

Evaluation of the Finnish action plan for the sustainable use of pesticides 2018–2022

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The Finnish National Action Plan (NAP) on the Sustainable Use of Plant Protection Products for 2018–2022 was evaluated by a survey indicated to the experts involved in its implementation in 2022. The survey revealed several successes such as the training and certification system of professional users, retailers and advisers, regular inspection of spray equipment, and the web-based register of plant protection products (PPP). Measures, where further improvement is necessary, are, e.g., setting of environmental quality standards for all active substances, and monitoring of surface and ground waters for PPP residues, which has suffered from a lack of resources during the NAP period. Overall screening of the sustainability goals revealed progress in all aspects, though targeting, resourcing, and monitoring remained the area with least progress compared to the same screening conducted in 2015. The perception of the experts on the constraints that limit the fulfilment of the NAP most seriously remained similar compared to their views in 2014.

Key words: policy evaluation, plant protection product, risk, success, constraint, sustainability goal

Introduction

EU Directive 128/2009 on the sustainable use of pesticides requires that all member states should have developed a National Action Plan (NAP) to fulfill the Directive's target of reducing human health and environmental risks from the use of plant protection products. The Finnish Safety and Chemicals Agency Tukes is the Competent Authority responsible for implementing the sustainable use of plant protection products (PPPs). In Finland, the first NAP was implemented in 2011, and the updated second NAP (NAP II) in 2018 (Tukes 2018). At the end of the NAP II period, Tukes decided to conduct an assessment on the programme's achievements and effectiveness, to gather information for the improvements of the next policy period.

Policy evaluation is an important tool for gathering data and analysis of the success and shortcomings of public policies (Mergoni and De Witte 2022). However, so far not much have been published about policy evaluations of the sustainable use programmes of plant protection products in different countries. Helepciuc and Todor (2021) recently compared some aspects of the NAPs in Denmark, Germany, the Netherlands, France, the UK, Romania, Hungary, and Poland. Barzman and Dachbrodt-Saaydeh (2011) analyzed pesticide action plans of five countries before the NAPs were mandatory according to the current legislation. In Sweden, the NAP 2019–2022 concentrated on six targets, which were evaluated using 22 indicators (Gissén et al. 2021).

Möhrling et al. (2020) point out the importance of choosing appropriate indicators to demonstrate the effectiveness of the sustainability policy on plant protection products. Robin and Marchand (2019, 2021) have assessed the development of the approvals of active substances of plant protection products in the EU, following the procedures laid down in the PPP Regulation (EU) 1107/2009. They found out that despite the aim of phasing out the most hazardous PPPs, their withdrawal and substitution with less hazardous active substances have not been as fast as expected.

As the time perspectives to reach environmental sustainability goals are long, stop-go target-setting may limit the emergence of desired policy outcomes, as pointed out, e.g., by Hildén (2009). Van Ongevalle et al. (2014) highlighted the strong involvement of actors in data collection for the evaluation of complex plans and programmes, and their reflection and learning from the information collected, to understand the long-term and unexpected changes. Autio (2016) developed methodological tools to conduct evaluations of the NAPs.

The European Commission has recently given its proposal for a reform of the legislation concerning the sustainable use of plant protection products in line with the EU Green Deal targets (EC 2019). Therefore, the aim of this paper is to discuss the observations of the expert survey on the Finnish NAP II period of 2018–2022, to allow focusing on the most critical issues in the preparation of the next policy period for further reducing the risks from the use of plant protection products.

Materials and methods

The Finnish NAP II for the years 2018–2022 consists of altogether 65 measures, grouped in 12 sections according to the articles of the Directive 2009/128/EC, in addition to continuing tasks in each section (Tukes 2018). An overview of the NAP II measures is presented in Table 1.

Table 1. Overview of the measures of the Finnish NAP II with reference to respective Articles of the Directive 2009/128/EC

Objective (Article)	Measures
Monitoring of active substances of particular concern (Article 4)	<ul style="list-style-type: none"> • Identification of active substances of particular concern • Reducing risks arising from the use of active substances of particular concern and controlling the use of such substances
Plant protection training (Article 5)	<ul style="list-style-type: none"> • New training for plant protection training and certification providers • Exchanging information and collective learning among trainers • Continuing training for professional PPP users in Finnish and in Swedish • Updating of the online training materials provided by Tukes and expanding them with a module about biocides • Controlling of the training and certification services aimed at professional users • Expanding of the plant protection training and certification system with a training and certification system targeted at staff members of farm advisory services
Requirements for sales of PPPs (Article 6)	<ul style="list-style-type: none"> • Obligation to inform distributors and producers of products approved for consumer use • Public information service on individuals holding a plant protection certificate
Information and awareness raising (Article 7)	<ul style="list-style-type: none"> • Informing the general public of PPPs • Informing non-professional users of PPPs • Arranging training for operators on the requirements of the reformed plant protection legislation • Information about acute and chronic poisoning incidents • Development of PPP biomonitoring methods • Exposure of tractor drivers during spraying • Revising of PPP product labels to better serve users • Reforming the PPP Register and implementing a Swedish language version of the Register • Biological control in glasshouses – exposure, allergies and prevention thereof • Monitoring of impacts on human health and the environment
Inspection of spraying equipment (Article 8)	<ul style="list-style-type: none"> • Regular checks and calibration of sprayers • Control of application equipment inspection activities
Aerial spraying (Article 9)	<ul style="list-style-type: none"> • Aerial spraying of PPPs using drones
Informing the public of PPP treatments (Article 10)	<ul style="list-style-type: none"> • Buffer distance to neighbours • Guidelines on informing bystanders
Specific measures to protect the aquatic environment and drinking water (Article 11)	<ul style="list-style-type: none"> • Use of PPPs in surface and groundwater areas used for the abstraction of drinking water • Buffer distances to wells and springs • Reducing the use of PPPs in specific areas with a high risk of run-off into surface or groundwater • Evaluation of the appropriateness of environmental restrictions • Setting of environmental quality standards for all active substances
Reduction of PPP use or risks in specific areas (Article 12)	<ul style="list-style-type: none"> • Use of PPPs in nature conservation (Natura) areas • Recommendation on the reduction of PPP use in specific areas • Communication on re-entry periods • Sensitising substances
Handling and storage of PPPs and treatment of their packaging and remnants (Article 13)	<ul style="list-style-type: none"> • Revision of the PPE instructions • Biobeds • Promoting the collection of PPP waste • Measures to inform operators of the sale and use periods for expired products will be taken when a product's authorization is withdrawn.
Promotion of integrated and organic pest management (Article 14)	<ul style="list-style-type: none"> • Low-risk substances • Basic substances • Active substances that are candidates for substitution and comparative assessment • Risk assessments concerning new pests • Controls of propagation materials • Promotion of pest monitoring methods • Pest prediction models and threshold values • Resistance to PPPs • Plant species- and plant group-specific IPM guidelines • Alternative control methods to glyphosate • Non-chemical control methods • Certified seeds and resilient varieties • Research on cropping systems

	<ul style="list-style-type: none"> • Actions promoting the use of pollinators and natural enemies of pests • Promotion of organic research • Biological efficiency of products approved for use in organic production • Information exchange conference on IPM and organic production • Identifying good practices • Network coordination • Implementing innovations for use by farms and in collaboration with farms
Indicators (Article 15)	<ul style="list-style-type: none"> • Harmonised indicators • Trends in the use of certain active substances • Identifying issues requiring special attention • Updating the risk indicator measuring the environmental load of PPPs • Catchment area-specific risk indicator measuring the environmental load of PPPs • PPP use statistics • Parcel-specific PPP use data

A steering group has been nominated to represent all stakeholder groups involved in the implementation of the NAP, to discuss the practical realization of the measures and to communicate their achievements and outcomes related to their expertise areas. The steering group has met twice a year during the programme period.

In spring 2022, Tukes conducted a survey among the steering group members and other stakeholders interested in the sustainability of plant protection in Finland. The survey contained 88 questions, organized according to the objectives and measures in the NAP II. For each measure, a Likert scale opinion was asked about the achievement of the target (not at all, rather poorly, moderately, well, completely). Additionally, for each section, open fields were provided to highlight specific achievements during the NAP II period, and for proposals to be considered in the planning of the future NAP.

The survey was sent to 74 individual experts to cover all stakeholders to whom specific tasks have been assigned in the NAP II (administration, research, education and training, advisory services, farmer organizations, sales). Altogether 14 responses were received (19%), but not all respondents answered all questions. It was also possible for individual respondents from a same organization to consolidate their responses. Based on the examination of the responses in several open fields about achievements, this was indeed the actual case. Therefore, any deeper statistical analysis of the results was not possible.

Two questions were exactly the same as in the limiting factors analysis and the screening of the sustainability goals as conducted by Autio (2016). The screening of the sustainability goals was based on the qualitative methodology, originally developed by Cherp et al. (2004) focusing on how national sustainability strategies follow international principles and criteria for strategic planning of sustainable development and adapted by Autio (2016) to specifically address the goals of the NAP in the context of evaluation of the Finnish NAP in 2015. The sustainability screening framework consisted of five principles, each covering four criteria that could be qualitatively scored from A to D indicating to what extent each criterion has been perceived as met (A = all criteria fully met, B = all the requirements are satisfactorily met, although some improvements are desirable, C = some requirements satisfactorily met, but others have not met yet, D = few criteria met yet). The results are presented in Table 2.

Additionally, the obstacles to goal-achievement were asked using similar methodology as described in detail by Autio (2016). She presented the results of a stakeholder workshop that prepared a list of constraints that limit the fulfilment of the NAP most seriously in 2014. In the survey 2022, the respondents were asked about their opinion on the severity of the same constraints again. The scoring of the severity of the likely obstacles was: 0 = does not limit in any way, 1 = the problem is manageable, 2 = limits to some extent, 3 = serious impediment to work, and 4 = completely prevents the work. The results from 2014 and 2022 are compared in Table 3. Obviously, at least some of the respondents in 2022 may have been the same as participated in the analysis in 2014 and 2015.

In addition to the survey, the participants of the NAP II steering group have been asked to present their projects, tasks, and achievements during the steering group meetings. The NAP II steering group has assembled twice a year, and the minutes, including presentations, were utilized to explain the outputs of different stakeholders in certain cases as presented in the results section, but a more detailed analysis was not conducted.

Results

In this chapter the results of the survey are presented in following order. First the screening of the sustainability goals and the limiting factors analysis are compared with results from 2014 and 2015. Then the rest of the sections summarize the results of the survey in 2022 on the achievement of different measures of the NAP II. The order of actions follows the Articles of the Directive 2009/128/EC, as given in Table 1.

Screening of the sustainability goals

The progress of the Finnish efforts on implementing the NAP was assessed using the sustainability screening framework. Comparison of screening results in 2015 and 2022 is presented in Table 2.

Table 2. Assessment of the experts on the Finnish progress in the implementation of the NAP in light of sustainability screening framework in 2015 and 2022. Qualitative rankings: A = all criteria fully met, B = all the requirements are satisfactorily met, although some improvements are desirable, C = some requirements satisfactorily met, but others have not met yet, D = few criteria met yet. M 2022 = Most typical (mode) ranking among the experts in the 2022 assessment. * = M 2022 is higher than the highest ranking given in 2015.

	Criteria and their explanation	Ranking range 2015	Ranking range 2022	M 2022
Principle 1. Integration of economic, social, and environmental objectives	Criterion 1.1. Integration. The NAP is based on a comprehensive and integrated analysis of economic, social, and environmental issues, which clarifies links between the three spheres, resolves conflicts between them where practicable, and negotiates appropriate trade-offs where conflicts remain.	B–D	A–C	B
	Criterion 1.2. Social and poverty issues. The NAP integrates poverty eradication, gender issues, and the short-term and long-term needs of disadvantaged and marginalized groups into economic policy.	C–D	A–D	B*
	Criterion 1.3. Environment and resource issues. The NAP integrates the maintenance of sustainable levels of resource use and the control of pollution to maintain a healthy environment into economic policy.	B–D	A–C	B
	Criterion 1.4. International commitments. Measures are in place to ensure compliance with international agreements on environmental and social issues.	A–B	A–C	A
Principle 2. Participation and consensus	Criterion 2.1. Involvement of stakeholders. The NAP processes of strategic planning, implementation, monitoring, and review include the participation of stakeholders, including government, decentralized authorities, elected bodies, nongovernmental and private sector institutions, and marginalized groups.	B	A–C	B
	Criterion 2.2. Transparency and accountability. The management of the NAP processes is transparent, with accountability for decisions made.	B–C	A–C	B
	Criterion 2.3. Communication and public awareness. Measures are taken to increase public awareness of sustainable development, to communicate relevant information, and to encourage the development of stakeholder involvement in the NAP process.	B–C	A–C	B
	Criterion 2.4. Long-term vision and consensus. The processes of the NAP are based on a long-term vision for the development of Finnish agriculture, which is consistent with our capabilities, allows for short-term and medium-term necessities, and has wide political and stakeholder support.	B–D	A–C	B
Principle 3. Ownership and commitment	Criterion 3.1. High level government commitment. The process of formulating and implementing the NAP is led by government, with evidence of high-level commitment.	A–B	A–D	B
	Criterion 3.2. Broad-based political support. The NAP process has a broad-based political support.	A–C	A–C	B
	Criterion 3.3. Responsibilities for implementation. Responsibility for implementing the NAP is clearly assigned to bodies with appropriate authority.	A–C	A–C	B
	Criterion 3.4. Coordination with sponsors. The NAP process is coordinated with its sources of funding.	B–C	A–D	B

Principle 4. Comprehensive and coordinated policy process	Criterion 4.1. Build on existing processes. The NAP is based on existing strategic planning processes, with coordination between them, and mechanisms to identify and resolve potential conflicts.	A–C	A–D	B
	Criterion 4.2. Analysis and information. Implementing the NAP is based on a comprehensive analysis of the present situation and of forecasted trends and risks, using reliable information on changing environmental, social, and economic conditions.	B–C	A–C	B
	Criterion 4.3. Realistic goals. The NAP is based on a realistic analysis of national resources and capacities in the economic, social, and environmental spheres, taking account of external pressures in the three spheres.	B–D	A–D	C
	Criterion 4.4. Decentralization. The NAP process embraces both national and decentralized levels, with two-way iteration between these levels.	C–D	A–D	B *
Principle 5. Targeting, resourcing and monitoring	Criterion 5.1. Budgetary provision. The NAP is integrated into the budget process, such that its measures have financial resources to achieve their objectives.	C	A–C	C
	Criterion 5.2. Capacity for implementation. The NAP includes realistic mechanisms to develop the capacity required to implement it.	C	B–C	C
	Criterion 5.3 Targets and indicators. Targets have been defined for key strategic economic, social, and environmental objectives, with indicators through which they can be monitored.	C–D	A–C	B *
	Criterion 5.4. Monitoring and feedback. Systems are in place for monitoring the implementation of the NAP and the achievement of its defined objectives, for recording the results, and for reviewing its effectiveness as a strategy for sustainable development, with effective mechanisms for feedback and revision within the planning process.	B–D	A–D	C

Compared to results in 2015, improvement in seven years is shown in Principle 1, Integration of economic, social, and environmental objectives, and in Principle 2, Participation and consensus. For those all criteria were perceived as fully met by at least some of the respondents and three of the four criteria were ranked at least as C by all experts.

In Principle 3, ownership and commitment and policy process, the opinions deviated significantly between rankings from A to D. Principle 4, Policy process showed improvement in the sense that in 2022 almost all objectives also received A rankings, but still there are objectives where some experts felt that the criteria are not satisfactorily met yet.

Principle 5, Targeting, resourcing, and monitoring, continues to be the area with least progress with most typical mode of rankings being C in three of four criteria, although compared to 2015 results, it also deserved some A rankings now. This section continues to be the most critical area for the success of the NAP.

In general, the variation between the opinions of individual experts was wider in 2022 than in 2015. The most typical mode ranking for most criteria was B (=all the requirements are satisfactorily met, although some improvements are desirable). Strongest performance showed the criterion 1.4 (compliance with international agreements) that got the mode ranking of A.

Limiting factors analysis

Table 3 summarizes the expert views on the obstacles most likely limiting the achievement of the Finnish NAP goals in 2014 and 2022. The obstacles were grouped in five thematic groups.

General profitability of farming and cost of introducing new technologies were continuously perceived to limit most severely the achievement of the goals of the NAP. Concern about invasive alien species and new pests had increased from 1.7 to 2.2 in eight years. Attitudinal issues like disregard were perceived as a slightly less severe impediment compared to the previous analysis (average 2.0 in the first analysis, while 1.3 in 2022).

The average scorings of individual respondents remained similar in 2014 and 2022. However, the range of scoring was generally wider in the 2022 analysis. It is notable, that in 2022 all factors are perceived as not limiting the NAP in any way by at least 7% of the respondents. Six factors were perceived to completely prevent the work according to 7% of the respondents in 2022.

Table 3. Factors recognized as most likely to limit the achievement of the Finnish NAP goals in 2014 and 2022. The scoring of the severity of the likely obstacles is 0 = does not limit in any way, 1 = the problem is manageable, 2 = limits to some extent, 3 = serious impediment to work, 4 = completely prevents the work.

Limiting factors for achieving the goals of the Finnish NAP	Average from individual responses in 2014 (n=10)	Range of individual responses in 2014	Average from Individual responses in 2022 (n=14)	Range of individual responses in 2022
1. Economy and resource issues	2.05		1.88	
General profitability of farming	2.50	2–3	2.50	0–4
Cost of introducing new technologies	2.40	2–3	2.40	0–4
Time and workload needed to gather and apply new knowledge	2.20	1–3	1.80	0–3
Economical risks from introducing new pest management practices	1.70	0–2	2.00	0–3
Lack of resources for disseminating new knowledge to farmers	1.44	1–2	1.50	0–3
2. Biological and environmental issues	1.95		1.82	
Problems in pest observation: use of time, identification of species	2.11	1–3	1.90	0–4
Lack of healthy propagation material	2.11	1–3	1.70	0–3
Climate and geographical location	1.89	1–2	1.50	0–3
Invasive and alien species, new pests	1.70	1–2	2.20	0–4
3. Policy issues	1.49		1.55	
Limited choice of PPPs on the market	2.33	1–3	2.30	0–4
Contradicting goals of legislative requirements and cultivation practices	1.60	1–2	1.90	0–4
Requirements set by clients, e.g., on residues in food	1.13	0–2	1.20	0–3
Changes in financial incentives policies, e.g., removed obligation to harvest	0.88	0–2	0.80	0–3
4. Information and communication issues	1.53		1.20	
Inability to use foreign research (availability, accessibility, limited applicability, different conditions)	1.67	1–2	1.10	0–3
Knowledge brokering between responsible NAP actors	1.40	0–2	1.30	0–3
5. Attitudinal issues	2.00		1.30	
Disregard, perceived uselessness of required investments	2.00	1–3	1.30	0–2

Active substances of particular concern (Art. 4)

Active substances of particular concern may not fulfil all criteria relevant for their approval and deserve therefore specific attention to monitor their uses. Glyphosate, azoxystrobin, deltamethrin, esfenvalerate and indoxacarb were identified as active substances of particular concern in Finland. For the time being, only limited information on their sales and other control has been published. According to the respondents, identification, reduction or risks and surveillance of active substances of particular concern was successful. It was not defined in the NAP II, what kind of control measures are specifically aimed to the active substances of particular concern, so the realization of this measure was not clear.

The notes of the NAP steering group meetings highlighted, that in the environmental monitoring there have been problems in analytical methods for certain active substances of particular concern, namely not being able to catch adequate low quantities of esfenvalerate and deltamethrin. As certain active ingredients will be withdrawn, a new list of active substances of particular concern should be established in the future.

Some respondents suggested that the uses of active substances of particular concern in different countries should be statistically compared before establishing any actions aiming to reduce their risks and uses. However, such comparisons may not always be meaningful if the crop protection needs, products on the market and uses are different in different conditions. It was not perceived as fair if similar reduction targets are set for each country

regardless of the initial level of applications. Experts reminded that adequate choice of PPPs should be available to cope with the increasing risks of introduction and establishment of new pest populations when the climate is changing.

Training and certification (Art. 5)

Training and certification system for professional users, retailers and advisers was established in the first NAP in Finland in 2011. Training is considered as the core of the NAP and crucial for its risk reduction target, taken as granted. According to the Tukes register, there are ca. 30 000 certification holders on professional PPP use and ca. 200 licensed training and certification providers in Finland.

All respondents considered that the training for plant protection training and certification providers and staff members of farm advisory services has been successful. Exchanging information and collective learning among trainers, as well as continuing training for professional users in Finnish and Swedish languages were perceived as well organized. The online training materials provided by Tukes (2021) were much appreciated, but some concern was raised about missing the valuable dialogue and knowledge-sharing between colleagues in online settings, contrary to face-to-face events. Training materials in English were proposed, as well as prerecorded lectures to be listened to. Training of the plant protection operators provided by the Finnish Food Authority on the requirements of the reformed plant health legislation was perceived as moderately or well realized. An area of improvement could be the control of the training and certification providers in the revision of the NAP.

Requirements for sales of PPPs and information at purchasing (Art. 6)

It was perceived that the requirements set for the retailers have improved the behaviour of both retailers and their customers. Information to the home gardeners in social media can reach a lot of amateurs and is therefore quite influential. Dissenting opinions between the respondents were shown about the realization of the obligation of distributors and producers to provide information about products authorized for consumer use. Furthermore, the views varied a lot about how the public information service on individuals holding a plant protection certificate is working.

It was proposed that in the next NAP a specific emphasis should be put on the market surveillance of PPPs for amateur uses. Further, glyphosate products should be completely withdrawn from amateur uses, because of their observed inappropriate disposal practices and uses close to water sheds by unskillful amateurs.

Information about health risks (Art. 7)

Investigation of the existing monitoring practices of acute and chronic PPP poisoning incidents and the observed poisoning cases and the update of the monitoring guidelines were carried out well or moderately well according to most respondents. The development of biomonitoring methods for currently used active substances is progressing well. This is an issue where Finland has received a reminder from the Commission.

Most respondents agreed that the instructions on preventing exposure and allergies in greenhouse work are a success. However, in a NAP II implementation project Suojalehto et al. (2022) showed that the main causes of allergies in greenhouse work are macro-organisms used in biological control, which are not subject to authorization as PPPs. EU Commission's guidance on monitoring of impacts on human health and the environment is implemented moderately or well according to most respondents. Information about sensitizing PPPs as well as communication on re-entry periods to protect workers are at least moderately shared in the training sessions for training providers and professional users, according to all experts.

The experts were doubtful about the actual progress of the project investigating the exposure of tractor drivers during spraying. The project was dependent on external funding and therefore could not be launched as proposed.

Awareness raising about PPPs (Art. 7 and 10)

The continuing process of awareness raising was emphasized. Revision of plant protection product labels to better serve users has realized either moderately or well, think most of the respondents. The new web-based PPP register KemiDigi is a remarkable success according to their views, but the delay in its Swedish translation was regretted by many, and this fact has also been noted by the Parliamentary Ombudsman. Tukes is committed to put specific effort in providing information in both national languages.

Awareness raising and communication about PPPs is realizing moderately or well based on the views of the majority, but there is still place for improvement, because there were also views that it is not adequate yet. Two thirds of the respondents are of the opinion that communicating about buffer distances to neighbors and guidelines on informing bystanders at spraying events are adequate, but one third would like to see more progress in this information.

Excessive bureaucracy should be avoided in informing the bystanders according to the responses. It was reminded that spray equipment can also be used to distribute fertilizers and biopesticides, in addition to chemical PPPs.

The Finnish Association of Landscape Industries – Viherympäristöliitto ry has established a website for informing about the most important plant health risks in green areas (Viherympäristöliitto 2022). Environmental monitoring results of pesticides in surface waters (Aroviita et al. 2022, Siimes 2022) and in ground waters (Juvonen 2022) have been published recently.

It was proposed that in the future NAP, communication about the benefits of chemical plant protection, the consequences of reduction of PPP choices, food security issues and the quantity and quality of yield would be desirable. Information about the toxicity of PPPs should be shared with the public. Further research on residues in soils, waters, the environment and food commodities, and communication on its results should be provided to the public also in the next NAP period, as proposed by the respondents and highlighted also by the NAP steering group.

Inspection of spraying equipment and aerial spraying (Art. 8 – 9)

All experts were unanimous that regular testing of spray equipment works well and has a concrete impact on reducing the risks of PPP uses. It was noted that the condition of application equipment has improved thanks to regular inspections already before establishing the NAP. In the register of Tukes there are 76 authorized inspectors of spray equipment in Finland in 2022. Views on the control of their performance were however diverging.

Better planning and implementation of testing requirements for new application equipment is desirable and should be started in advance, before the introduction of new technologies, such as drones. More emphasis on the use of different nozzles in different situations should be put in the inspections.

An innovative project in collaboration with authorities, research and education is developing training material for the inspectors of spray equipment by using virtual reality devices. The project will be finalized in 2023.

An inquiry on the use of drones in plant protection (Laitinen and Ronkainen 2021) has been conducted to prepare for the future development of drone technologies, although drones are not allowed in practical operations yet. As a conclusion of the project the authors proposed a change of the current legislation to allow a derogation to the ban of aerial applications for using drones in field trials. The proposed derogation has not been transposed into legislation yet. The survey respondents proposed to allow application by drones for instance for the spot wise control of cabbage aphids on Brussels sprouts in the next NAP.

Protection of the aquatic environment and drinking water (Art. 11)

Mandatory buffer distances to wells and springs in the labels of PPPs are working at least moderately. Restrictions of use in ground water areas and buffer zones along water courses are applicable in view of all respondents. Reduction of the uses in specific areas with a high risk of run-off into surface or ground waters has progressed moderately or well. The assessment of the adequacy and necessity of measures for protecting the surface waters and ground waters in areas for the abstraction of drinking water has been realized moderately or well according to most of the experts, although also opposite views exist.

One measure where progress is still limited is the setting of Environmental Quality Standards (EQS) for all active substances. The proposal of Kontiokari and Mattsoff (2011) has not been updated following the changes in the selection of PPPs on the market since then, and there was a wish that the EQSs should be used more actively in the authorization of PPPs. Even a project proposal was drafted to establish also EQSs always when a risk assessment of an active substance would be finalized. It was requested that Tukes should assign adequate resourcing for this work and provide a web-based database for the EQSs for instance connected to the PPP register. It would help the interpretation of results and the selection of analytical methods of monitoring.

Although there is still a lot to be improved in the monitoring of environmental concentrations of PPPs, analytical methods have developed recently. E.g., the use of passive collectors over a longer sampling period allows the assessment of average concentrations in surface waters. Funding for the organization of monitoring in the environment should be granted in longer run to be able to assess the trends in use.

Reduction of PPP use or risks in specific areas (Art. 12)

No specific achievements concerning the reduction of uses and risks in sensitive areas were mentioned by the respondents. A project proposal to investigate the impacts of potential restrictions on PPP uses in arable farming on nature conservation areas, has not received funding, and therefore this measure was assessed as poorly realized.

On the other hand, in the authorization decisions of each PPP, restrictions of use have been given e.g. on specified ground water areas, if warranted according to the risk assessment. According to a preliminary geoinformation analysis, agricultural fields under Natura 2000 programme cover less than 100 km², which is ca. 0.4% of the whole agricultural area in Finland, but locally the potential restrictions might significantly affect the farming practices (Laitinen 2022, personal communication).

The recommendation for the greenery workers to reduce PPP uses in the vicinity of sensitive areas is followed at least moderately in view of most respondents. Planning of risk reduction was felt good, although no evidence of success of such actions were mentioned.

It was proposed that in the future NAP, communication to professional users in other sectors than agriculture should be significantly increased, for instance to motivate and obligate them to organize social events for mechanical weed control. Good practices for reducing the risks to humans and the environment have been moderately implemented according to 56% and well according to 44% of the respondents.

Handling and storage of PPPs (Art. 13)

Communication about the grace periods for sales and use of withdrawn products is working well according to most of the respondents. Revision of the instructions for personal protective equipment in the product labels has been realized moderately or well according to most respondents, but there were still 17% who considered this objective as not at all realized yet.

Guidance of building and implementation of biobeds intended for the washing of application equipment should be enhanced in the following NAP, as 87% of the respondents believed this objective has realized only poorly or not at all.

It was mentioned that the collection of hazardous waste and packages is well organized and utilized by the users. Furthermore, the effort of retailers was highlighted, as an example, a campaign to recycle empty packages. However, further information on safe handling, storage and disposal of PPPs and their packages, including the instructions at local waste stations, would be appreciated in the future NAP. It was emphasized that collection points for hazardous waste should be located at reasonable distances from the farms, and fixed times of collector cars for hazardous waste circulating in the countryside villages would enhance the appropriate disposal of obsolete PPPs.

Promotion of integrated and organic pest management (Art. 14)

This category includes up to 20 measures (almost one third of all objectives of the NAP II), which are further divided in sub-groups reflecting the gradually growing requirements of increasing levels of IPM (integrated pest management) measures.

General requirements

The prioritization of authorization and timetables to promote low-risk products has been realized at most moderately, in view of most experts and considered a clear area of improvement in the next NAP. The promotion of the uses of basic substances shared the opinions of the experts. In spring 2022, Tukes provided information and guidance on the uses of basic substances on its website and communicated on it (Autio 2022, Nevala and Autio 2022).

Practices to perform comparative assessment and substitution of most hazardous PPPs in product authorizations were assessed as moderately or well developed by half of the respondents, whereas half thought that this measure was poorly or not at all realized. Risk assessments concerning new pests were considered as only moderately or poorly implemented. However, control of the quality of propagation materials by the Finnish Food Authority worked well in view of all respondents.

Levels I-III of the IPM and organic production

IPM guidelines specific for the main crop species and plant groups were considered as well established according to 90% of the respondents. Promotion of pest monitoring systems, pest prediction models and threshold values are at least moderately implemented according to most experts. In the gardening sector the IPM is well known and mainstream already. It was noted that many farmers continuously monitor the pests, but mandatory measures like those required in the previous agri-environmental support scheme are not well accepted by many.

The limited choice of IPM means was criticized, and the climatic constraints were perceived to hinder the practical application of IPM measures by some of the respondents. The experts had different opinions on adequate attention to resistance management in the product authorizations.

Alternative control methods to glyphosate uses are yet poorly developed in their view. Research on non-chemical control methods and their implementation is still only moderately or poorly realized and should be continued in the future.

The promotion of certified seeds and resilient varieties is going well according to all experts. Reinforcing the research on the redesign of cropping systems in IPM and organic production, e.g., crop rotations and functional biodiversity, realizes moderately or well according to 75% of the respondents.

Also, actions promoting practices that benefit pollinators and natural enemies are well or moderately established in farms in view of 80% of the respondents. Recent research has been published on residues in pollen (Kaila et al. 2021). The national pollinator strategy (Ympäristöministeriö 2022) sets up a monitoring programme for wild pollinators. It was acknowledged that collaboration between sprayers and beekeepers has increased during the NAP II period.

Promotion of research on organic farming has realized moderately or well in view of all respondents. However, the biological efficacy of products approved for use in organic production are still only moderately or poorly studied according to all respondents and should be highlighted in the next NAP.

Collective learning between integrated and organic pest management

It was mentioned that juxtaposition between organic and conventional farming is reducing. Knowledge sharing days for IPM and organic farming have been successful according to one third of the respondents, while half are of the opinion that they have been realized only poorly. Obviously, the restrictions of assembly due to the Covid-19 in years 2020–2022 affect this view. Such a knowledge sharing day was proposed to be planned by one of the experts for the next year.

A permanent forum for sharing the knowledge on successful and less successful experimentation between farmers, researchers and advisers should be established. Availability of such information would be desirable even after many years. Joint seminars for conventional IPM and organic farming should be organized also in the future.

Lots of research, experimentation and new ideas are needed about alternative control methods, for instance on biological control of potato blight, to replace glyphosate in weed control or diquat in controlling strawberry runners. Biological products for minor crops should be authorized. Longer term visions on future IPM needs should be produced using different interesting scenario methodologies also for Finland. Such methods have been utilized in other countries, but not yet in Finland.

Indicators (Art. 15)

As no clear indicator targets were set in the Finnish NAP II, it is difficult to show the progress in reducing the risks and uses of PPPs using risk indicators. The experts' views on the indicator development were variable. Measures

related to harmonized risk indicators in the EU have been realized rather poorly according to 37%, moderately according to 38% and well according to 25% of the experts. Monitoring of the trends in use of active substances of particular concern on crops and in areas that require special attention and reporting the related results to the Commission and other Member States, has been realized moderately or well according to 80% and poorly according to 20% of the respondents.

The development of the national environmental load risk indicator and on the communication of its results was assessed as divergent by the respondents. Most of the respondents considered the work to develop a catchment area-specific risk indicator measuring the environmental load as insufficient.

EU requirements of compilation and publication of the use statistics of PPPs are well or completely met according to most respondents. However, more detailed statistics such as parcel-specific PPP use data from farms was perceived as insufficient. It was claimed that the production and reporting of the indicators are not adequately communicated to the practical level and unclear what for the parcel-specific use data is needed. The minimum requirements are met in the reporting to the EU and other Member States.

It was pointed out that the confidentiality of the use and sales data on specific active substances is limiting the scientific work and may prevent a satisfactory peer review, and some respondents wished that such limitations could be nationally removed in order to enable appropriate scientific practices in the research of PPP uses. Comparative research of PPP uses in different European countries as well as in different regions in Finland should be enhanced in the next NAP.

Räsänen et al. (2022) studied the use of PPPs on vegetable cultivation in field based on industry data on their contract farmers in 2003–2017, which allowed comparison to Swedish and Scottish data. Resources for the development of the catchment area-specific indicator have been limited during the NAP II period, but EU-based coefficients have been used in it.

Discussion and conclusions

In general, the coordination of the network of plant protection actors and their commitment to the general targets of the NAP II is high. The survey revealed some areas, where the respondents felt the Finnish NAP II has been specifically successful. Specifically, actions established in the first NAP period or already before it, such as training and certification system of professional users, retailers, and advisers or the inspection system of spray equipment are well appreciated by all respondents and perceived as the core in adoption of risk reducing practices. This is in line with literature about sustainable PPP practices in other countries (Gissén et al. 2021, Karamfilova 2022).

The Finnish reform of the electronic PPP register KemiDigi was undoubtedly a big achievement during the NAP II period, however, its pending translation into Swedish language was mentioned as a shortage that must be fixed as soon as possible. Restrictions of use of PPPs in ground water areas and buffer zones along water courses were seen as well applicable. Recommendation for the landscape workers on the reduction of PPP uses was highlighted as a success.

Variable opinions on the current level of IPM uptake were presented. Many of the IPM measures were felt to be well established in Finland, although there is still much to be improved in putting the innovations in practice in the farms. In specific sectors such as gardening, the IPM practices are perceived as mainstream, and the development of crop specific IPM guidances is proceeding well. However, tools for measuring the IPM uptake at farm level are not well developed in Finland yet. Lykogianni et al. (2021) conclude, that the enforcement of IPM actions in the EU is low and there is limited evidence that IPM principles are systematically being applied in the NAPs.

The general opinion is positive on reducing the risks and uses of chemical PPPs. Pouta et al. (2021) showed that biological pest control is one of the most preferred ecosystem services the Finnish consumers are willing to pay extra in their food purchases. In the survey it was mentioned that the general attitude on organics is improving. Promotion and funding for the research on organic farming has increased in several years (Autio and Iivonen 2021). There are plenty of research projects aimed to develop alternative plant protection methods to substitute chemical PPPs, but still many data gaps to overcome. The knowledge-sharing between conventional and organic producers was perceived functioning well.

People have learned, how research can be conducted on commercial farms to best serve their practices. However, there are also challenges in it, for instance the uneven distribution of pests and how the observations and sampling can be organized in commercial farms. Experiences on such practices should be exchanged. Knowledge produced on farms is directly applicable when obstacles are exceeded, and collaboration is gotten to work. The purchasers of farm products should also be committed to the targets of the NAP and its requirements that increase the cost of the farmers. Acknowledging farmers' views in implementing the sustainability policies for agricultural sector is elemental to ensure their success in farm-scale (Sorvali et al. 2021).

Helepiciuc and Todor (2021) and Lykogianni et al. (2021) showed, that only a few EU Member States have set ambitious risk reduction targets in their NAPs. Helepiciuc and Todor (2021) conclude that the lack of uniformity in terms of measures, timetables and indicators create constraints to assess any progress in the Member States' NAPs. Similar conclusion can be drawn also from the Finnish NAP II, as Finland is one of those countries, where the attitudinal climate has not been ready to set any fixed targets so far.

The survey also showed some areas of improvement, where the targets were only partially or not at all met. Updating of environmental quality standards (EQSs) for all active substances on the market lacked resources and was not realized during the NAP II period. Monitoring of surface and ground waters of PPP residues require still further development and funding to meet the expectations. Impacts of restrictions of PPP uses in sensitive areas has neither been investigated yet. Guidance and implementation of biobeds has also been delayed. Effort on promoting low risk substances should be increased. Further issues that should require further studies and funding are e.g., risk assessments concerning new pests, alternative control methods to substitute glyphosate, and development, calculation, and publishing of risk indicators.

The EU appraisal of the implementation of the directive 2009/128/EC (Karamfilova 2022) concludes that the assessment of IPM uptake at farm level is the weakest point of implementation across the EU, while safe handling and storage as well as training and certification systems are well established in the Member States. Therefore, developing guidance on IPM principles and measuring their implementation would contribute to the assessment of the NAPs.

Depending on the progress of the negotiations of the draft regulation on the sustainable use of plant protection products in the EU and its future obligations to Member States, the improvement areas could be incorporated as objectives in the next revision of the Finnish NAP in order to reach the Farm to Fork targets of the EU (EC 2020).

Continuity and coherence are important in the work to reduce the risks from the use of PPPs, and the future measures can be based on the achievements of the previous NAP periods. It is obvious that the time perspective to demonstrate desired outcomes of the NAP should be long enough.

However, limited resources will hamper the implementation of any well-intentioned targets, and therefore, the proportionality of tasks assigned to the NAP actors should be carefully considered, and adequate resources granted for their implementation.

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