

eip-agri
AGRICULTURE & INNOVATION



EIP-AGRI Focus Group

Sustainable ways to reduce pesticides in pome and stone fruit production

Mini Paper 4

Improve farmers position with reduced pesticide use

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Summary

The main question of this paper is how to improve the position of farmers in the value chain by adapting alternative strategies and reducing the use of pesticides. The designed strategies can be divided into the following topics:

- diversification on farm levels and labels
- education and consulting
- cooperation and networks
- insurance and finance to reduce risks

There is an imbalance between society's expectations regarding pesticide use reduction and the economic risks that fruit growers have to bear by producing with less pesticide. Fruit growers will only be able to produce with less pesticide if the risk can be compensated.

1. Introduction

As part of the EIP AGRI focus group 44 on "Sustainable ways to reduce pesticides in pome and stone fruit production", this minipaper aims to address the question of how the position of farmers in the value chain may be improved by adapted or alternative, novel plant protection strategies that result in a significantly reduced pesticide use. Documented effectiveness under practical field conditions is a basic requirement for any altered strategies considered in this minipaper, a point that is covered in detail by other minipapers in this focus group. Additionally, the focus of this minipaper is entirely on conventional fruit production. Due to author expertise, this minipaper has a predominant focus on apples, but listed examples may also apply to pears and stone fruit. Based on the results of a SWOT-analysis examining current fruit production, strategies are formulated which may help achieve the goal of reaching a win-win-situation for both farmers and the environment.

Why is it so difficult for fruit growers to switch to a strategy with less pesticides?

Conventional production of quality crops with little use of plant protection is very demanding and requires considerable knowledge to prevent yield or quality losses and thus revenue losses. In fruit production the costs are high and yield and quality losses have a high input on the income. Fruit growers bear the risk in fruit production. In addition, the production and protection of crops requires a great deal of knowledge about diseases and pests. Every change in strategy requires new information, knowledge, experience and is associated with an even higher risk. From the aspect of agricultural producers, reducing the use of pesticides in production and introducing alternative forms of production poses a kind of risk. To encourage producers to take risk and embark on change, they need a proven methodology and technology to guarantee revenue security. Thus, growers are usually not ready to test new strategies on their own plot and to expose themselves to potential financial risks. Especially in the area of permanent crops, short-term changes in strategy can be long-lasting for the entire duration of the crop, which is at least ten years.

Growers need the help of consulting services to reduce plant protection products. However, this service is often not cost free and not all (also public) consulting services are up to date with knowledge about new strategies and consequences for fruit production. Consulting services from plant protection firms on the other side are free and well trained but may often come with a vested interest. Caught in this conflict, farmers face the challenge to obtain trustworthy information about new technological solutions and their applications.

2. Method - SWOT analysis

A SWOT analysis is used as a framework to evaluate the implementation potential of the production and selling of fruits with less pesticides. The strengths, weaknesses, opportunities and threats for fruit producers in adopting a strategy for reducing pesticide use were evaluated by the three authors (chapter 3). Based on this analysis various strategies were identified and are presented (chapter 4), when possible with examples from practice. All of those strategies are aimed at incrementing fruit production with less use of pesticides while at the same time have the potential to improve farmers' position in the value chain. The analysis was done by the authors on several online meetings without consulting external experts.

A SWOT analysis is a common tool to build business strategy's:
 "SWOT (strengths, weaknesses, opportunities, and threats) analysis is a framework used by entrepreneurs to evaluate the company's competitive position and to develop strategic planning. The analysis assesses internal (strengths, weaknesses) and external factors (opportunities and threats), as well as current and future potential. A SWOT analysis is designed to facilitate a realistic, fact-based, data-driven look at the strengths and weaknesses of an organization, initiatives, or within its industry."
 (**Strength, Weakness, Opportunity, and Threat (SWOT) Analysis Definition** (investopedia.com)).

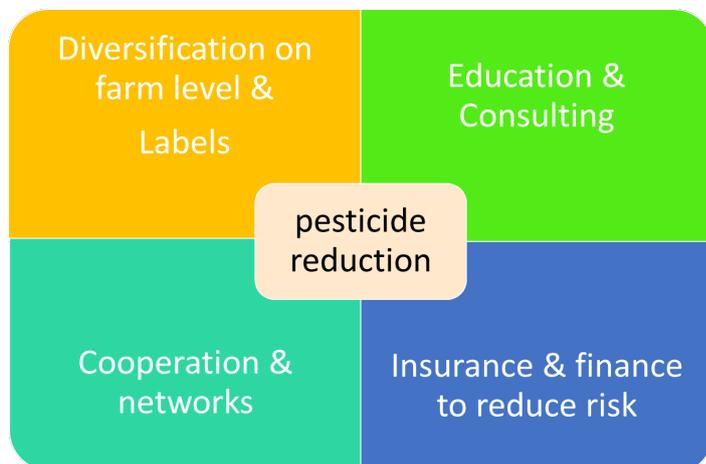
3. Results - SWOT analysis

In the following we will list strengths, weaknesses, opportunities and threats that, to our opinion, play an important role in the implementation of a production with a reduction in pesticide use. Details for the strengths, weaknesses, opportunities and threats are given in the annexes.

Strengths	Weaknesses
S1 Short food supply chains and the good image of the farmers	W1 Gaps in farmers knowledge base, education and information about new technologies and alternative strategies for plant protection
S2 Copy the approach of neighbouring farmers and importance of collective approach	W2 Costs, risks and labour-intensity associated with alternative, novel strategies
S3 Inhomogeneity in farm size	W3 Consumer & retailer expectations and influences
S4 Farmers have expertise in fruit growing and they are interested in production with less pesticide	W4 systemic, crop-inherent challenges
S5 Family business	
S6 There is already a potential market of people waiting for fruits with less pesticide use	
Opportunities	Threats
O1 New sales routes/internet, Direct marketing - use experience with increases seen during Covid	T1 New pests and diseases
O2 Food cooperatives	T2 Climate change
O3 Meeting the expectations of highly demanding customers	T3 Market instability and insufficient food production
O4 Alternative product development	T4 Slow or stopped transition of farmers businesses on younger generations due to lack of knowledge and application of new concepts (because usually what older know is most often passed on to younger ones).
O5 Social relations: farmers-consumers	
O6 Scandals about pesticides	
O7 An increase in pesticides prices	

4. Strategies & examples

This section includes strategies from a combination of strengths, weaknesses, opportunities and threats with existing examples. Different strategies can be developed from the combination of strengths, weaknesses, opportunities and threats. We have divided the strategies into four different groups.



Picture: Agroscope

Diversification on farm level & labels

4.1 Diversification at farm level

Fruit growers have as entrepreneurs the potential for diversification. They can diversify in their products (different cultivars, different fruit culture) or they can diversify in the process (sell fresh fruits, processed fruits) and they can diversify in the selling strategy (direct to consumers or through wholesale). They can also diversify in the kind of production (with less pesticides). The income generated by diversification is a vital component of many farming businesses. With the help of diversification, financial risks can be reduced when new alternative methods of reduced pesticide use are introduced, i.e. it's a way of stabilizing income and maximizing profits. Diversification can offer options when it comes to planning how best to hand the family farm on to the next generation, particularly if there are children who don't wish to farm but are interested in the new business. From a marketing standpoint, it is important to consider where to meet ideal customers and how to add value.

Family farm Hažić from Međimurje County in Croatia is an example of a very well diversified farm that combines the production of apples and grapes, their processing and direct sale mainly on the farm through a winery and wine camp and sales through various models of short supply chains. This farm was engaged in production only a few years ago, but due to the low purchase price of apples, they decided to start the production of apple juice, dried apples and apple vinegar. As a result, apples became better paid as juice, vinegar and apple chips than being sold unprocessed. From the previous 300 tons of apples produced, they reduced production to 200 tons, of which approximately 70% of apples are processed. Production costs have decreased because first-class apples are no longer produced for the larger market, but for processing. This reduced the use of pesticides and the use of mineral fertilizers. The yield of apples per hectare was reduced from the previous 60 tons to 40 tons, which improved the organoleptic properties of apples. Thanks to this less intensive production, the resistance of apples to adverse climatic conditions (such as frost) has increased. The diversification of the farm has enabled the reduction of pesticide use and better economic viability. This is a very win-win solution, both when looking at a more positive impact on the environment but also on raising the profitability of this farm.

Picture: Valentina Hažić



4.2 Diversification - individual or adapted alternative methods that generate an income

Alternatively, relative to diversification at the entire farm level, individual alternative plant protection methods or adaptations thereof may represent opportunities for generating income from different occupational sources. Thereby, the position of farmers in the value chain may be improved. In the following, short descriptions of some such examples:



Picture: Valentin Hazic

Apple and free-range eggs production

In some regions and years, the European apple sawfly is a serious pest in apple production. Based on the fact that free-roaming chickens scratch the soil and feed on any upturned insects, such as for example mature sawfly larvae, a project was started examining the potential of keeping chicken in organic apple orchards to combat some insect pests and thereby rendering some insecticide applications needless. The project is still in its beginnings, but first results show that the involved farmers have been able to generate an additional source of income by selling eggs. This project has generated a lot of positive media attention and has resulted in one of the main regional retailers to join in. While the potential of this approach for reduced pesticide use may be limited, it may constitute a means to promote the topic, which could be tested also for conventionally managed apple orchards.

There are examples from the UK and France, where sheep are kept in apple orchards and used to control weeds which may reduce herbicide use or by consuming e.g. fallen fruit they reduce pest or disease pressure. In various parts of Spain, sheep farming is coupled with almond orchards. In many of these systems, sheep are sold as lamb meat or for breeding. A major challenge for all these systems to lead to win-win-situations is the necessity to integrate all the dimensions of livestock farming into the respective orchard system.

Rain covers and panels with photovoltaic cells

Plastic coverings shielding fruits in orchards from direct exposure to rain is a strategy that has been shown to reduce pressure from some fungal diseases and as a consequence enabled pesticide, especially fungicide reductions in the range up to 50 % and more (see minipaper 2 and 3). For such coverings, mostly foils have been used. In a further development of this strategy, the use of rigid or maneuverable panels equipped with solar photovoltaic cells and installed above the tree rows is currently being researched for its potential as a pesticide reduction methodology as well as for its potential to generate electricity.

The panels may additionally protect the fruit trees from hail and frost damage, thereby decreasing the need for investments against such threats in affected regions. The generated electricity may be used on-farm or fed into the power grid. Several test orchards have been established, focussing on aspects such as the extent of covering necessary for maximum protection against fungal diseases and thus potential pesticide savings, light transmissibility for optimum production and many more.

4.3 Direct marketing

There are many and very diverse examples of direct marketing across the EU, beginning from the more traditional forms like farm gate sales or farmers markets to more recent examples like online platforms that have seen a sharp increase in numbers in recent years. Digital marketing, which profits from recent technological developments, is considered to possess considerable potential as a source of business for farmers that allows short food chains while establishing and maintaining close relationships with consumers. This presents good marketing opportunities, where farmers control prices and costs for logistics are kept at a minimum due to sharing by all farm businesses involved.

Ortoloco

Ortoloco is a self-managed cooperative in the Zurich area in Switzerland with a collectively run farm of 15 ha with vegetables, fruit and juice production, cereals, beef, edible soya, sunflower oil, eggs, tea herbs. The organic cultivation is complemented with hedges, extensively used meadows and pastures, orchard and forest. Ortoloco was founded in 2009 as a vegetable cooperative. The cooperative works according to the principles of solidarity farming, which means that consumers and producers join forces and share the responsibility for the farm and production risks. The work on the cooperative is organized as follows: five skilled workers take care of the agricultural business on the farm. The members of the Ortoloco cooperative buy an annual subscription and thus purchase the farm's products. With an annual contribution they finance the wages and the running of the farm. By subscribing, members commit themselves to working on the farm. A considerable part of the working hours is thus distributed among many hands and a lively relationship to the farm is created. A voluntary board and several working groups take care of the administration and various other tasks. Everyone contributes to the effort and everyone reaps the benefits.

Pictures: Ortoloco



4.4 Zero Residue Fruit

Knowing that surveys show pesticide residues to be a major concern of European customers, initiatives have been started to produce commodities, also apples, with no pesticide residues above the MRL for food intended for infants and young children (= 0,01 mg/kg for most active pesticide ingredients), subsequently called 'zero residue'. In this approach, production mostly follows an adapted conventional production scheme with either reduced or no (in that case only non-synthetic) chemical synthetic pesticide use during the primary season and, for the secondary season, shifts to a combination of IPM (without chemical synthetic pesticides) and organic practices. The use of chemical synthetic pesticides is thereby significantly reduced. Past and ongoing research show the potential but also some still to be resolved challenges of this approach. Judging from market presence of such products in different EU countries, consumer acceptance seems to vary across the EU. In France, products labelled "Zero Résidue de Pesticides" an initiative started by producers, have reached a sizeable proportion of the fruit and vegetable market share and are also marketed via major supermarket chains. In Italy, some products are available on the market and research into 'zero residue' apples is ongoing. In Austria, research confirmed the practicability of 'zero residue' apple production, but a market launch was subsequently deemed not sufficiently feasible by an involved retailer. Certification of 'zero residue' products is already offered

by some certification companies. While ‚zero residue‘ products may possess considerable market potential, major challenges include implementation (risks associated with a guarantee of ‚zero residues‘; negative press if not fulfilled => effects on consumer trust), necessity of yet an additional label (amidst ongoing discussions about consumer confusion caused by many different labels) and consumer acceptance (positioning between the established conventional and organic segments).

4.5 Create a label that states "this farm is working to reduce pesticides"

To help market the fruit of farmers who are applying less pesticide on a year-to-year basis (maybe the creation of a three or four star brand (one for every class of pesticides...))

Pesticide residues are a major concern for a sizeable proportion of European customers. Many customers also have concerns about negative side effects of pesticide use on the environment. This issue also affects their purchasing decisions. Credible information about pesticide use during the production of fruits may support interested customers in their choice preferences. Such information may be communicated by e.g. a label. Such a label would have to be assigned in a transparent way by an independent body and could thus back up the already very high level of trust in farmers. It could confirm efforts by the respective producer to reduce pesticide use and additionally describe the level of pesticide reduction already achieved. Such a label may be particularly suitable for farmers focussing on direct marketing. Additionally, it could be used in the selection process of farms interested in participating in school cooperations to raise awareness on issues regarding agricultural sustainability.

Education and consulting

4.6 Public knowledge about agriculture, education, school

Efforts to reconnect the public/consumers with agricultural knowledge require diverse approaches. School children, for example, may learn about agricultural production during study visits to farms that may last from single to several days. Several countries offer programs for educational farm visits (e.g. Norway: ‚The farm as a pedagogical resource‘), however, to ensure a focus on sustainable plant protection, participating farms may need to be certified accordingly. Increased cooperation between farms and schools may offer farmers a new business opportunity. And the school children’s awareness for agricultural production and for factors such as pesticide use that affect its sustainability are raised.

For the general public, a realistic image of fruit production should be presented, contrary to many marketing or advertising materials. Only thereby, conscious purchasing decisions can be made. The effort, economic and environmental effects of current, mainly conventional plant protection should be communicated objectively. At the same time, the public should also know about the risks taken by farmers when extensifying or abstaining from conventional plant protection. It should also be communicated that ecosystem services on which numerous alternative methods rely also come with a cost. Agritourism on specifically certified farms may be another component that may contribute to raise awareness to the issue of sustainable plant protection/production.

4.7 More intensive consulting by specifically trained advisors

Farm advisory systems are among the main sources of information for farmers about any novel agricultural practices. In theory, this also applies to alternative plant protection strategies besides the use of chemical synthetic pesticides. To achieve the aim of a substantial reduction in pesticide use in pome and stone fruit production, advisors should possess a detailed knowledge about practical alternative plant protection methods and proactively communicate such information to farmers. They should additionally possess up-to-date technological and farm management skills, to be well connected within the respective agricultural knowledge and innovation systems (AKIS) and ideally be independent. With regards to this, there is substantial room for improvement within the advisory services in many EU member states.

Experiences so far have shown that despite the availability of effective alternative methods for combatting numerous pests and diseases or for preventing them from developing into serious threats, only relatively few farmers have adopted these novel strategies. It is therefore of major importance in all EU member states to support or install farm advisory services that are independent of any agricultural stakeholders with an economic interest in the sale or use of chemical synthetic pesticides. Advisors employed by those independent services should have an in-depth knowledge about alternative plant protection measures as well as about any strategies generally reducing the reliance on pesticides.

The expertise of advisors highly knowledgeable in alternative plant protection needs also to be made available to all farmers. A transition from an established farming practice to an alternative, pesticide-reduced strategy is often considered risky by farmers and requires knowledge provisioning and sometimes even detailed consultations for it to be started or to work.

ArboPhytoRed

This project in Switzerland may serve as an example, how such an assisted transition to a markedly reduced pesticide use may work in pome and stone fruit production. The aim of the project is a 30 % reduction of chemical synthetic pesticides. Participating farmers commit themselves to abstain from herbicide use and, additionally, to follow specified fungicide and/or insecticide treatment plans. For its implementation, farmers receive technical support, and the whole project is scientifically monitored. Intensive interactions between the participating farmers are a central issue in the project, in which also the economic feasibility of the pesticide-reduced strategies are considered.



4.8 Increased efficiency of current practices

Currently, pesticides are frequently applied at constant volume rates throughout the growing season. Canopy dimensions, the main target area for pesticide effect, however vary depending on growth stages and tree training. Decision support systems (DSS) have been developed that calculate optimal application volume rates based on the leaf area present at the time of a specific treatment measure. Applying such adjusted volume rates in fruit orchards have achieved pesticide reductions in the range of 50 % without compromising the health status of the fruit crop.

Sprayer equipment and settings also markedly affect the efficiency of a pesticide treatment. Sprayers should therefore undergo compulsory checks by authorized workshops on a regular basis. Also by using drift-reducing nozzles on the sprayer, a higher proportion of the spraying solution may be deposited on the orchard trees, with the added benefit of reducing spray drift.

Concerning the number and timing of applications, disease warning systems are available to farmers in some but not all EU member states. These DSS use information about disease risks and weather conditions, relationships that have been established in scientific trials, to recommend more efficiently timed and therefore also less frequent pesticide applications. Such DSS should ideally be made available to all farmers.

4.9 Education about pesticide-reduction - also include in curricula starting from secondary education of future farmers

Education programs for farmers should be designed taking into account the different circumstances in which farmers live and work. It is well known that farmers prefer interpersonal methods of receiving information (e.g. on-farm demonstrations, tours and field trips) but, additionally, more attention should be given to educating farmers to become more competent and confident in using the new, digital information sources which would consequently speed up adoption and implementation of new practices on alternative forms of production.

Information about the potential of pesticide reduction with a strong focus on alternative methods (= others than the use of chemical synthetic pesticides) should more prominently be included in curricula of schools (especially agricultural (technical) schools) attended by future farmers, and not only for the organic curricula. This may require current teachers to extend their knowledge on alternative plant protection which in turn may require more training opportunities specifically in that field in further education programs.

As this minipaper also addresses the position of the farmers in the value chain, from that standpoint, it would seem beneficial if at least basic information about business management should be provided to current and especially future farmers, as an improved knowledge base in that area may help improve the economic performance of a farm/business.

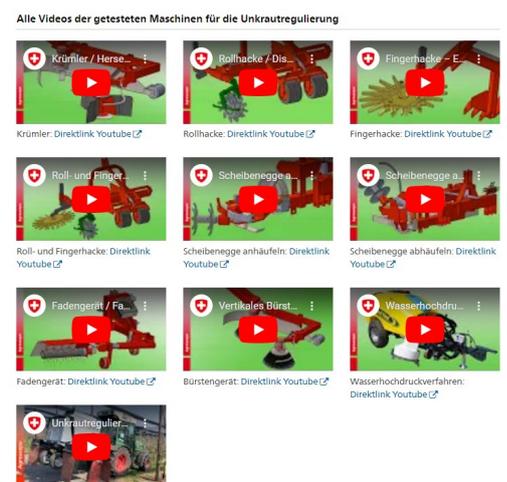
4.10 joint efforts by civil society (e.g. NGOs), retailers and producers regarding knowledge exchange & information

Pesticide use is a major concern for entire societies as it, beyond its intended aim of combatting or preventing crop pests and diseases in a targeted way, also affects societal aspects such as e.g. public health and environmental quality. A reduction in pesticide use is therefore of interest for the whole society, and as a consequence there are examples where civil society representatives such as e.g. environmental NGOs have been very active in raising awareness for alternative plant protection strategies and in promoting their adoption by producers. In one such example, varying consortia of an NGO, a supermarket chain, its suppliers and partners from research and advisory services have investigated the potential of alternatives for solving various plant protection issues on commercial farms. In pome fruit, this included work focussing on scab and storage disease control. The close cooperation between the various partners was considered very positive and beneficial by all partners involved. Financial support by the supermarket chain demonstrated also their commitment to promoting pesticide reduction. Ideally, such cooperation would result in sustainable pesticide reduction and adoption of alternative measures as well as financially award participating practitioners.

In another multi-actor approach, management of new or existing orchards may be planned as a common project by farmers and other stakeholders such as advisors, consumers with input from sales representatives to yield orchards with management plans tailored and adapted to prevailing local conditions.

4.11 Public videos with information about fruit production with less pesticide

With smartphone technology, fruit producers can access videos at any time. Both biology and knowledge about measures for sustainable fruit production are constantly evolving. In order to be informed about new pests and diseases, fruit growers need to keep up to date. The development of technically correct and applicable knowledge in the context of education and training videos can help fruit producers to use the appropriate measures at the right moment. Networks of selected advisors could be established for the conception and production of such videos with the goal to reduce pesticide in production - ideally with the information being provided in all languages spoken in the respective production regions.



Picture: Agroscope

4.12 An EU wide program to test and publicly release results of alternative measures improving cooperation between farmers, manufacturers, and researchers across all EU members.

Already currently, there is a wealth of information about the effectivity and practicability of many different alternative plant protection measures. However, the information has been generated by numerous different universities/organisation/research institutions and the results have been published in many different sources (journals/reports/book chapters/online/...). Even for experts in the field, it is very difficult and extremely time consuming, to gather all the relevant information for each specific methodology. It would thus be very beneficial if there was an official, independent program covering fruit production in all EU member states designated to track and summarize the relevant information for at least the most relevant plant protection challenges and, in exchange with practitioners, to identify knowledge gaps that needed further research efforts. The work of such a program should also be made publicly available.

Cooperations and networks

4.13 networks of growers to share experiences, risks, promote companionship and their action

Networks of growers are significant in terms of sharing knowledge and agricultural practices in general, and above all risks and troubles. Farmers generally like to rely on the experiences of others and make decisions in

their own business accordingly. There are numerous benefits from the association of farmers, but it is difficult to achieve that everyone strives for a common goal, which ultimately becomes the success of each individual. United on the market, it is easier to choose sales channels, achieve higher incomes and thus acquire the financial possibility for further development of their farms. Labels on products help them in this organized appearance on the market, although the recognition and saturation of these brands is another aspect that needs to be addressed.

4.14 Integrate/support/build a system within universities and research centers that work with farmers

In many countries there is little true connection between academia and the “real world” of agriculture, creating a divide, leading to a lack of relevance with research conducted

Research into many aspects of agricultural production is conducted by a large number of universities and research centers. Due to various reasons, not the least due to financial reasons such as availability of grants or funding possibilities, research at universities however is frequently not aimed at solving pressing and applied plant production issues. Most active research is conducted by graduating or postgraduate students, who frequently have to follow predesigned project plans. They do not have the flexibility frequently necessary for applied field research and have to consider publication requirements to be able to graduate or pursue a scientific career. Thereby, interaction and information exchange with practitioners is, if at all, often only taking place at a very minimum. But such interactions are a prerequisite for finding solutions for applied problems and for ways to implement such solutions in the field.

There is thus a need for more interactive research including all relevant stakeholders, a way which e.g is pursued by EIP AGRI by the bottom-up approach on a European level. Ideally, such a concept should also more frequently be adopted at national levels. This would mean that more funds should be made available for research addressing pressing problems in agricultural production. In the evaluation process of the submitted proposals, it has to be ensured that the environmental sustainability of the work described has to be a decisive criterion.

4.15 Grant awards for farmers who work with approved research centers

integrating different pest/disease management practices to cover the costs associated with the trial work. Field days to showcase the trial results would be needed for grant payout.

Farmers should be interested in cooperating with research centers that would conduct trial work on their fields with the aim of improving agricultural practices related to reducing the use of pesticides. In return, the costs of that work as well as the potential risks should be covered, especially the loss of income resulting from the implementation of such activities. This would motivate farmers to become more actively involved in collaboration with scientists and allow research to be carried out on their production plots.

5. Discussion and conclusions

In this minipaper, an effort was made to describe the current situation in fruit production using a SWOT analysis with regards to the four components strengths, weaknesses, opportunities and threats concerning a reduction of pesticide use in fruit orchards. Based on this analysis various strategies on how this could be achieved while at the same time improving farmers position in the value chain are presented. Where possible/known to the authors, concrete, existing examples for such strategies are presented.

Over the last fifty years, fruit research, extension, production and market have focussed on yield and various quality attributes. The aim was to produce fruit at low cost and appealing to consumers. The use of chemical synthetic plant protection products was an inherent, largely cost-effective and efficient aspect of conventional fruit production to minimize the risk of damage and economic losses, while at the same time effects of their use on the environment and human health were largely overlooked. While the environmental impact of pesticide use in conventional fruit production has decreased within the past years, as some high-risk active substances have seen their authorisations withdrawn and been replaced by lower-risk substances, the intensity of pesticide use in pome and stone fruit production within the EU is still reason for concern. As a consequence of this and with regard to the commitment of the EU Commission to pesticide reduction as detailed in the Farm to Fork and Biodiversity strategies, this Focus Group, in the frame of which this minipaper was conceived, was set up to collate and discuss available information about sustainable ways to reduce pesticides in pome and stone fruit production.

In the SWOT analysis, we identified several relevant features/characteristics in each of its components. Farmer interest in reducing chemical synthetic pesticide use was e.g. identified as an important strength, while low general societal/consumer knowledge about fruit or generally agricultural production was seen as a weakness for an economically beneficial transition of fruit farms towards less pesticide use. Consumers who are willing to pay more for fruit produced with no use of chemical synthetic pesticides are being served by organic production, which (at least in countries with a strong organic fruit segment) was thus seen as a threat to pesticide-reduced conventional fruit. New sales routes (direct marketing, online) were seen as an opportunity.

Based on the various approaches and alternative methods presented in minipapers 2 and 3 that also have been shown to be effective under practical field conditions, we were able to present some strategies for alternative plant protection that have the potential to also economically benefit fruit farmers (some with existing examples). However, there are still many gaps to fill and challenges ahead. It is also important to note that there won't be any universally applicable strategies to all the different farms within all EU member states - each farm will require a strategy of its own, and trade-offs will be necessary.

One most important aspect is the access of farmers to information about how to achieve sustainable pesticide reduction, about alternative methods and generally up-to-date knowledge. For this to be achieved, adaptations/improvements in training (already starting from school) and knowledge transfer (advisory services) will be necessary.

Annexes

Annex 1

Strengths

S1 Short food supply chains and the good image of the farmers

Short food supply chains can be very helpful in marketing a product based on alternative production methods, because direct access to customers makes it easier to present techniques and the product that results from such production, i.e. its value. The closeness achieved with the customer can potentially guarantee a higher price for such a product. Given that there are different models of short supply chains, it is crucial to give preference to one that operates on the principle of proximity (which is not the case, for example, with online sales). Additionally, short food supply chains may also be used to circumvent secondary (quite often visual) quality standards set by e.g. supermarket chains: fruit produced by techniques of reduced pesticide use may e.g. show minor insect or disease damages which have no influence on taste or health effects of the fruit. Especially with direct contact to consumers, the sale of such, in terms of internal quality, impeccable fruit may be easier via short food supply chains.

Opinion polls show a generally very high level of trust of European consumers in farmers (<https://eit.europa.eu/news-events/news/farmers-most-trusted-group-within-food-sector-says-report-eit-food>), the highest within the food sector as a whole. The Covid pandemic has contributed to raise the level of trust in farmers, as well as to increase the proportion of consumers that view farmers as systemically relevant.

S2 Copy the approach of neighbouring farmers and importance of collective approach

In agriculture, the influence of the neighbouring farmers is relatively important. Often there is a meaningful exchange with the neighbouring farmers and if strategies or innovations work on their farm, they will be also adopted by more farmers in the area. Concerning the collective approach, some alternatives to pesticides such as mating disruption against codling moths require large surface areas to be used: need/interest to have a collective approach = actions on the territory and cooperation of neighbouring farmers.

S3 Inhomogeneity in farm size

The structure and size of fruit farms in Europe is very heterogeneous: there are professional farms that are very small or professional farms that have a larger area. The integration of storage, processing and marketing is also very different.

S4 Farmers have expertise in fruit growing and they are interested in production with less pesticide

Farmers' skills are valorised since they more intensively observe their orchards and adopt sometimes more complex plant protection strategies. From both an environmental and operational budget point of view, as well as health considerations (lower exposition to pesticides for farmers, persons who apply pesticides, workers in the fields, and even neighbors in densely populated areas).

S5 Family business

Differently, from other types of family business, family business in agriculture is more concerned with their business continuance. They value their business more than just a tool to earn a profit. The family business is perceived as a family existence and heritage to the future generation. Family farms are more flexible in introducing newer technologies than some more complex production systems and it is assumed that they could be leaders in introducing alternative methods related to reduced pesticide use.

S6 There is already a potential market of people waiting for fruits with less pesticide use

In various surveys, food safety was found to rank amongst the most important criteria for European Consumers when buying food. Across all member states, 39 % of consumers mentioned concerns about pesticide residues when asked about food safety (<https://www.efsa.europa.eu/de/interactive-pages/eurobarometer-2019>). This topic thereby ranks in second place, just behind concerns about antibiotics use in animal husbandry. Consumers in Cyprus, Denmark, France, Greece, Malta, Portugal and Sweden are especially concerned about pesticide residues. Sustainable production is an important criterion for purchasing decisions, even more so than

organic production. About one third of European consumers perceive ‚little or no pesticide use‘ as the most important characteristic of ‚sustainable‘ food.

Weaknesses

W1 Gaps in farmers knowledge base, education and information about new technologies and alternative strategies for plant protection

W1a Education about new technologies and alternative strategies for plant protection

For better living in a better environment, having knowledge on pesticide use and its impact on the environment are very important. Many studies show that education has a profound influence on farmers' perception of the negative impacts of pesticides on soil, water, air and beneficial organisms. Besides family background the degree of perception is also based on the quality of education received starting from teenage years at agricultural (technical) schools. The adoption of information and knowledge by adult farmers about new agricultural practices additionally depends on other factors such as age, gender.. partly also on farm size, etc.

W1b Advisors: knowledge gaps about alternatives measures and independence

For farmers, verbal communication of information from especially other farmers but also agricultural ministries, agricultural chambers and agricultural NGOs are the most important sources for agricultural decision-making (Maas et al. 2021). Advisors are the main contact points with these agricultural organisations and therefore play key roles for an efficient transfer of newest knowledge to farmers.

In order for farmers to approach the application of techniques they have not used so far, they need advisors to provide them with knowledge that has been proven effective. Advisors also need to help them use these practices so that they can be successfully integrated into existing production systems and techniques learned so far. This requires advisors to possess up-to-date technological and farm management skills including detailed knowledge about practical alternative plant protection methods, to be well connected within the respective agricultural knowledge and innovation systems (AKIS) and ideally to be independent. With regards to this aspect, there is substantial room for improvement within the advisory services in many EU member states.

W1c Inability to adopt new methods due to lack of knowledge among farmers

If training opportunities are not available for fruit producers, they cannot adapt to advances in the biological, technical and commercial fields.

W1d There are very few to no websites or documents publicly available that contain detailed but at the same time easily understandable and implementable information about alternative strategies and new technologies for plant protection. Information is most often not easily found online and requires most often a good understanding of English, as the respective information is largely missing in many other EU languages.

W2 Costs, risks and labour-intensity associated with alternative, novel strategies

W2a Difficult to produce with less pesticide

Because fruits are very susceptible to damages from pests and diseases, also because they are perennial crops and fruit are stored for long conservation and transport it is very challenging/difficult to produce fruits with less pesticides. For fruit growers, quality and quantity loss may mean considerable income losses, the extent of which depends on many factors such as disease/pest pressure, weather conditions,... and in extreme years may reach more than 75%.

W2b Cost of implementation of new strategies

The implementation of new strategies need the investment in new infrastructure, materials or in knowhow. Especially with regards to new methodologies that require investment in new infrastructure/spraying equipment, farm size is a determining factor, whether that methodology may contribute to the economic viability of a farm. Novel equipment will in many cases only be an option for larger farms. For joint purchase of novel equipment by several farms together, the practicability of an equipment only successively available to each farmer in turn must be considered.

W2c Risk of implementation of innovative strategies with less pesticide

The implementation of new strategies is associated with the risk of quality and quantity losses.

Due to distrust of efficiency and profitability farmers often slow the introduction of change in their business. Support in transition is indispensable for farmers to make their production practices sustainable, both in terms of providing applicable knowledge and in terms of covering financial expenses as long as these practices do not prove to be financially viable.

W2d Few alternative or biological pesticides are sufficiently effective on diseases, with only very few being as effective as the most effective conventional fungicides

Biologically based fungicides and insecticides have been shown to be effective in mild to moderate disease pressure years, with breakdown of control within moderate to high disease pressure years (the same conditions in which you need them to work). This can lead to total crop failure. For alternative methods to work, the additional use of preventive measures is thus a necessity. Alternative methods quite often also require more frequent treatments/applications (than the use of chemical synthetic pesticides) which often results in them being more time & labour-intensive.

W2e over-production in Europe

The self-sufficiency rate for fresh as well as processed apples, peaches and nectarines within the EU-27 is consistently greater than 100%, in most years close to 120% (https://ec.europa.eu/info/sites/default/files/food-farming-fisheries/farming/documents/short-term-outlook-statistical-annex_en.pdf). As a consequence, prices are under pressure. Changing to low-pesticide production practices would frequently incur higher production costs. In view of the high rate of self-sufficiency, there is a certain degree of uncertainty in whether such higher production costs can be offset by correspondingly higher sales prices.

W3 Consumer & retailer expectations and influences

W3a Consumer/retailer demand on high quality fruits and low prices

In the EU, marketing norms apply to a range of agricultural products including some fruits. These norms define minimum requirements to ensure classification, labelling (consumer information, origin) and consumability. In stone and pome fruits, specific marketing norms apply to apples, pears, peaches and nectarines. They mainly require fruit to be intact, ripe, clean and healthy and free of pests and defects due to pathogens which render the fruit unsuitable for consumption. Additionally, fruits are classed into quality classes mainly based on visual quality criteria (e.g. scab stains). On top of these official norms, consumer expectations and secondary retailer standards also mainly focus on visual quality criteria. Together, these requirements for 'flawless' fruit result in increased pesticide use, in apples for example specifically to avoid any scab stains on the peel (https://www.umweltbundesamt.de/sites/default/files/medien/479/publikationen/texte_72-2020_umwelt-_und_klimarelevante_qualitaetsstandards_des_leh_fin.pdf). It is important to note, that the omission of pesticide treatments solely aimed at preventing visual quality stains would not result in fruit with deficiencies with regards to nutritional quality or hygiene. Additionally, low prices continue to be an important selling point, even for fruit. In apples for example, recent developments in prices have shown that consumer demand starts to markedly drop off starting from a price increase in the range of 20 %.

W3b level of education about fruit production of consumers is low - low interest

As with other branches of agricultural production, the public in Europe has a largely only very limited knowledge about current fruit production due to being progressively disconnected with agriculture or food production. This also applies to all plant protection measures undertaken for the production of fruit of a quality that is expected by the consumers. This general lack of agricultural knowledge continues at school, where only very little is taught about agriculture. And this although research shows that the willingness of adults to take environmental considerations is often linked to childhood experiences.

W3c Long conservation time of apples (post harvest disease)

As a consequence of an increasing disconnectedness to agricultural production and facilitated by globalisation, consumers have come to expect some fruit including apples to be offered all-year-round. Due to the development of sophisticated storage techniques, pome fruit may be kept fresh for increased periods of time. As a down-side of this, fungal post-harvest diseases have more time to spread on the fruits and are the reason for a sizeable proportion of fungicide applications.

W3d Supermarket and retailer are powerful

Supermarkets/retailers affect fruit production and farmers position in the value chain for various reasons, which in theory also could represent strengths. Mainly due to competition between supermarket chains and efforts to increase the profit margin, the power of retailers and especially wholesalers contributes to hamper a transition to low-pesticide fruit production. In recent years, it has become common practice for supermarkets to set secondary standards for pesticide residues in fruit and vegetables. These individually set standards are introduced claiming increased sustainability but have often been set without much consideration of practical plant production.

In particular, an often required limit to the number of residues from different pesticide active ingredients in the harvested product may result in the use of fewer but potentially more potent pesticides during production.

Additionally, in some EU countries the market power is concentrated on only very few supermarket chains, which buy from many fruit sellers (individual producers to cooperatives). In such a situation, the buyers are able to push the price considerably. As a consequence of this, the margin for fruit producers is extremely low, precluding any necessary investments or risk-taking associated with farmers' adoption of novel, alternative, low-pesticide plant protection strategies.

W4 systemic, crop-inherent challenges

W4a Most currently grown cultivars are pest and disease susceptible

Commercial varieties are appealing to consumer tastes, have a good consistency, are storable, transportable and have a high yield. Because of the use of chemical synthetic pesticides in the selection process, important criteria such as disease and pest tolerance were mostly disregarded. These problems could be kept under control thanks to conventional PPP strategies.

W4b Current farms aren't designed to implement future pest management strategies - and generational time of an orchard is 15-25 years. Whole sector needs to be redesigned. Because the orchard is a perennial culture only short term strategies can be implemented - however not long term strategies which involve a new orchard.

W4c Dependency on inputs

Fruit growers today are dependent on many inputs to produce high quality fruits (labour, machinery, materials (mainly pesticides, fertilizers), capital and operational costs). Costs for machinery constitute a considerable proportion of overall production costs. Sharing of equipment between farmers may thus be an option to reduce production costs. For this to work in practice, it needs to be very well coordinated. As pome and stone fruit orchards undergo quite frequent pesticide/plant protection treatments, and the effectiveness of these treatments depends on the correct timing with regards to crop developmental stage, disease/pest pressure and weather conditions, the practicability of sharing equipment needs to be carefully considered.

W4d Due to the permanency of the crop, the risk may be present during several years due to carry-over effects. Some plant protection measures not only have an effect on orchard crops in the year they are applied but have longer lasting effects.

Opportunities

O1 New sales routes/internet, Direct marketing - use experience with increases seen during Covid
The share of farms in Europe that are involved in direct marketing from original producer to final customer varies from nearly 25% in Greece to below 5% in some other European countries (https://ec.europa.eu/info/sites/default/files/food-farming-fisheries/key_policies/documents/cap-specific-objectives-brief-3-farmer-position-in-value-chains_en.pdf). This share as well as the proportion of farmers incomes generated thereby is expected to gain further importance, because consumers are requesting it – even more so following the Covid pandemic. Perceived benefits of direct marketing include fair prices and a greater profit margin, greater independence and short transport. Compared to sales via retailers/supermarkets it is less harmful to delicate products such as fully ripe fruit, it furthers personal contacts with customers and promotes diverse ideas and cooperation with other farmers. A high labour- and time-intensity, necessary investments into sales area and infrastructure, cooling, packaging and own marketing expenses rank amongst the disadvantages. While the sales volume of directly marketed farm products via the internet is still relatively small, it possesses a very high potential for expansion.

O2 Food cooperatives

With food cooperatives the know-how and new techniques for the production with less pesticides can be transferred among fruit growers. It will be possible to organize local meeting and training offers.

O3 Meeting the expectations of highly demanding customers

Because of high fruit quality production in the last 30 years (fruits without damages, tasty cultivars, long conservation) customers are used to consuming high quality fruits. Meeting consumer expectations will keep them as customers and they will be ready to pay the production costs.

O4 Alternative product development

New products and strategies with small ecological impact are an opportunity for fruit growers to carry out their production with less pesticides.

O5 Social relations farmers-consumers

O6 Scandals about pesticides

Scandals may contribute to the wider/general population rethinking current food production practices and their effects on the environment and human health. While this may have the potential to accelerate change processes, scandals are also extremely bad for producer image.

O7 An increase in pesticide prices

Pesticide costs are the largest item of expenditure within the material costs, which themselves contribute considerably to overall production costs. Rising pesticide prices would therefore increase production costs and thereby directly affect the profitability of an operation.

Threats

T1 New pests and diseases

New diseases and pests are a risk for high-quality high production and must be combated again with effective strategies. The period between appearance of new pests and a solution is often long.

T2 Climate change

Climate change increases dry and wet periods. As a consequence, disease and pest pressure may increase, which in turn should be combated with effective strategies.

T3 Market instability and insufficient food production

With price uncertainties and uncertainties of the quantities purchased, fruit producers are dependent on short-term revenues and risk reduction. With the use of plant protection products, fruit producers can minimise the risk of harvest and quality losses.

T4 Slow or stopped transition of farmers businesses on younger generations due to lack of knowledge and application of new concepts

(because usually what older know is most often passed on to younger ones)

If the farms are no longer taken over by the descendants, active farm managers will not work towards sustainable solutions.

Annex 2

Links:

There are other examples of orchard/livestock combinations throughout Europe that may contribute to reducing pesticide use (see e.g. <https://ec.europa.eu/eip/agriculture/en/publications/eip-agri-focus-group-agroforestry-final-report>).

Panels equipped with solar photovoltaic cells and installed above the tree rows is currently being researched for its potential as a pesticide reduction methodology as well as for its potential to generate electricity (<https://www.ise.fraunhofer.de/en/research-projects/apv-obstbau-orcharding.html>, <https://www.ecowind.at/unternehmen/referenzen/agri-pv-anlage-haidegg/>).

Examples of direct marketing (e.g. <https://ec.europa.eu/eip/agriculture/en/news/cooperative-online-shop-and-delivery-small-scale>) and digital marketing (e.g. <https://ec.europa.eu/eip/agriculture/en/find-connect/projects/digitale-planungs-vermarktungs-und>).

Past and ongoing research about zero residues (Cross and Berrie 2008; <https://www.eitfood.eu/projects/cleanfruit>) In France, products labelled „Zero Résidue de Pesticides“ (<http://www.nouveaux-champs.fr/le-collectif/>; an initiative started by producers) Certification of ‚zero residue‘ products is already offered by some certification companies (e.g. <https://de.scsglobalservices.com/services/certified-pesticide-residue-free>; <https://www.checkfruit.it/certificazioni/residuo-zero/>).

ArboPhytoRed project in Switzerland

(<https://www.ifelv.ch/sites/default/files/Communiqu%C3%A9%20ArboPhytoRed.pdf>).

Optimal plant protection rate for volume application

(<https://repositori.irta.cat/handle/20.500.12327/1640>).

Decision support system: (https://www.nature.com/articles/s43247-021-00291-8?utm_campaign=related_content&utm_source=SUSTAIN&utm_medium=communities)

Investigation about potential of alternatives for solving various plant protection issues. (<https://www.global2000.at/forschung-projekte>).