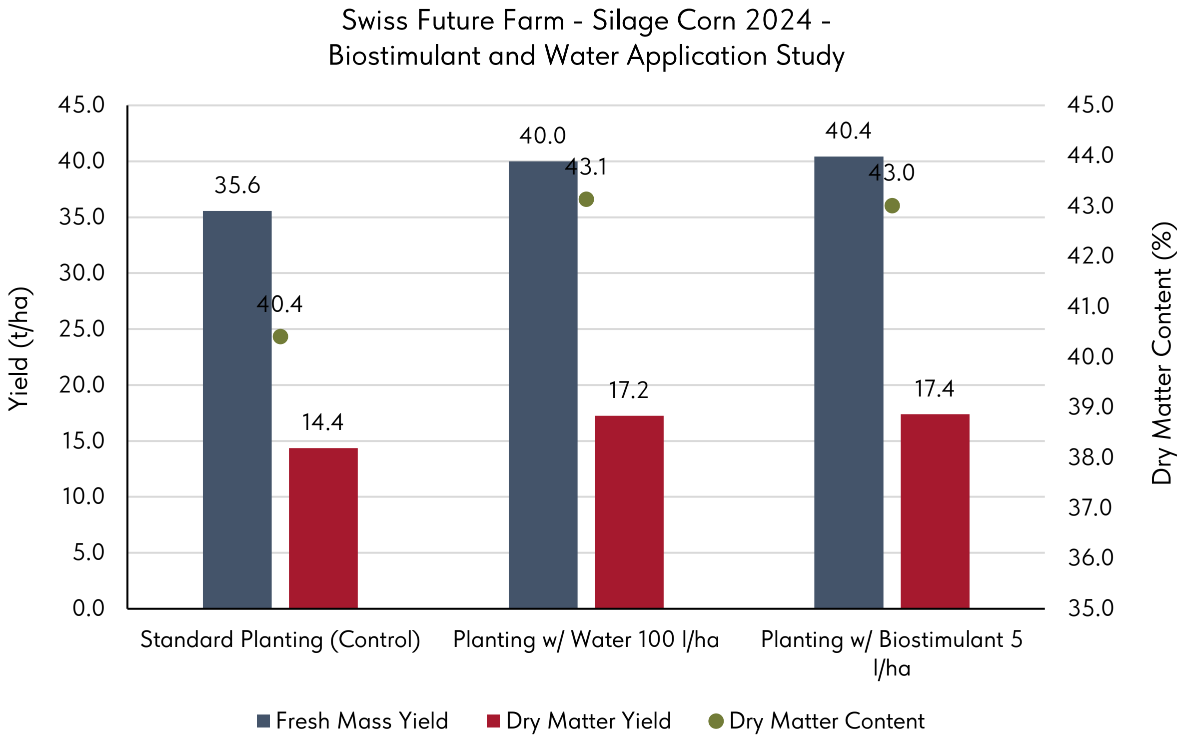

Figure 11. Yield and dry matter results of Biostimulant and Water Application Study in silage corn.

These results show that both water and biostimulant applications at planting resulted in significantly higher fresh matter yield and dry matter content. Hence, the dry matter yield increase with water and biostimulant application in comparison to the standard planting control treatment was 19.4% and 20.8%, respectively (Figure 11).

ADDITIONAL OBSERVATIONS

Hand-harvesting was completed to determine a grain yield estimate, and was done two days before harvest on an area of 9 square meters with corn ears sampled from each trial strip. The trend between treatments obtained from this grain yield estimate is in line with the yield differences found at silage corn harvest (Figure 12).

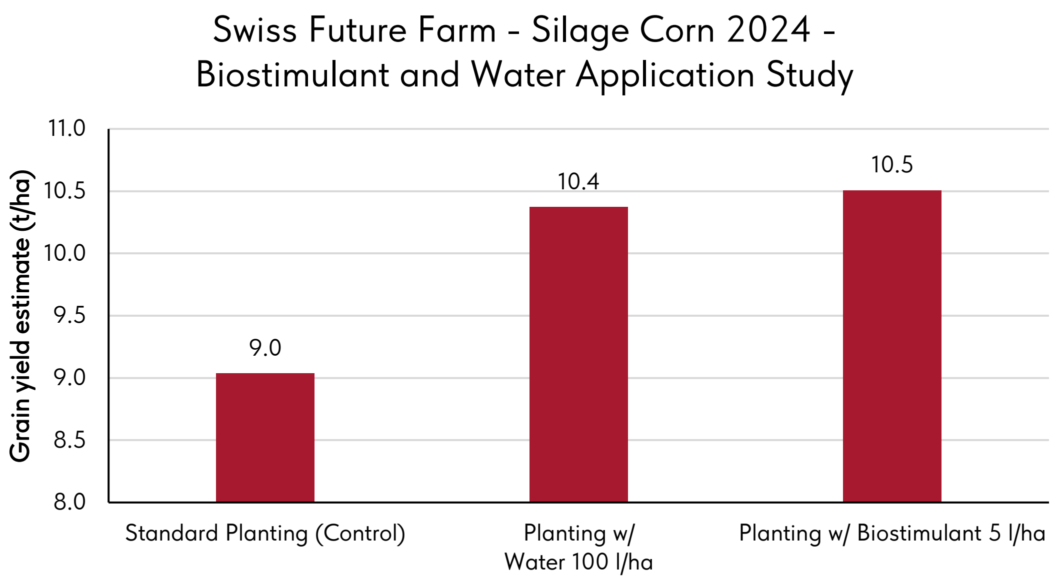

Figure 12. Grain yield estimate based on hand harvest on 18 September 2024.

FINANCIALS

Table 12 shows the revenue obtained from the different trial strips, assuming a silage corn price of 60 CHF/ton fresh mass for silage corn harvested with ≥40% DM content. The revenue obtained was limited by the low yield levels at this location in 2024 (14.4-17.4 t/ha vs. 19.0-21.0 t/ha historic average). Factoring in operating costs resulted in a negative gross margin for the standard planting treatment (i.e. operating costs could not be covered by the income from crop). Operating costs include all machine, labor, and input costs including the purchase price of the biostimulant product of 25.70 CHF/l and water costs of 0.002 CHF/l. However, gross margins increased by 265 CHF/ha or 163 CHF/ha due to the application of water or biostimulant, respectively.

Table 12. Financial results of the Biostimulant and Water Application Study in silage corn.

	Standard Planting (Control)	Planting w/ Water 100 l/ha	Planting w/ Biostimulant 5 l/ha
Revenue (CHF/ha)	2134	2399	2426
Operating Costs (CHF/ha)	2207	2207	2336
Gross Margin (CHF/ha)	-73	192	90

CONCLUSIONS

- Biostimulant and water applications at planting have both shown to be a promising approach to improve silage corn yield.
- Water application at planting enabled the increase of silage corn dry matter yield by 19.4%, and biostimulant application resulted in 20.4% higher dry matter yield in comparison to the control treatment with standard planting.
- Water application represents a favorable option from a profitability standpoint due to lower input costs while still achieving significant yield increase, which resulted in the highest gross margin obtained in the comparison of treatments.

1.6 Weed control in Sunflower

CONTACT

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The trial was conducted by the Forum Ackerbau and overseen by Carol Tanner, Arenenberg.

OBJECTIVE

Sunflowers, as an oilseed crop, have been gaining renewed importance. One reason is the increasing difficulty of cultivating rapeseed due to restrictions on certain crop protection agents. This trial aimed to explore the sunflower cultivation system more closely, especially herbicide-free weed control (a contribution (Produktionssystembeitrag) "Verzicht auf Herbizide" of 250 CHF/ha is granted). The goal was to assess the effects of different weed control methods on sunflower yield and profitability.

TRIAL SETUP

The trial was conducted on the Swiss Future Farm in 2023 and 2024 as a strip trial with three repetitions per method. The weed control methods listed in Table 13 were compared.

Table 13. Trial Variants for Weed Control in Sunflowers

Strip	Treatment	Field Operations
1	Pre-emergence herbicide	Stomp Aqua, BASF (2l/ha) + Dacthal SC, Stähler (1-2l/ha)
2	Mechanical weeding	• 1-2x harrowing • 1-2x hoeing
3	Mechanical weeding + cover crop mix "Solegu"	• 1-2x harrowing • 1-2x hoeing • Cover crop sown while harrowing after last hoe pass. (18kg/ha, mix of hop clover, crimson clover and white clover)
4	Mechanical weeding + cover crop mix "Sofix"	• 1-2x harrowing • 1-2x hoeing • Cover crop sown while harrowing after last hoe pass. (20kg/ha, mix of hop clover, crimson clover and English ryegrass)

RESULTS OF TWO TRIAL SEASONS

Sunflower sowing took place on April 1, 2024 under good conditions. Before emergence, harrowing or herbicide application occurred. The crop stands were generally uniform, though mechanical methods occasionally caused plant losses from harrowing or hoeing. Due to sufficient moisture, the cover crops (applied after the final hoeing) established well and did not compete with the sunflowers. Weed pressure was low, with only scattered creeping thistle. The purely mechanical method showed the highest weed pressure, followed by the herbicide treatment, while methods with cover crops had almost no weeds. Chickweed, manyseed goosefoot, and some millet grasses dominated the weed flora. Harvest took place on October 21, 2024 under good conditions. Over the two years at the Tänikon site, yields across methods were similar, with an average of 27.3 dt/ha.

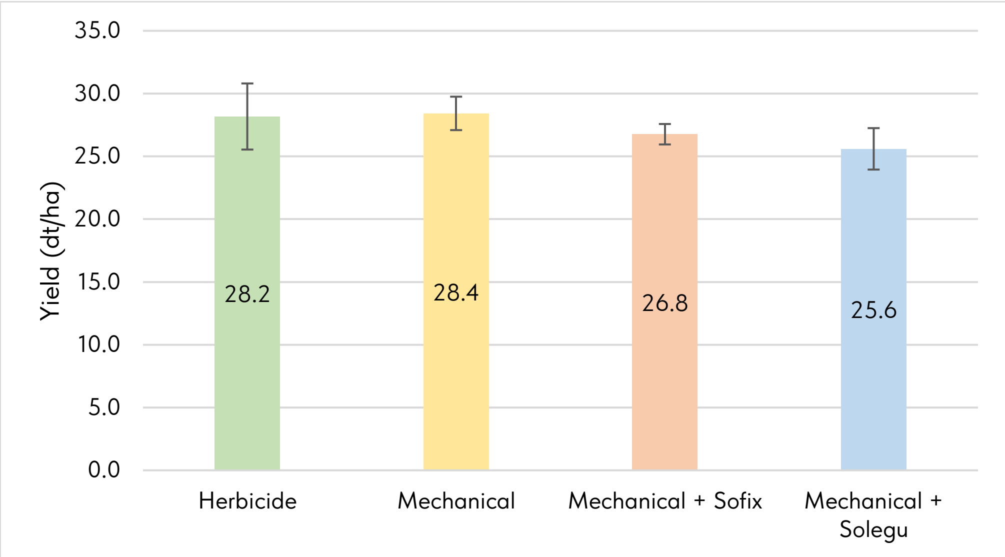

Figure 13. Average sunflower yield in dt/ha at 6% moisture, average of 2023 and 2024.

ECONOMIC EVALUATION

There were economic differences between methods. The “mechanical” method performed best with CHF 2,544/ha, followed by “herbicide” (CHF 2,291/ha) and “mechanical + Sofix” (CHF 2,163/ha). The PSB (production system contribution) “adequate soil coverage” was included for all methods since the sunflowers were harvested after September 30, so no cover crop was mandatory. The cost of cover crops cannot be directly offset through this PSB. However, well-developed cover crops offer additional benefits (weed suppression, field trafficability, harvesting/grazing of cover crops, improved soil structure). These can provide long-term economic value by reducing tillage needs in subsequent crops due to lower weed seed bank. However, some cover crops species (e.g., ryegrass) may regrow in following crops if not properly terminated.

Table 14. Economic comparison between the different methods with data of 2023 and 2024. Sources: Kostenkatalog Agroscope 2024, average prices swiss granum 2024, prices UFA Samen 2024

	Herbicide	**Mechanical**	**Mechanical + Sofix**	**Mechanical + Solegu**
Ø Yield* (dt/ha) 2023-2024	28.2	28.4	26.8	25.6
Revenue (CHF/ha)	2'275	2'295	2'161	2'067
Herbicide cost (CHF/ha)	-184	0	0	0
Harrowing cost (CHF/ha)	0	-39	-39	-39
2x hoeing cost (CHF/ha)	0	-162	-162	-162
Seeding + seeds (sunflower and cover crop mix) (CHF/ha)	0	0	-247	-258
PSB "no herbicides" (CHF/ha)	0	+250	+250	+250
PSB "adequate soil coverage" (CHF/ha)	(+200)	(+200)	+200	+200
Total revenue (CHF/ha)	**2'291**	**2'544**	**2'163**	**2'059**

* Average yields across all locations, weighted 50% each year

TRIAL PHOTOS 2024

a) seeding cover crop during harrowing

b) emergence of cover crops

c) drone picture after harvest in October 2024

d) cover crop development at harvest

Figure 14. Images of the weed control trial in sunflowers 2024 at the Swiss Future Farm in Tänikon.

1.7 First Experiences with Spring Rapeseed

CONTACT:

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Florian Bachmann, Project Leader Swiss Future Farm, florian.bachmann@tg.ch

BACKGROUND

Given the numerous insecticide applications and sometimes unsatisfactory yields in winter rapeseed cultivation, many farms are questioning whether growing winter rapeseed remains viable in the future. Spring rapeseed could be a promising alternative. But how can it be successfully cultivated? Initial findings were gathered in a demonstration trial.

CROP MANAGEMENT

Action	Used Plant Protection Products	Date
Sowing		12.04.2024
Herbicide Slug Pellets	Devrinol Top (3 l/ha) + Successor 600 (1 l/ha) Metarex Inov (6 kg/ha)	13.04.2024
Slug Pellets	Metarex Inov (5 kg/ha)	29.04.2024
Insecticide against common pollen beetle Treatment for sclerotinia	Audienz (0.2 l/ha) + Heliosol (0.75 l/ha) + X-Change (0.6 l/ha) Proline (0.7 l/ha)	05.06.2024
Harvest		14.08.2024

RESULTS

After 4 months of growth, the spring rapeseed yielded an average of 24 dt/ha (2.4 tons/ha), which is a satisfying result for spring rapeseed.

ECONOMIC COMPARISON: WINTER RAPESEED VS. SPRING RAPESEED IN TÄNIKON FOR 2024

For the economic comparison, the winter rapeseed plot in Tänikon from 2023/2024 was used. As always, caution is advised when comparing individual years, but this example can serve as orientation.

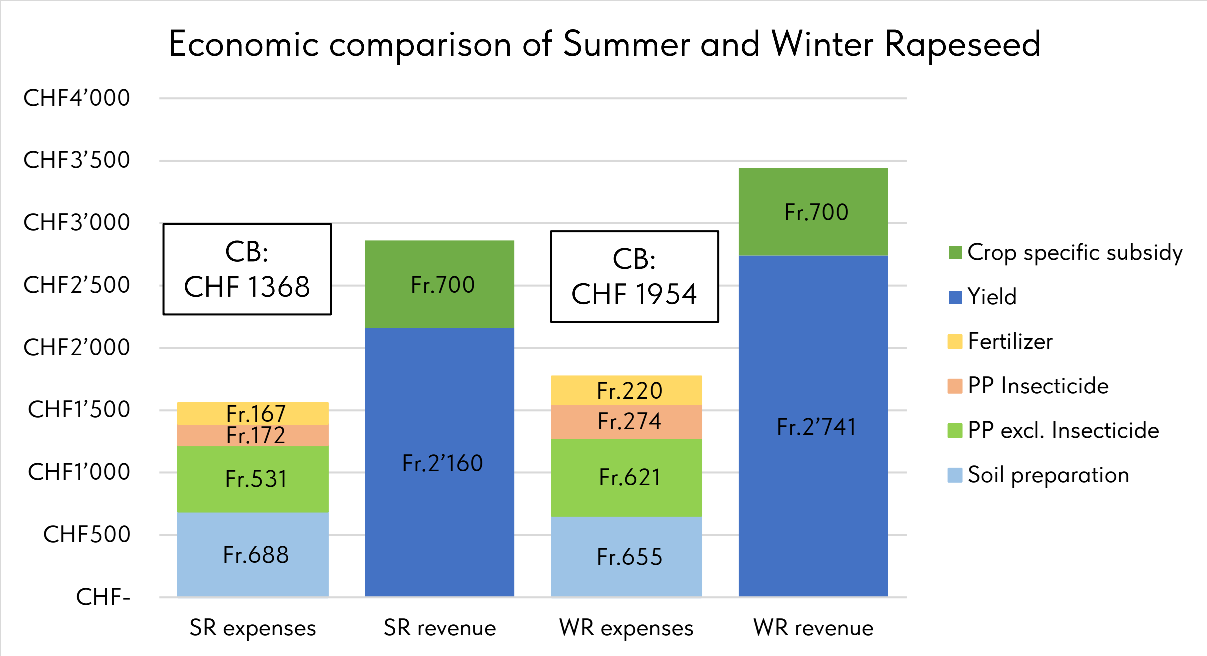

Figure 15: Economic Comparison between Spring (SR) and Winter Rapeseed (WR).

Different machinery was used for soil cultivation, but generally the overall costs are comparable or assumed to be identical. Winter rapeseed required more intensive herbicide use due to the preceding crop, but again, overall costs (apart from insecticides) of plant protection products can be considered similar. As mentioned, Audienz was used in spring rapeseed, though cheaper alternatives might also be viable. The winter rapeseed was a HOLL variety, which fetched a slightly higher price per kilogram.

Not quantifiable is the potential advantage of growing spring rapeseed after late crops such as corn.

At sites with higher potential (than Tänikon) for rapeseed cultivation, winter rapeseed would likely benefit more, and the difference in contribution margin would be greater.

OUTLOOK 2025

Spring rapeseed will be grown again in Tänikon in 2025. The findings from the first year will be supplemented by a second growing season.

TRIAL PICTURES 2024

a) Isolated flea beetle infestation, control threshold not reached

b) Common pollen beetle infestation, control threshold exceeded

c) Spring rapeseed on 21.05.2024

d) Spring rapeseed on 10.06.2024

e) Spring rapeseed on 24.06.2024

Figure 16. Images of the 2024 spring rapeseed trial at the Swiss Future Farm in Tänikon.

1.8 Green Manure Application via Drone Seeding

CONTACT

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OBJECTIVE

To meet the requirements of the production system contribution (PSB) "adequate soil cover," arable land must not remain uncovered for more than seven weeks after harvest. One method to cover the soil is by sowing green manure, which can be done either shortly before or after the harvest of a crop. An innovative method for pre-harvest sowing is the use of drone seeding. This trial investigated the following questions:

- What is the spreading pattern of green manure seeded via drone?
- How does green manure develop when applied via drone?
- Which plant species establish well?
- Is there a difference in germination and establishment of green manure if the straw is removed versus when it is chopped and left in the field?

TRIAL SETUP

- Crop: Wheat field (variety: Axen)
- Green manure mixtures (coated):
  - Terra Gold 21 (with cruciferous species)
  - Terra Gold 22 (without cruciferous species)
- Straw treatment:
  - Straw removal after harvest
  - Straw chopped and left in the field

Drone seeding was conducted on July 8, 2024, twelve days before the wheat harvest. Two different coated green manure seed mixtures were applied. According to manufacturers, coated seeds offer advantages such as even distribution, better germination due to improved soil contact, and optimal seedling development. These advantages were not specifically tested in this trial. The drone's spreading pattern was analysed during sowing. Twelve days after sowing, the wheat was harvested. Part of the straw was removed, and the rest was chopped and left on the field.

Figure 17. Trial setup

RESULTS

Spreading Pattern Results:

New application methods like drones require attention to even distribution of the seed. Therefore, collection trays were placed in the field before the drone flight (similar to fertilizer spreading).

- Tray dimensions: 50 cm x 50 cm
- Spacing between trays: 100 cm
- 10 trays in two rows
- Row spacing in flight direction: 350 to 500 cm
- Distance of first row from headland: approx. 13 m
- Drone working width: 450 cm

Target rate: 30 kg/ha → equates to 0.75 g per tray (0.25 m²)

Measured range: 0.60 g to 1.33 g per tray (except outermost trays)

Average measured: 0.89 g per tray → corresponds to 35.4 kg/ha

Estimated total range: 24.0 – 53.2 kg/ha

Figure 18: Placement of the trays

Overall, the drone achieved the target rate well, and the total applied quantity matched the intended area. However, localized deviations from -32% to +50% are possible.

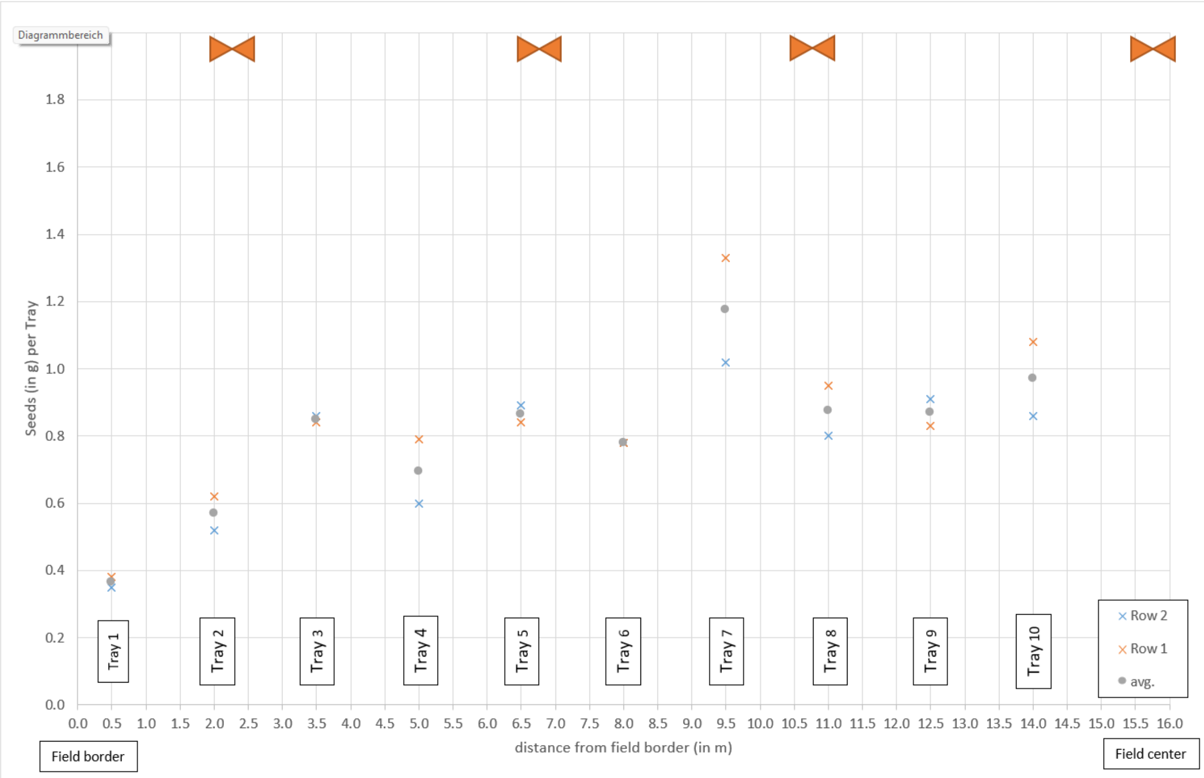

Figure 19. Distribution of seeds between the trays. Orange triangles at the top mark the position of the drone.

Variability may stem from differences in seed size and weight within the mixtures. Wind from the drone's rotors and drop height could influence how uniformly the seeds fall. The exact composition of seeds in each tray was not analyzed, which could have provided more insight into distribution behavior.

Poor emergence prevented further evaluation

Weather following drone seeding was very rainy, leading to high humidity in the wheat stand and promoting heavy slug activity. Since drone-sown seed is not incorporated into the soil, it was exposed and vulnerable. Slug pellets were not allowed at this growth stage.

At the first assessment, a few germinated plants (mostly crucifers) were observed, but numbers were far below expectations. After harvest, only a few millet plants were found.

Possible causes for poor emergence:

- High slug activity
- Poor soil contact
- Weed pressure
- Residual herbicide effects from spring
- Low seed quality (no germination test performed)

TRIAL PHOTOS 2024

a) Filling the drone with seed

b) Drone in operation

c) Flight map of the drone

d) Coated seeds

Figure 20. Images of the green manure trial using drone sowing 2024 at the Swiss Future Farm in Tänikon.

1.9 Suppression of Fusarium in winter wheat using transfer mulch

CONTACT

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Andreas Kägi, Agroscope, andreas.kaegi@agroscope.admin.ch

This project is investigating the use of transfer mulch to reduce Fusarium infestation in winter wheat after silage corn. The aim is to evaluate the effect of transfer mulch on plant health and the practicability of mechanized application.

The trial follows a crop rotation of silage corn followed by winter wheat using the no-till method. Immediately after sowing the winter wheat, transfer mulch is harvested from a donor area (Alexandrine clover) and spread on the trial area with a loader wagon.

TREATMENTS

Three different methods are compared with each other:

- Method 1: winter wheat without mulch (control), direct sowing of winter wheat after silage corn, without additional measures.
- Method 2: winter wheat with transfer mulch (alexandrine clover), direct sowing of winter wheat after silage corn, followed by application of freshly harvested mulch material (alexandrine clover) from a donor area.
- Method 3: winter wheat without corn residues (negative control), after the corn harvest the remaining corn stubble is removed by hand to minimize the risk of infection by Fusarium fungi.

STUDY DESIGN

- Trial setup: randomized block design
- Replicates: Quadruplicate
- Objective:
    - Evaluation of the health effect of the transfer mulch system on winter wheat
    - Assessment of the practicability and economic efficiency of mechanized mulch application

BACKGROUND FUSARIUM INFECTION

Fusarium fungi prefer to develop on organic corn residues and can infect flowering winter wheat. The risk of infection increases significantly, especially in warm and humid weather during wheat flowering. Such conditions prevailed in the trial year 2024, which led to a visible differentiation of the methods with regard to Fusarium infestation. Different varieties showed different susceptibility to Fusarium and different mycotoxin contents. The data is not fully evaluated at this point and a second trial season must be done before any conclusions can be drawn.

Figure 21. Trial plot at the Swiss Future Farm in Tänikon.

Figure 22. Fusarium infestation in winter wheat.

1.10 Legendary - Lentil mixed cultivation

CONTACT

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BACKGROUND AND PROJECT GOAL

The aim of the LEGENDARY project (https://www.legendaryproject.eu/) is to quantify ecosystem services in mixed cultivation of legumes in different climatic zones. This involves factors such as weed, pest and disease pressure, pollinator and beneficial insect occurrence, nitrogen cycle and preceding crop effect, effects on soil aggregate stability and yield performance.

STUDY DESIGN

The trial design in Tänikon includes lentils (two different varieties) and oats in pure stands with two different fertilizer levels in the oats. The two lentil varieties are also tested in mixtures with oats. Winter barley is cultivated as a subsequent crop.

Figure 23. Trial field on 10.06.2024 with lentils and oats in pure and mixed cultivation. Picture: Georgios Karagkounis, Agroscope.

IMPLEMENTATION

In 2024, the lentil trials were cultivated and various assessments were carried out. Subsequently, winter barley with reduced fertilization was sown on the original lentil plots after reduced tillage to investigate the preceding crop effect. Sample material and data will continue to be analyzed. The trial will also be repeated in 2025 to generate data from two years of cultivation.

1.11 Micro flower-strips in sugar beets – Experiences from Tänikon

CONTACT

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Micro flower-strips are narrow strips with specifically selected flowering plants placed between the rows of sugar beets. They are intended to promote beneficial insects such as ladybugs and parasitic wasps, which naturally keep pests in check. At the same time, these plants must not compete with the sugar beets and thereby reduce yields.

As part of a project supported by the Federal Office for Agriculture (BLW) and Lidl Switzerland, various flower mixtures were tested in Tänikon, sown in autumn. In spring, the rows for the sugar beets were cleared with a strip tiller and selectively treated with a band sprayer. The aim was to investigate the impact of the micro flower-strips on sugar beet yields.

Preliminary results show: In Tänikon, four of the five tested mixtures showed a reduction in sugar beet yield compared to the control. However, for one mixture – consisting of chervil and lopsided oats – no significant yield difference compared to the control without flower strips could be detected. These two plant species established well and seemed to compete less with the sugar beets. Other species, such as fenugreek, barely germinated and contributed little to the desired effect. This highlights how crucial the targeted selection of plant species in micro flower-strips is. The combination of chervil and lopsided oats was chosen because the oats provide vertical structure, thereby supporting the chervil.

Setting up such strips is technically demanding. To function properly, modern technology such as GPS-controlled seeders and band sprayers, as well as flat fields for precise management, are needed.

Conclusion: In Tänikon, micro-flower strips show potential – they could become an environmentally friendly complement to sugar beet cultivation in the long term, provided the conditions are right.

Outlook: The results will now be analyzed in detail and published scientifically.

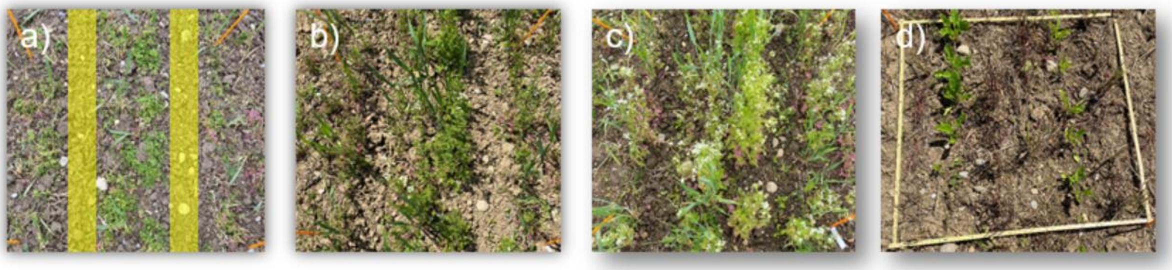

Figure 24. The pictures show the temporal progression in the field. the letters refer to the following time points: a) end of April, b) beginning of may, c) end of may and d) mid-Jun

1.12 Red clover trials Langacker Tänikon

CONTACT

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Over the past three years, 168 red clover varieties have been tested in plots on the Langacker in Tänikon, including 100 varieties from Agroscope's breeding program, 27 old Swiss farm varieties and 41 varieties from foreign breeders. The biomass at each cut, the occurrence of diseases and the plant density before and after winter were recorded. The data show that the varieties bred by Agroscope were very persistent and practically weed-free even in the third year (<14% weed content of the harvested biomass in the last cut). By comparison, the weed percentage of the old Swiss farm varieties was 94% on average in the last cut and 73% in the foreign varieties. Significant breeding progress has also been made in terms of resistance to diseases: Farm varieties were significantly more susceptible to powdery mildew (caused by the fungus *Microsphaera trifolii*) and clover canker (caused by the fungus *Sclerotinia trifoliorum*) compared to breeding varieties.

The next step is to analyze the genetic diversity of the varieties and investigate whether their performance in the Tänikon field trial and our smaller, regularly conducted plot tests can be predicted on the basis of their genetic characteristics (so-called genomic prediction). The aim is to use these models and the accurate field data to make the breeding of red clover more efficient.

Figure 25. Aerial view of the various red clover varieties of the trial.

Further information:

Agroscope: Züchtung von Futtergräsern und Futterleguminosen für einen standortangepassten, nachhaltigen Futterbau (agroscope.ch)

1.13 Can precision fertilization reduce N_2O emissions in cropland?

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Agricultural soils are a major source of nitrous oxide (N_2O), a potent greenhouse gas and the third most important contributor to climate change after carbon dioxide (CO_2) and methane (CH_4). Most N_2O emissions from cropland result from the application of nitrogen (N) fertilizers, highlighting the need for strategies that improve nitrogen use efficiency and reduce N losses.

To investigate whether precision fertilization can help mitigate N_2O emissions, an experiment was established at the SFF field site "Altkloster". Two fertilization strategies were compared: (i) conventional fertilization and (ii) precision fertilization. N_2O emissions were measured using two complementary methods: an Eddy Covariance station for continuous, field-scale fluxes, and semi-automatic chambers for high-resolution, plot-scale data.

This experiment will provide valuable insights into the effectiveness of precision fertilization as a mitigation strategy for agricultural N_2O emissions. The findings will contribute to the development of climate-smart practices for sustainable crop production.
Data and updates are shared at:
👉 https://www.swissfluxnet.ethz.ch/index.php/sites/site-info-ch-tan/

Figure 26. Eddy Covariance station for continuous, field-scale fluxes measurement.

1.14 CowToilet

KONTAKT

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BACKGROUND

Innovative systems are needed to reduce ammonia emissions in cattle farming. The CowToilet separates urine and feces directly in the barn to specifically prevent emissions. During urination, the urine is collected in a special station (CowToilet) after targeted stimulation.

Figure 27. Cow entering the CowToilet.

TRIAL SETUP

In spring 2024, Agroscope, in cooperation with the University of Hohenheim, studied the functionality and animal welfare aspects of the CowToilet. Two stations were installed in the dairy barn at the Swiss Future Farm in Tänikon and monitored over several weeks with about 55 cows, evaluating visit frequency, urine volume, and animal behavior. Additionally, video analyses were conducted to assess behavior.

Figure 28. Cow inside the closed CowToilet.

RESULTS

On average, cows used the CowToilet 9.8 times per day, with about 40% of visits triggering urination. An average of approximately 5.6 kg of urine per cow per day was collected – equivalent to 12–31% of the total urine volume, depending on the reference values. After an adaptation period, stress-related behaviors were rarely observed.

DISCUSSION

The CowToilet proved technically functional but requires stable infrastructure. Animal observations confirm good acceptance after acclimation. The collected urine volume is substantial but lower than in previous studies – possibly influenced by location, feeding, and the number of stations. Emission measurements under Swiss conditions are still pending. The cost per station is approximately CHF 30,000.

FURTHER INFORMATION

https://www.agroscope.admin.ch/dam/agroscope/de/dokumente/aktuell/Veranstaltungen/wbk-baufachtagung/2024/14_zaehner_schrade.pdf.download.pdf/14_WBK_2024_Z%C3%A4hner_Schrade_Agroscope_D.pdf

2 Projects

2.1 Third season of Smart-N project successfully completed

CONTACT

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BACKGROUND

The Smart-N consulting project is the first project within the framework of the Experimental Station Smart Technologies in Agriculture in the application region of Schaffhausen and Thurgau. The experimental station is a consortium of the Agroscope research institute, the cantons of Thurgau and Schaffhausen, and the AGRIDEA advisory center. Its goal is to test the digitalization opportunities in agriculture for the benefit of resource-efficient and climate-friendly farming, and to specifically further develop them for practical application. For this purpose, projects are carried out in cooperation with and on commercial farms. Swiss Future Farm is responsible for technological implementation and on-farm consulting within the project.

GOALS

Smart-N applies a methodology for satellite-based, variable rate nitrogen fertilization in winter wheat on commercial farms in the cantons of Schaffhausen and Thurgau. The aim is to better estimate the nutrient requirements of the plants, improve nitrogen use efficiency, and reduce nitrogen surpluses. The focus lies on supporting farms with consulting services and transferring the methodology into practical farming routines.

TRIAL SETUP

In 2024, the trial was implemented analogously to 2023. Seven farms participated with a total of 11 plots covering 36.4 hectares. By the end of 2024, the dataset will comprise 26 fields over three years. The simplified trial setup, which was introduced in 2023, proved effective and was retained. Zero plots and GRUD Nmin fertilization plots were again implemented using tarpaulins. The trial layout is shown in Figure 29.

Figure 29. Exemplary trial layout: left side shows VRA treatment, right side uniform fertilization. Values are given in kg fertilizer per hectare. Black areas mark zero plots and GRUD-fertilized zones.

Description of the different fertilization treatments:

<u>Farm:</u>

In this treatment, the fertilization strategy used on the farm is applied. Total nitrogen amount as well as the timing and size of individual applications are determined by the farm manager. Fertilization is uniform and not variable within the field.

<u>Variable Rate Application (VRA):</u>

To implement the satellite-based variable rate fertilization approach, the project cooperates with Vista – Geowissenschaftliche Fernerkundung GmbH. As part of their TalkingFields® product line, Vista generates prescription maps based on long-term biomass maps, recent satellite images of crop development, and the calculated prior nitrogen uptake of the crop. For the first application, long-term biomass patterns are most relevant; in subsequent applications, current satellite data plays a larger role. More information is available at: www.talkingfields.de. The maximum nitrogen amount per field is defined by farm managers at the beginning of each season.

Zero plot / Fertilizing based on GRUD N_{min}:
In each trial-field there are six plots of 4x6 meters which were covered by the project team before every application of fertilizer. In Figure 29 these plots are pictured as blue rectangles. Half of the plots did not receive any fertilizer at all throughout the season (zero plot). By the end of the season those served as indicators for the Nitrogen supply by the soil. The other half was fertilized according to the N_{min} GRUD Method (Principles of Agricultural Crop Fertilisation in Switzerland). The fertilizer was spread by hand in these plots.

TECHNICAL IMPLEMENTATION OF FERTILIZATION

In the third year, the same seven farms participated as in 2023. Fertilizations were mostly carried out without issues. One terminal was unable to display the prescription map due to an excessive number of features (i.e., small sub-zones), but this was resolved by a firmware update. It is not strictly necessary to apply updates immediately, but it is recommended to check for available updates during the off-season to ensure readiness for the main growing season. Additionally, it is again recommended to become familiar with new equipment early and ideally during the off-season. Once a setup (tractor and spreader configuration) is functional, it typically remains reliable, but sufficient time should be planned for the initial setup.

YIELDS AND APPLIED FERTILIZER QUANTITIES IN 2024

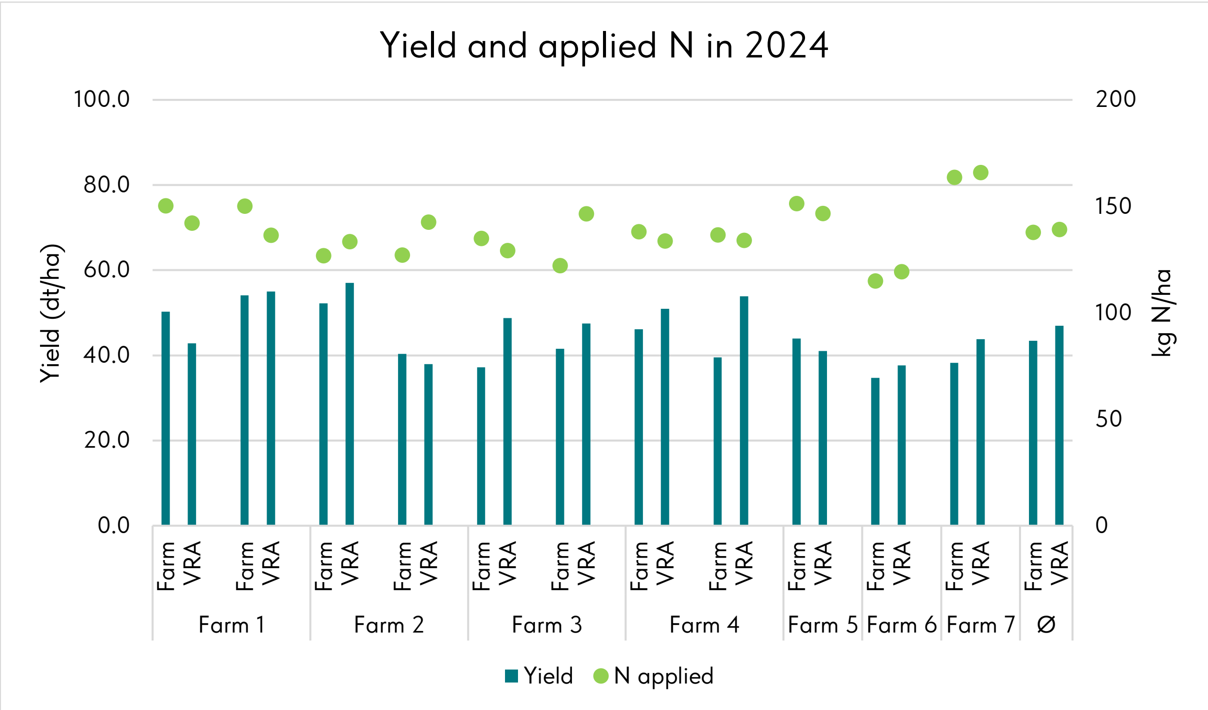

Figure 30. Yield and applied N, per field.

Figure 30 shows the yields and fertilizer amounts applied in both Farm and VRA treatments on the 11 trial plots in 2024. The yields were determined using hand samples, which are known to overestimate actual yields. However, the yield ratios between treatments matched those observed in the yield maps.

In the farm treatment, yields ranged between 34.7 dt/ha and 54.1 dt/ha with an average of 43.5 dt/ha. In the VRA treatment, yields ranged between 37.6 dt/ha and 57.0 dt/ha, with an average of 46.9 dt/ha. Yields were therefore 8.0% higher under VRA fertilization.

The nitrogen amounts applied ranged from 115 to 164 kg N/ha in the farm treatment (avg. 138 kg/ha), and from 119 to 166 kg N/ha in the VRA treatment (avg. 139 kg/ha). Nitrogen input was thus comparable between treatments.

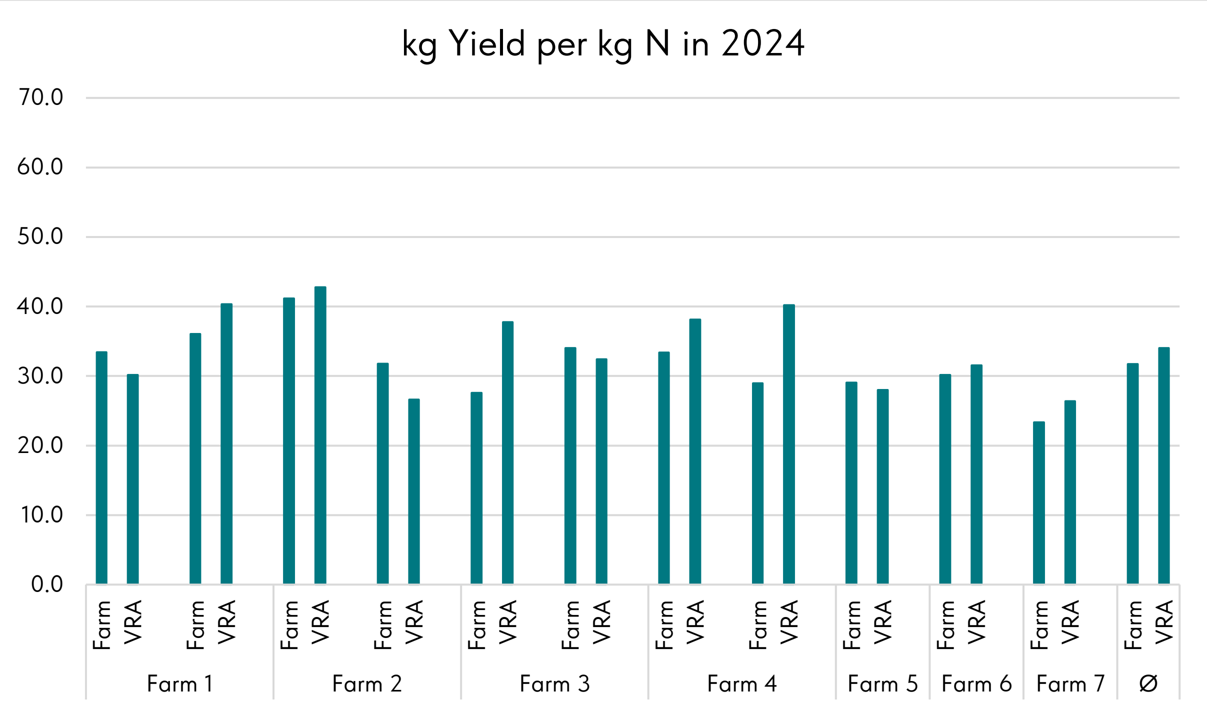

Figure 31. Yield per kg N.

Grain yield per kg N was higher in 7 out of 11 fields in the VRA treatment. The farm treatment averaged 31.7 kg grain per kg N, while the VRA treatment averaged 34.0 kg (+7.3%). Like the overall yield, nitrogen use efficiency was somewhat lower in 2024 than in 2023 due to difficult weather conditions.

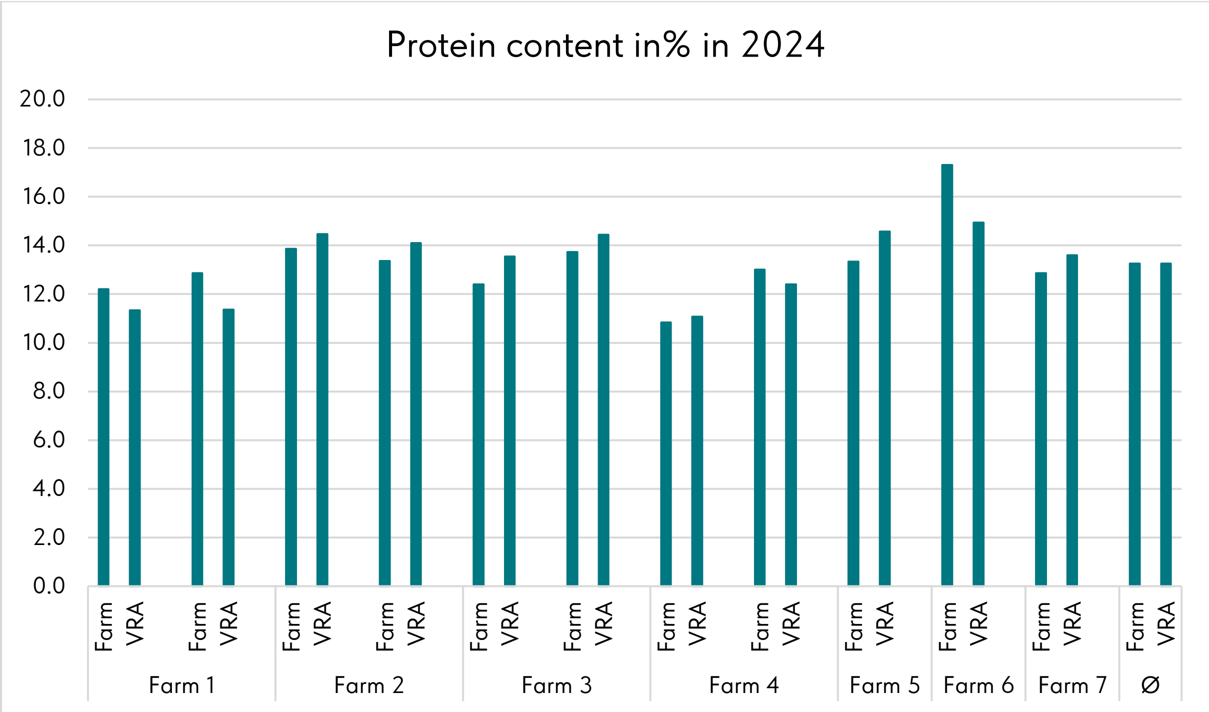

Figure 32. Protein content in %.

No differences in average protein content were found between treatments – both averaged 13.3%.

REDUCTION OF SURPLUS N IN VRA FERTILIZATION

One main goal of the project is to reduce surplus N through adjusting N-fertilization to the plants needs. Surplus N is defined as Nitrogen derived from mineral fertilizer which is not taken up by the wheat. It is calculated by adding Nitrogen from fertilizers to Nitrogen from the soil and subtracting Nitrogen found in the wheat after harvest.

$$N_{Surplus} = N_{applied} + N_{from\ soil} - (N_{Straw} + N_{Grain})$$

To determine surplus at the end of the season the Nitrogen content of grain and straw is analyzed in a laboratory. Values from the zero plots indicate how much Nitrogen was supplied by the soil.

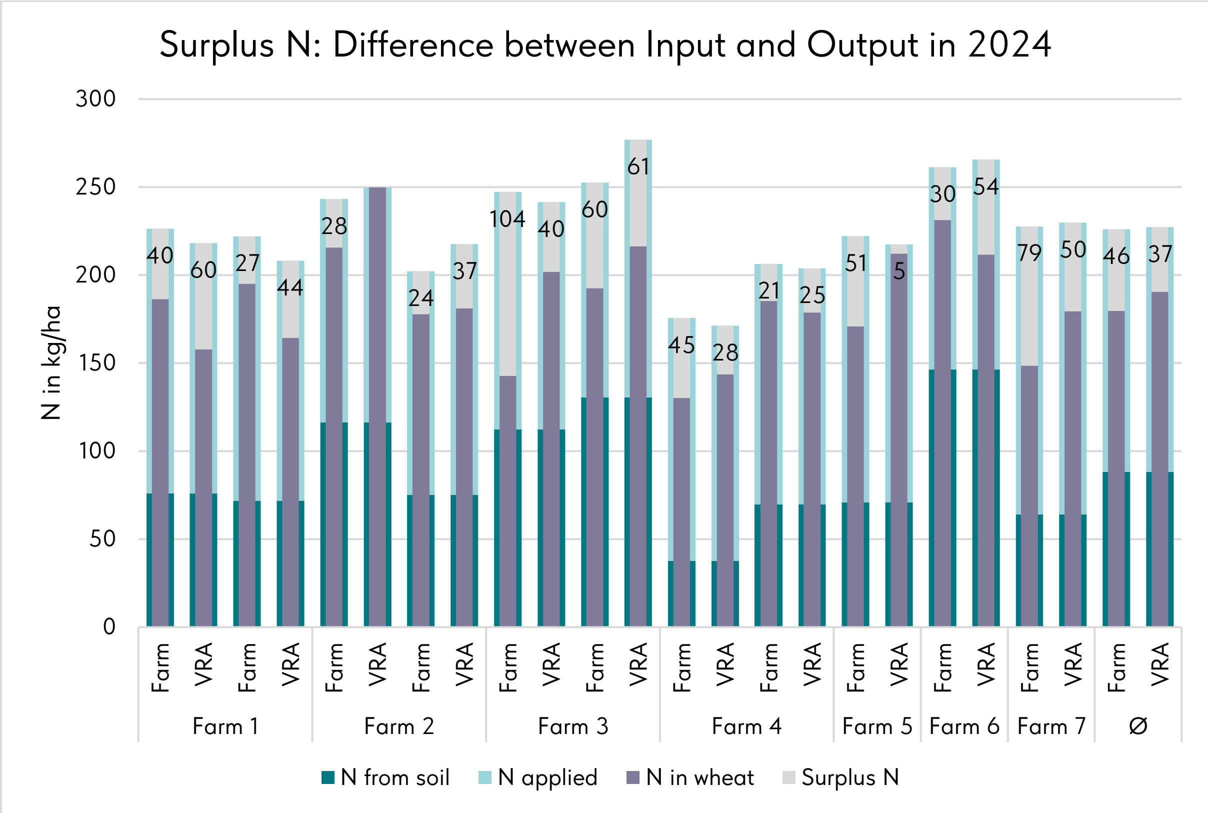

Figure 33. Surplus N as difference between N-Input and N-Output.

In 2024, soil nitrogen supply ranged from 37.5 to 146.4 kg N/ha – higher and more variable than in the previous year. Surplus nitrogen in the farm treatment ranged from 21 to 104 kg N/ha, with an average of 46 kg N/ha. In the VRA treatment, values ranged from 0 to 61 kg N/ha, with an average of 35 kg N/ha. This represents a 24% reduction in surplus N on average under the VRA treatment. Due to heavy and persistent rainfall, leaching losses were likely significant across all treatments. Despite this, 75% of the VRA-applied nitrogen was taken up by the crop, compared to 66% in the farm treatment. Persistently wet soils impaired root development, low temperatures slowed growth, and fungal infections caused some fields to be downgraded or even sent to biogas plants. The thousand-kernel weight (TKW) was on average 10g lower than in 2023.

CONCLUSION AND OUTLOOK

Across all fields, the third year of the project confirmed that variable rate nitrogen fertilization contributes to achieving the targets of the federal nutrient reduction initiative (19.475). On average, nitrogen surpluses were consistently lower and yields were even slightly higher at comparable nitrogen inputs. The budget was used prudently, allowing for a fourth and final project year in 2025.

In 2025, the trial will continue with the same seven farms and 14 trial fields. This will further expand the dataset on the potential of sensor-based, site-specific fertilization. Additional options in the low-cost segment will also be explored, including mobile phone apps and retrofit solutions for existing spreaders.

Further information on the Experimental Station Smart Technologies in Agriculture and Smart-N:

Link: https://www.agroscope.admin.ch/agroscope/de/home/ueber-uns/standortstrategie/versuchsstationen/versuchsstation-smarte-technologien.html

Videos: https://www.agroscope.admin.ch/agroscope/de/home/aktuell/newsroom/2022/11-24_intelligente-duengung.html

2.2 Effects of insecticide drift on arthropods in flower strips

CONTACT

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BACKGROUND

Plant protection products applied with the spray bar not only land on the crop to be treated, but also drift onto the adjacent habitats in some cases. In order to protect surface waters and biotopes, minimum distances must be maintained and drift-reducing measures taken. However, flower strips, which are cultivated and financially supported to promote biodiversity, usually border directly on arable crops. It would be unfavorable if the beneficial pollinators, predators and parasitic wasps that are attracted to the flower strips and reproduce there were harmed by the application of plant protection products in the crop.

PROJECT GOALS

The effects of pesticide drift on arthropods in flower strips were investigated in several field trials. In the first two years, the drift distribution in the flowering strip vegetation was measured using fluorescent tracers. In the following two years, flower strip sections were treated with simulated drift concentrations of the insecticide acetamiprid and arthropod populations were monitored over the season.

STUDY DESIGN

The trials were carried out on the Rüedimoos plot in Tänikon. In 2024, a total of five flower strips were sown with the seed mixture "Nützlingsstreifen Sommerkultur einjährig" (UFA seeds). Each strip was a good 100 m long, 6 m wide and had a distance of 18 m to the next strip (Figure 34). The flower strips were surrounded by an artificial meadow. Each flowering strip was divided into three experimental sections that received different (insecticide) treatments: 1) water (negative control); 2) simulated drift rate; 3) field rate (40 g acetamiprid per hectare). The drift rate was sprayed at 3 concentrations: 28 % of the field rate in the first meter, 1.2 % in the second and third meters and 0.4 % in the remaining three meters. These values correspond to the concentrations previously measured using tracers. The experimental setup in 2024 was similar to 2023, except that in 2023 only four "beneficial insect strips summer crop" were created and between each of these strips a "beneficial insect strip VV annual" (UFA seeds) was created for trials with bees.

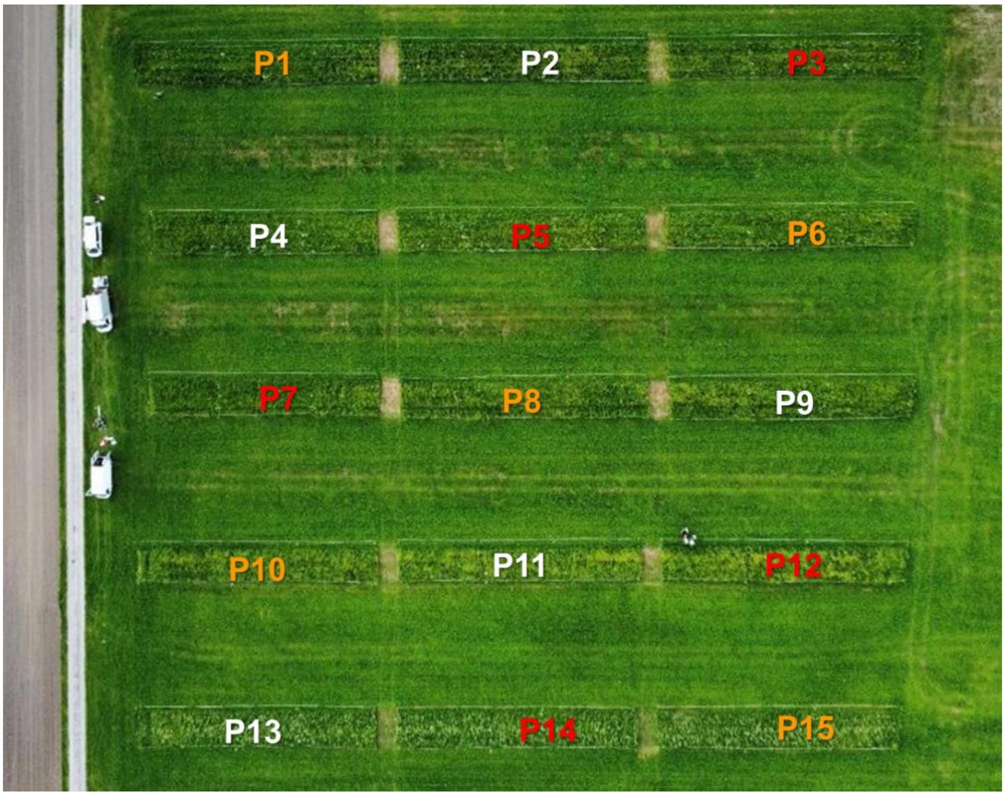

Figure 34. Layout of the 2024 flower strips on the Rüedimoos plot with the trial sections field rate (red marking), drift rate (orange) and negative control (water, white).

The flower strips were sprayed in mid-June using a portable, 3 m wide spray bar. The spray was applied directly to the flowering strip vegetation after sunset. A second treatment was carried out four weeks later.

Arthropods damaged directly by the spraying were collected in polystyrene containers, which were placed in the flower strips before spraying (so-called knock-down effect, Figure 35 left). The long-term development of the arthropod populations was determined by suction sampling. Using modified leaf vacuums, arthropods were sampled weekly in the various experimental sections and brought to the laboratory, sorted and identified as far as possible (usually at family level) (Figure 35 right). In the two experimental years 2023 and 2024, a total of almost one million arthropods were sorted and identified. The suckers were mainly used to collect less mobile arthropods that live in the vegetation layer. Pollinators, such as honey bees and wild bees, were studied in another sub-project in 2023.

Figure 35. Left picture: Trays for collecting damaged arthropods directly after insecticide application (knock-down effect). Right picture: Weekly suction samples to record long-term effects on arthropod populations. The small picture shows arthropods after they have been removed from the samples, sorted and identified.

RESULTS

As the processing of the samples has not yet been completed, only preliminary results can be presented here. The data from 2023 and 2024 show that, as expected, the amount of insecticide applied at the normal application rate (field rate) had clearly measurable effects on the arthropods in the flowering strip vegetation, e.g. on aphids and various ichneumon wasp families, both in the short and long term. The amount of insecticide applied at the drift rate also had an effect on several arthropod groups immediately after application in the first meter, where the concentration was highest. However, the effects were significantly lower than in the sections treated at the field rate. The weekly suction samples in the sections treated with the drift rate showed no clear deviations from the water-treated controls in terms of arthropod numbers and groups. This indicates that the arthropod populations can compensate for negative effects in the first meter across the entire width of the flowering strip and over time.

CONCLUSIONS

The trials in Tänikon show that the risk of long-lasting damage to arthropod populations in the flowering strip vegetation due to insecticide drift is rather low. Since the insecticide input and thus the damage to the arthropods is highest in the first meter next to the crop, measures to reduce drift make sense.

2.3 Optifert

CONTACT

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BACKGROUND

Optifert is an Innosuisse project that began on March 1, 2024. The goal is to provide farmers with information on the optimal use of fertilizers using Digit Soil technology. This aims to reduce costs and negative environmental impacts. Additionally, reliable statements about soil bulk density are to be made to enable the acquisition of carbon credits.
As part of the project, soil samples are taken from several farms and analyzed using Digit Soil technology. Based on the results, fertilization recommendations are made and evaluated. The Swiss Future Farm was one of the farms where the process was tested for the first time in 2024 before the full-scale implementation on practical plots in 2025.

TRIAL SETUP

The trial setup closely follows that of the MaisNet project.

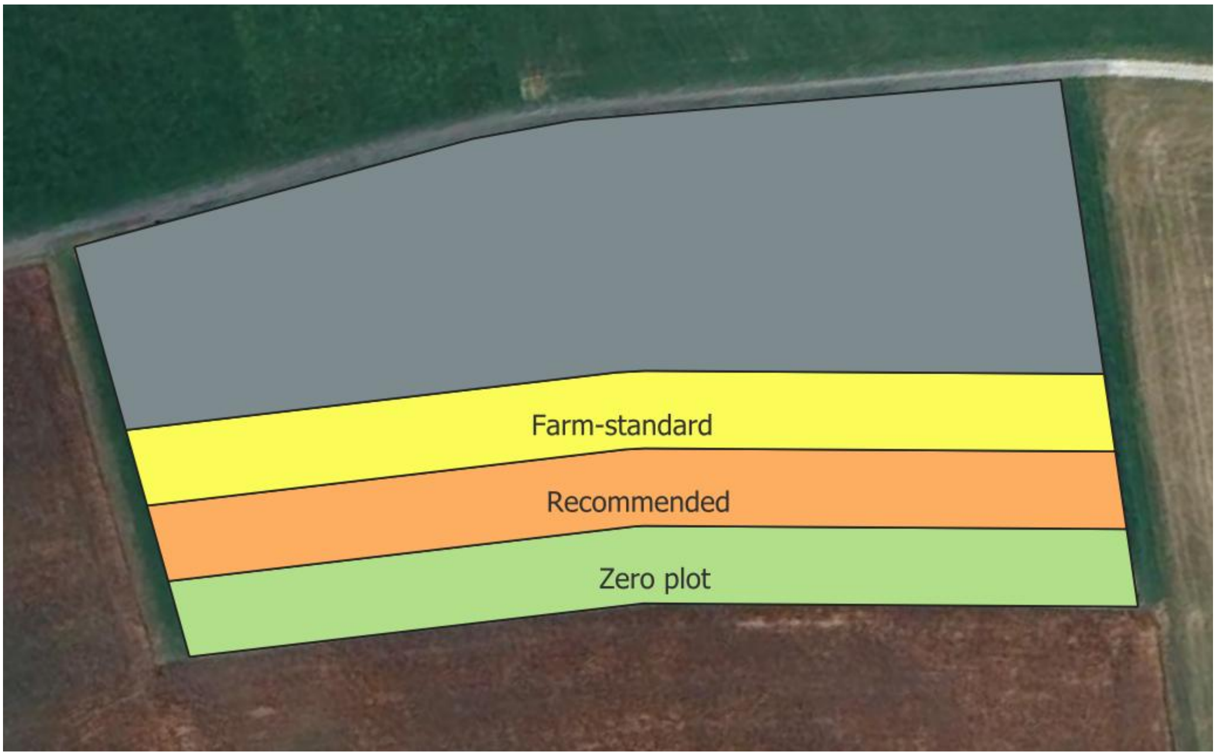

Figure 36. Trial setup Optifert 2024

The trial was conducted on the Krapf plot at the Swiss Future Farm. One 15-meter-wide strip was established per fertilization variant. At the eastern edge of the field was the zero-fertilization strip, followed by the recommended variant and the farm-standard variant. The rest of the field was also managed according to farm practice but was not part of the trial.

The Krapf plot has a 7% slope toward the zero strip. The previous crop was a temporary grassland, which peeled with a cultivator in two passes on May 17. The seedbed was prepared on May 29 with a disc harrow, and sowing (LG 31.207) was done the same day.

Cattle slurry was applied on May 16, and cattle manure on May 28 (except on the zero strip). A third fertilization with mineral fertilizer (urea) was carried out on July 9.

Herbicide application was done across the entire field on June 25 using Equip Power and Spectrum. Harvest took place on October 15.

Soil samples were taken at the 4–5 leaf stage and at harvest, and N_{min} was determined. At the 4–5 leaf stage, the Digit Soil sample was also taken.

RESULTS

Fertilization

Table 15. Applied Nitrogen

		Zero plot	Recommended	Farm-standard
16. Mai	Cattle slurry	0 kg N/ha	24.3 kg N/ha	24.3 kg N/ha
28. Mai	Cattle manure	0 kg N/ha	15.3 kg N/ha	15.3 kg N/ha
9. Juli	Urea	0 kg N/ha	0 kg N/ha	69.0 kg N/ha
Total		0 kg N/ha	39.6 kg N/ha	108.6 kg N/ha

N_{min}

Table 16. N_{min}-Values (0-90cm)

	Zero plot	Recommended	Farm-standard
4-5-leave-stadium	78.0 kg N/ha	91.6 kg N/ha	105.6 kg N/ha
harvest	2.9 kg N/ha	61.6 kg N/ha	67.0 kg N/ha

Yield

Table 17. Yield

	Zero plot	Recommended	Farm-standard
Yield (DM whole plant)	395.0 dt/ha	473.0 dt/ha	473.0 dt/ha
DM	42.8%	41.5%	42.2%
NEL	7.11 MJ/kg DM	7.17 MJ/kg DM	6.80 MJ/kg DM

DIGIT SOIL

The experimental design of *Maisnet* was supplemented in *OptiFert* with measurements of soil enzyme activities. These measurements are conducted using a device developed by Digit Soil, which is being further improved during the project. Enzyme activity was measured in parallel with available nitrogen. The results—along with data from other test plots distributed across various cantons—were incorporated into the calibration of a model that Digit Soil intends to use in the future as a basis for fertilization recommendations. Unlike current methods, this model aims to quantitatively include soil mineralization based on enzyme activities rather than relying on generalized assumptions. The enzyme activities for the *Krapf* plot were notably high at both sowing and harvest. At the 4-5 leaf stage, fewer differences were generally observed, and the values for the Swiss Future Farm plot were similar to those of the other locations. A marked decrease in enzyme activity in the 30–60 cm and 60–90 cm soil layers was consistently observed across all sites and sampling times in the project.

DISCUSSION AND OUTLOOK

As always, data from a single year should be interpreted with caution. The main goal of this preliminary study was to test the Digit Soil process and lay the foundation for successful practical implementation of the Innosuisse project. Unfortunately, the fertilization recommendation arrived too late, so the recommended variant did not receive mineral fertilization. Thus, the recommended variant received about 40 kg N/ha, while the farm-standard variant received about 110 kg N/ha.
However, there was no difference in yield between the two variants. The zero-fertilization variant had a yield that was 78 dt/ha or 16% lower. Nmin values at the 4–5 leaf stage were similar, but after harvest, there was almost no available nitrogen left in the zero-fertilization strip.

The lack of a fertilization effect in the standard farm practice compared to the recommended variant may indicate a high mineralization potential of the soil. Interestingly, high enzyme activities were measured at harvest time. In the 2025 season and as the *OptiFert* project progresses, it will become clear whether this correlation occurs more frequently.

For detailed results, reference is made to the final report from MaisNet. The Swiss Future Farm will participate again in the Optifert project in 2025 and provide a silage corn field.

3 Public Relations

3.1 Public field trip on 30th May 2024

As part of the PFLOPF project (Optimierung und Reduktion des Pflanzenschutzmitteleinsatzes mit Precision-Farming-Technologien), a field walk was conducted at Swiss Future Farm in late May. Together with the arable team from Arenenberg, four stations focusing on the theme “Reduction of plant protection products” were presented.

At the sugar beet station, results from the previous year were shown (see the 2023 sugar beet trial report and the current annual report). The presentation focused mainly on technical implementation of band spraying and strip tillage.

The second station presented results on forecasting models for plant diseases. Various models were tested within the PFLOPF framework, followed by recommendations. A field report on digital yellow traps rounded off this topic.

At the sunflower station, the focus was on weed control. As sunflowers are regaining importance, the influence of mechanical weeding, herbicide application, or catch corps was demonstrated. As with sugar beets, the production system contribution for “herbicide-free farming” was also addressed.

Lastly, rapeseed was discussed—a valuable crop for crop rotation but challenging due to insecticide use. The Swiss Future Farm's experience with spring rapeseed cultivation was shared.
After these informative presentations, the event ended with food and drinks, with Arenenberg advisors and the Swiss Future Farm team available for further discussions.

Figure 37. Spring rapeseed station during the May field walk. Unfortunately, weather conditions in 2024 were poor even for this event.

3.2 Public field trip on 27th August 2024

For the first time in 2024, a summer field trip was held in late August, about three months after the spring field walk, continuing on similar themes.

Sugar beets and sunflowers were now well developed, and participants could observe the effects of different soil cultivation and weed control methods directly in the field.

Swiss Future Farm's corn trials were also shown, comparing plough-based and strip-till methods. A new short-growing corn variety specifically developed to address climate change challenges was introduced (details available earlier in the publication).

For spring rapeseed, yield data and the actual insecticide applications were analyzed, with comparisons to the winter rapeseed field. An outlook for the next rapeseed season was also shared, including the effects of catch crops and early sowing dates on winter rapeseed.

3.3 Innovation Forum Food Industry

On November 28, 2024, the fifth Innovation Forum for the Food Industry was held at Swiss Future Farm. Organized by the Innovation Board Tänikon, the forum aimed to communicate current developments in agriculture and food sectors with a practical focus. Key technologies included AI, robotics, drones, and automation, all contributing to the sector's sustainability and competitiveness. The full-day event included expert presentations and pitches, and also marked the official opening of the ISF (Institute for Intelligent Systems and Smart Farming). Participants could choose between parallel sessions and tour the Living Lab. Attendees included professionals, researchers, farmers, and others interested in agri-food innovation.

A wide range of content along the value chain was presented. Topics in production included drones and automation. Martin Germann and Adrian Hohl (LANDI Weinland) showcased current uses of drones in plant protection, undersowing, and fawn detection. They also previewed future tools like SoilDron (soil scanner) and OptiDrone (beneficial insect release). Dr. Leonie Hart demonstrated how automation in grazing management at the Tänikon trial farm reduces labor and improves decision-making with data—highlighting the importance of user-friendly systems for adoption.

In processing, Thomas Rohn (sancofa AG) presented BBN-Prognos, an AI tool for automated order planning in bakeries to reduce waste and optimize sales through accurate forecasts. Agata Sroka (aikemy) and Michael Simmler (Agroscope) introduced the "Pocket NIR", a portable spectrometer for analyzing feed quality in under 10 minutes—cloud-based and self-learning for precision feeding.

For retail, Thomas Holenstein (Sebotics) showcased service robots for cleaning and carrying tasks in hospitality and agriculture. In animal husbandry, Thomas Denninger (swissherdbook) presented a digital tool for dairy cow mating planning, incorporating genetic values, inbreeding risks, and farm-specific breeding goals.

A highlight was the keynote by Prof. Dr. Guido Schuster (OST) titled "From Blossoms to Bytes," which explored the intersection of botany and AI, showing how data models from plant science help develop agricultural algorithms.

The forum culminated in the official inauguration of the ISF – Institute for Intelligent Systems and Smart Farming of OST. Present were Government Councillor Denise Neuweiler, Rector Prof. Dr. Daniel Seelhofer, and Director Prof. Dr. Dejan Šeatovic. The ISF unites research, teaching, and applied development in digitalization, automation, and smart farming. The Living Lab Tänikon enables real-world testing of technologies. Šeatovic's presentation highlighted innovations from 5G drone applications to the Open Farming Platform (OFA).

Figure 38. ISF opening ceremony with Regierungsrätin Denise Neuweiler, institute director Prof. Dr. Dejan Šeatovic an rector Prof. Dr. Daniel Seelhofer.

Figure 39. Swiss Future Farm booth at the Innovation Forum 2024

Further information: https://innovationsforum-ernaehrungswirtschaft.tg.ch/

3.4 Module Smart Farming BF30

In 2024, the BF30 Smart Farming module was again held in cooperation with the agricultural schools of St. Gallen and Strickhof. Participants in the farm management training received an overview of current technologies in indoor and outdoor farming. The module concluded with an excursion to farms showcasing real-world smart farming applications and farmer experiences.

Figure 40. BF30 participants during a tour in the machinery hall.

3.5 "School on the farm" (SchuB) with a high school class

As part of the "School on the Farm" (SchuB) program, Swiss Future Farm welcomed a school class for the first time. The 3rd grade of Sekundarschule Ägelsee visited during their economics project week (November 5–8). Their project involved running a food stall, and at Swiss Future Farm, they explored where these foods come from.

In the dairy barn, they learned about animal needs and how they affect barn design. They analyzed cow feed and discussed why cows produce milk not used for their calves. Topics also included nutrient cycles and feed conservation.

Figure 41. Students in the dairy barn

In the crop production section, they examined the difference between target crops and weeds in a sown grassland. In two groups, they experienced how much time chemical vs. mechanical weed control takes, and what that means when scaled to the whole farm. Using a field record example for winter wheat, they learned the steps needed before wheat can be milled.

Figure 42. Students searching for weeds in the field

3.6 Visit from Parliamentary Groups SVP, Die Mitte, EVP, EDU, and Aufrecht

On May 22, 2024, Peter Bühler (Die Mitte) was elected President of the Thurgau Cantonal Parliament for the 2024/2025 term with 116 votes. The celebration took place in his hometown of Ettenhausen. Several parliamentary groups used the occasion to visit the Swiss Future Farm and learn about ongoing projects and trials. Christian Eggenberger gave an overview of the farm, Sven Dönni led a barn tour and explained the milking robot, and Florian Bachmann shared the latest findings from the Smart-N trial and other experiments. We thank the parliamentary groups for their interest and the opportunity to present the Swiss Future Farm.

4 Links

4.1 Websites

www.swissfuturefarm.ch

www.agcocorp.com

www.bbz-arenenberg.ch

www.gvs-agrar.ch

www.fusesmartfarming.com/de

www.agrar-landtechnik.ch

www.precisionplanting.com

eu.precisionplanting.com

www.agroscope.admin.ch/agroscope/de/home/themen/wirtschaft-technik/smart-farming/swiss-future-farm.html

4.2 Social Media

https://www.instagram.com/swissfuturefarm

https://www.facebook.com/swissfuturefarm

https://www.youtube.com/channel/UCzsEm9mMLs0X_IT3MoaCJXQ

5 Publishing Information

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