EU CAP NETWORK

EU CAP Network Workshop

Innovative arable crop protection - using pesticides sustainably

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Table of Content

1. Introduction

The EU CAP Network Workshop entitled 'Innovative arable crop protection - using pesticides sustainably' started in the afternoon of Wednesday 19 April 2023 with a number of field visits. During these visits the participants had the opportunity to get acquainted with inspirational cases of pesticide use reduction in a region near Amsterdam. The farms visited are in the province of Flevoland, which mostly consists of reclaimed land. In Flevoland, 14% of the agricultural land area is organic, contrary to a range of between 2-4% organic at the national level.

All participants visited the 'Farm of the Future' together as one group, while afterwards the participants were then assigned to different groups. Group A visited Exploitatie Reservegronden Flevoland, Group B visited Gilbert van Campen's farm and Group C visited the Operational Group Akker van de Toekomst.

During the field visits, among other things, the participants could familiarise themselves with examples of:

- crop diversification through strip cropping and more diversified rotations over longer time periods. They noticed the importance of Global Positioning Systems (GPS), digitalisation and mechanisation adaptations for added efficiencies. Furthermore, they learned that biodiversity goals could be achieved, but that in some cases it is not yet economically sustainable;
- the possible contribution of resistant and tolerant varieties. Participants noticed the importance of resistance management to keep resistance genes for the future, and the need to boost/ retain market demand for these varieties;
- the value of high-tech solutions such as precision spraying and decision support systems (DSS) to reduce pesticide use. Participants learned that it is possible to significantly reduce pesticide use in this way, but it takes knowledge, investments and many small step changes over a longer time period for a farmer to reach the required reduction targets.

2. Farm of the future

The Farm of the Future is an initiative based in the Netherlands, bringing together Wageningen University & Research and progressive Dutch farmers to tackle the challenges that the agricultural sector is contending with. Situated in Lelystad, within the Dutch polder province of Flevoland known for its predominantly arable farming focus, this initiative endeavours to evolve into a collaborative platform encompassing other agricultural regions across the country. Moreover, it seeks to establish a network of international partners, including businesses, research institutes and government bodies engaged in similar initiatives.

The Farm of the Future combines the principles of agroecology and advanced technology, incorporating field trials initiated through the EU Horizon 2020 project IWMPRAISE. Serving as a valuable resource for individuals involved in the sector, it acts as a central hub for sharing best practices and techniques in agronomy, ecology, and technology. By harnessing the knowledge and experiences of both organic and conventional agriculture, the Farm of the Future strives to develop a sustainable business model. Its activities revolve around achieving a harmonious coexistence of nature, landscapes and agricultural practices while minimising emissions to the greatest extent possible. Essentially, it promotes a forward-thinking farming approach that prioritises environmental harmony.

In essence, the Farm of the Future offers a practical solution that strikes a balance, integrating the preservation of nature and landscapes with a concerted effort to minimise environmental impact. It embodies a vision of agriculture that is sustainable and adaptable, ensuring a promising future for the sector. The Farm of the Future has three main activities: a 60 hectare (ha) field lab, an 'Agroecology and Technology Experimental' site encompassing an area of 80 ha and a platform for discussion, cooperation and knowledge exchange.

The participants of the workshop were divided into two smaller groups. One group visited the 60 ha field lab, the other group the agroecology and technology experimental site. At the field lab, arable crops are grown in rotation with eight crops grown on strips. This field lab structure enables the testing and the demonstration of innovations and interventions such as robots, sensors, recycled fertilisers, biopesticides, robust crop varieties and crop diversity, both in time and in space.

The 'Agroecology and Technology Experimental' site, an 80 ha area of polder clay where biodiversity is encouraged and promoted with the objective of minimising the use of crop protection agents by applying nature-inclusive and ecological principles and using decision support tools, robotisation, sensor technology and autonomous vehicles. Of this land area, 15 ha is dedicated to a long-term field trial (an eight-year trial, which started in 2018) where disease, weeds and pests are managed according to the five pillars of the Integrated Crop Management (ICM) framework: crop diversification, robust varieties, soil management, targeted control and monitoring & evaluation. The goal is to grow arable crops without the use of candidates for substitution (CfS)[1]. Further information: https://farmofthefuture.nl/en/

2.1 What participants learned/noticed

Voices from participants:

"Addressing a combination of challenges, not only IPM, is important for uptake by farmers".

Crop diversification can serve as an effective method to enhance biodiversity and alleviate the challenges posed by diseases, pests and weeds in arable farming. Ideally, potatoes should be cultivated once every 6 to 8 years on the same ground; however, this is not a viable option for a cash crop of such significance for many growers. The choice of crop variety plays a crucial role in managing pests and diseases effectively. Implementing decision support tools and precision agriculture techniques offer potential avenues to reduce pesticide usage without compromising harvest yields.

Voices from participants:

"The importance of resistance management, to keep resistance genes for the future, and the need for market demand for these varieties".

It is imperative to address multiple challenges in an integrated manner, rather than solely focusing on Integrated Pest Management (IPM). This holistic approach is also crucial for encouraging earlier and broader adoption by farmers. Long-term research plays a pivotal role in developing sustainable practices.

Collaborating with farmer organisations assists in devising practical solutions that better meet the needs of the farmers. The farm itself serves as an excellent demonstration site to assess the practical limitations and determine the extent to which we can implement IPM/ICM. Research institutions, farmers and technology companies can co-operate more effectively to explore solutions.

The framework of Integrated Crop Management (ICM) is applicable to both temporal and spatial crop diversification.

The feasibility of cultivating arable crops without relying on Substitution Candidates appears promising.

Voices from participants:

"Excellent living lab, research helping farmers with their journey".

3. Exploitatie Reservegronden Flevoland (ERF)

ERF is the largest private organic agriculture company in the Netherlands, cultivating a range of crops on approximately 1,500 hectares of land in Flevoland (with 1,300 hectares dedicated to organic farming and 250 hectares under conversion). Situated on reclaimed land dating back to the 1960s and 1970s, the farm lies nearly 5 meters below sea level. This unique location results in highly fertile soil, characterised by large square fields with excellent water retention capacity. The organic matter content ranges from 2% to 4%.

[1] "Active substances with certain properties defined in Regulation (EC) No 1107/2009 are considered as candidates for substitution. For plant protection products (PPPs) containing these active substances, Member States are required, when assessing an application for an authorisation, to evaluate if they can be replaced (substituted) by other adequate solutions (chemical or non-chemical)." https://food.ec.europa.eu/plants/pesticides/approval-active-substances_en#candidates-for-substitution

ERF stands out as the sole Dutch agricultural company affiliated with the global network of lighthouse farms, well known for their sustainable and future-proof cultivation systems. These farms have adopted modified cultivation practices in response to sustainability concerns in agriculture. ERF embraces modern cultivation and processing techniques while striving to be '2050-proof', combining sustainable food production with ecosystem services. The farm collaborates with organic growers, researchers, suppliers and consumers.

With over 15 different organic crops, ERF employs a strategic approach of spreading the various crop types across the entire area to mitigate the risks associated with weather conditions, diseases and pests, ensuring resilient harvests. The farm also conducts experiments with cultivation techniques such as strip cultivation and agroforestry to enhance functional biodiversity. Additionally, ERF utilises advanced machinery, including agricultural robots, self-propelled weed beds and camera-based weed control.

Since 2015, ERF has been experimenting with strip cropping and is currently conducting field trials covering an area of 64 hectares near the city of Almere. In this approach, field crops are grown in 6-meter-wide strips. Wageningen University monitors the impact on biodiversity, pest management, yield and efficiency, comparing the results with traditional monoculture practices. Furthermore, in 2023, ERF plans to embark on agroforestry experiments combining strip cropping with hazelnut production, as well as agrovoltaics experiments combining strip cropping with renewable energy generation. (Further information: https://www.erfbv.nl/en)

3.1 What participants learned/noticed

Voices from participants:

"Example that shows how production of crops is feasible with strip cropping, and the resultant biodiversity increases".

Participants were impressed by the innovative use of strip cropping at this expansive organic farm, aiming to minimise the spread of diseases while enhancing biodiversity and crop yield. The absence of pesticides served as an inspiration for the attendees. A wide range of crops, including oats, peas, beans, maize, parsnips and brussels sprouts are cultivated organically. Strip cropping facilitates the movement and provision of shelter for fauna, making crops less susceptible to diseases like late blight. Compared to broader strips and monoculture, crops grown in strip cultivation show lower infection rates. While leaf diseases affecting sugar beet and potatoes remain problematic, strip cropping promotes increased insect biodiversity, including spiders and beetles, as well as bird populations. This, in turn, maximises the effectiveness of biological pest control.

Voices from participants:

"The main limiting factor is adaptation of machinery".

However, mechanisation poses a significant limitation to the implementation of the strip cropping system. The available machinery is responsible in shaping the design, necessitating the use of satellite/GPS tractors. Additionally, strip cropping requires more careful planning.

The farm engages in collaborations with other farmers to trade manure for feed and further assist with crop processing and delivery. For instance, ERF undertakes the processing of red beets internally. Irrigation presents challenges within the strip system. The existing watering rail covers a distance of 90 meters in one pass, which is not suitable for 6-meter-wide strips. Applying uniform irrigation is inefficient when only specific crops require it. Experiments have been undertaken with drip irrigation methods but this has not yet yielded satisfactory results due to the time-consuming nature of the process. Alternative irrigation methods are sought.

Voices from participants:

"I appreciated the good attention to sustainability".

Crop yields have fallen short of expectations. Results are similar to conventional crops during relatively dry seasons, but when faced with wetter conditions yields were lower than with conventional crop systems.

4. Gilbert van Campen's farm

Gilbert van Campen is an innovative arable farmer based in Kraggenburg, located in the Noordoostpolder region of the Netherlands. His 135 hectare farm cultivates a variety of crops, including potatoes, wheat, sugar beet, onions, carrots and tulips. Gilbert is deeply invested in agro-ecology and precision technology, striving to enhance his production processes and promote sustainability. He actively participates in multiple projects and farmer groups, such as the EU Horizon 2020 IPMWorks project (IPM) and the Dutch NPPL project (precision agriculture). He is also involved in farmer groups within the Dutch 'Duurzaam Praktijknetwerk Akkerbouw' network.

Taking potato cultivation as an example, Gilbert employs a range of agro-ecological and technological tools to foster the growth of healthy and productive crops while minimising pesticide usage through an integrated pest management (IPM) approach across his entire farm. Some of these tools include:

- **Seed potato quality**: Gilbert utilises a sophisticated (seed) tuber sorter equipped with advanced image analysis capabilities, enabling automatic grading for quality and size based on flexible, user-defined size classes.
- **Potato storage units**: Gilbert's storage units are fitted with a humigator system, which ensures the inflow of moist, clean air to optimise storage quality while minimising losses. This system replaces the need for chemical treatments by naturally cleaning the air using water.
- **Precision spraying**: Gilbert's cutting-edge spraying equipment is equipped with sensors, section control and pulse nozzles. This allows him to automatically switch spraying on and off in various sections based on the specific varieties that require treatment. Furthermore, the spray volume can be adjusted according to the amount of foliage present, reducing overall spray volume. By using late blight resistant potato cultivars, Gilbert can significantly decrease fungicide input by 75% or more.
- **Companion plants and banker plants**: Gilbert incorporates various flowering plant species within his potato crops as companion plants. These plants serve to confuse aphids, discouraging them from landing on his crop. The ultimate aim is to reduce the need for insecticide use in aphid control. As part of the IPMWorks project, the species mixture is optimised, and the impact on aphid populations within the potato crop is quantified. Additionally, flowering plants sown at the edges of his fields, known as banker plants, attract and nurture natural enemies of aphids, promoting biological aphid control.

4.1 What participants learned/noticed

Gilbert is a third-generation farmer who oversees a 135 hectare farm, with the primary focus being on potato cultivation. Given that potatoes are a high-value cash crop, the farm primarily produces seed potatoes, although this crop requires significant inputs and pesticide usage.

Voices from participants:

"The passion of this farmer to reduce ppp input with super interesting machines and techniques".

Taking charge of the farm in 2000, Gilbert initially followed the existing management strategy. However, he soon recognised the need for change, not only to adapt to the evolving agricultural landscape. His goal was to reduce inputs while maintaining both quantity and quality.

Gilbert places considerable emphasis on precision agriculture technologies, employing tools such as a 'humigator' to prevent disease development during storage. He also incorporates companion and banker plants and utilises 'foliar' fertilisers. Through these practices, he has achieved notable advancements. For instance, the implementation of an automatic seed potato sorting machine has streamlined the process. Additionally, the introduction of the humigator device has improved tuber storage by increasing atmospheric moisture content and purifying the air using water. This has effectively reduced disease incidence, minimised storage losses and decreased reliance on chemical treatments.

Voices from participants:

"The philosophy of small and continuous steps towards sustainability".

Regarding crop protection in the field, Gilbert focuses on key pests, particularly aphids, which act as vectors for plant viruses and diseases. Monitoring and insect counts guide decision-making, while the use of different potato varieties, including those resistant to aphids, allows for targeted and precise insecticide spraying. This approach ensures higher precision and lower costs compared to indiscriminate spraying. The utilisation of interactive sensors on tractors and the resulting task maps further enhance the precision spraying process. Gilbert also pays specific attention to monitoring the Colorado beetle, another significant pest.

Overall, by integrating new techniques, practices and technologies, Gilbert has achieved a sustainable and productive farm management system. As a result, he has successfully reduced chemical applications by 50-60%. Gilbert believes that, although the implementation of new technologies can be costly and require significant initial financial outlay and investment, production costs over time fall due to the reduced need for pesticide treatments and the elimination of outdated equipment expenses.

Voices from participants:

"Nice to see that the farmer thinks he can reach the target of F2F (50% reduction)".

Participants appreciated the fact that a farmer thinks it is possible to reach the target of the Farm to Fork strategy of a 50% reduction. They particularly appreciated his passion, strong interest and his step-by-step approach to implementing technologies on his farm.

5. Operational Group Akker van de Toekomst

The Operational Group Arable Field of the Future, known as Akker van de Toekomst, serves as a physical testing ground for circular agriculture. Its primary focus is on sustainability and the advancement of arable farming, aiming to create a business system that is both innovative and environmentally friendly.

The goals of Akker van de Toekomst include maintaining a stable input cost price, promoting nature-friendly production and reducing reliance on external inputs. To achieve these objectives, the project emphasises minimal use and low emissions of plant protection products, low consumption of fossil energy, limited loss of minerals into the environment, reduced nitrogen (N) fertiliser usage, more efficient water utilisation and residue-free cultivation practices.

Voices from participants:

"It is practically possible to produce products with reduced pesticide inputs, but not economically.....yet?".

As mechanisation in agriculture expands due to scaling-up, there is a consequential increase in ground pressure, leading to soil health degradation. This, in turn, results in less robust crops and heightened demand for crop protection measures. To ensure sustainable arable crop production, Akker van de Toekomst focuses on developing and testing innovative farming techniques such as strip cultivation and 'unridden' bed cultivation[2].

Voices from participants:

"The joy and desire with which the farmer implements new strategies to reduce PPP use and implements new technology for conservation and restoration of biodiversity".

The project combines knowledge from both organic and conventional agriculture, striving to utilise no more than 10% of the average amount of plant protection products used conventionally. This approach aims to achieve residue-free end products while minimising the negative impact of arable farming on biodiversity and soil fertility. The project promotes prolonged 'green' soil coverage, encourages wide crop rotations, cultivates resilient and disease-resistant crops while employing modern precision techniques. By integrating the strengths of both organic and conventional approaches, Akker van de Toekomst aims to pave the way for sustainable and responsible arable farming practices. Further information: https://ec.europa.eu/eip/agriculture/en/find-connect/projects/akker-van-de-toekomst-de-fysieke-proeftuin-voor , https://www.futurefoodproduction.nl/

5.1 What participants learned/noticed

The group of farmers firstly initiated the project with discussions on how to reduce production costs while maintaining income levels, prompted by significant increases in input prices, particularly when compared to the prices of agricultural produce.

The size and weight of machinery used in farming operations are substantial, but alternatives are available, such as unridden bed cultivation. Moreover, the occurrence of extremely hot summers indicates a changing climate, necessitating the implementation of even more careful soil management strategies.

[2] https://www.futurefarming.com/crop-solutions/harvest-storage/video-potato-harvester-for-unridden-cultivation-beds/

The following goals have been set: a 40% reduction in fossil energy usage, elimination of the need for mineral fertilisers containing phosphorus (P) and potassium (K) due to the abundance of these elements in the Netherlands, and a target of 40 kg/ha/year for nitrogen (N) usage. External water consumption is also targeted to be reduced by 50%. In addition, the goal is to use no more than 10% of the usual amount of plant protection products so as to realise residue-free end products.

While 3 metre wide crop strips prove beneficial for biodiversity, they also present some practical challenges. This approach works effectively with robot machinery, but it becomes less suitable when larger machines are engaged/involved. The farmer employs light mechanisation and incorporates green manure crops, ensuring the fields remain predominantly green during the winter season. Additionally, a mixture of clover grass is included in the crop rotation. Although the farmer does not keep animals, they have established a productive collaboration with neighbouring farmers, who provide manure in exchange for silage or hay materials. Tulips are also included in the crop rotation, with an aim to grow them without the use of pesticides. As it is their first year attempting this method, the outcome will be further evaluated accordingly in the coming years.

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