Organic-PLUS - grant agreement No [774340]

Pathways to phase-out contentious inputs from organic agriculture in Europe

Deliverable 6.2: Version 2.0

Feasibility of designed scenarios

Versions

Version: 1.0 (2. April 2019) First version

Version: 1.1 (30. April 2019) Text updated with latest information.

Version: 2
while version 1.1 (30. April 2019) focusses on the methodology of the feasibility assessment of design scenarios version 2, including the field data with case studies.

Funding

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No [774340 — Organic-PLUS]

Project Details:

Programme: **H2020, SUSTAINABLE FOOD SECURITY – RESILIENT AND RESOURCE- EFFICIENT VALUE CHAINS**

Call topic: **SFS-08-2017, (RIA) Organic inputs – contentious inputs in organic farming**

Project Title: **Pathways to phase-out contentious inputs from organic agriculture in Europe**

Project Acronym: **Organic-PLUS**

Proposal Number: **774340-2**

Lead Partner: **Coventry University**

Time Frame: **01/05/2018 – 31/04/2022**

Authors: Erik Fløjgaard Kristensen (AU), Claus Sørensen (AU), Ulrich Schmutz (CU)

Deliverable Details

WP: 6 MODEL

Task(s): 6.2: Feasibility of designed scenarios

Deliverable Title: Feasibility of designed scenarios, version 2

Lead beneficiary: AU

Involved Partners: [11]CU, [1]UTH, [15]UNIPD, [16]UoH, [17]AU, [8]CUT, [9]SEGES, [13]IRTA, [18]ETO, [2]NORSOK, [19]WSL, [20]SLU, [21]RHS, [10]SA, [7]FORI

Deadline for delivery: 2022

Date of delivery: 2022

The authors of this report are very grateful for the kind assistance of many organic farmers and advisors, willing to share their knowledge and experiences. For valuable contributions we also thank:

[1]University of Thessaly, Dept. of Agriculture Crop Production and Rural Environment, Fytokou Str., 38446, Volos, Greece	
[2]Norwegian Centre for Organic Agriculture (NORSØK), Gunnars veg 6, N-6630 Tingvoll, Norway	
[7]Forschungsring e.V., Brandschneise 5, 64295 Darmstadt, Germany	
[8]Częstochowa University of Technology, Institute of Environmental Engineering, Brzeźnicka 60a, 42-200 Częstochowa, Poland	
[9]Danish Agriculture & Food Council, SEGES. Agro Food Park 15, 8200 Aarhus, Denmark	
[10]Soil Association, Spear House, 51 Victoria Street, Bristol BS1 6AD, United Kingdom	
[11]CAWR, Centre for Agroecology, Water and Resilience, Coventry University, Garden Organic, Ryton Gardens, CV8 3LG, Coventry, UK	
[13]Institute of Agrifood Research and Technology (IRTA), Torre Marimon, 08140 Caldes de Montbui, Spain	
[15] University of Padova - Department of Agronomy Food Natural resources Animals and Environment	
[16]University of Hohenheim	
[17]Aarhus University, Department of Engineering, Operations Management group	
[18]Association of Ecological Agriculture	
[19]Swiss Federal Research Institute for Forest, Snow and Landscape	
[20]Swedish University of Agricultural Sciences	
[21]Royal Horticultural Society	

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1. Summary

Contentious inputs in organic agriculture and horticulture are undesirable inputs within the organic ethos, but permitted by the European Commission Regulation (EC) No 889/2008. The contentious inputs investigated by Organic-PLUS are the plant inputs, copper, sulphur and mineral oils; the soil inputs, conventional manure, plastic and peat, and the livestock inputs, conventional straw, antibiotic medicine and anthelminthic medicine. In order to select the most suitable alternatives, the consequences of substitution must be evaluated in terms of feasibility, sustainability and environmental impact. Specifically, it is important to consider whether the adoption of certain alternatives is feasible from not only a technological viewpoint but also from an operational, economic, and conceptual perspective. The overall objective of a feasibility study is to support different stakeholders and decision-makers (e.g. farmers, advisers, developers) in determining whether to implement a specific alternative production method as part of their business. A feasibility study comprises research, testing and experimentation, designed to determine if a strategy, design, product or process is possible and practical. This feasibility study design is partly based on the basic production data collected for the sustainability and LCA assessments, and partly on supplemental data concerning specific operations. Data collection will take place on selected case study farms, encompassing the contentious inputs Organic-PLUS focusses on. The feasibility study will examine advantages and disadvantages of both the current production methods and the proposed alternative methods.

2. Introduction

Contentious inputs in organic farming are undesired inputs, but permitted by the Commission Regulation (EC) No 889/2008, where in the annex I, II, V, VI, and IX it is specifically mentioned, which fertilisers and soil conditioners, pesticides - plant protection products, feed materials, feed additives and ingredients of agricultural origin which have not been produced organically can be used.

Contentious inputs in organic farming have been grouped according to the theme area in which they will be investigated by the Organic-PLUS consortium. The three themes are 1) Plant; 2) Livestock; and 3) Soil. Within these themes, specific issues have been identified which have been discussed extensively and are cause for concern, as they are not in line with the organic principles (IFOAM guidelines) and may be detrimental to the reputation and marketing of organic products. The market is the driving force behind the vigorous development of the volume of organic agriculture, in terms of area, farm numbers and amount of produce.

In order to select or frame possible alternatives, and to determine which alternatives are best, the consequences of transition to these alternatives needs to be evaluated. As part of the feasibility process and evaluation, each proposed alternative is studied in-depth and different pathways to implementation may be explored. An initial analysis may appear to be negative, but sometimes solutions to overcome obstacles may be identified through the process.

3. Methodology

3.1 Overall feasibility design

Generally, a feasibility analysis is the process of determining that a process, plan or design is possible and makes sense. The result of the feasibility study may be used to validate assumptions, constraints, decisions, approaches and business cases. Formally, a feasibility study is defined as an evaluation or analysis of the impact of a proposed method as compared to current methods or practises (e.g. Sørensen et al., 2005; Gael & Ellen, 2015). In this case, the feasibility of alternative scenarios involves assessing the functional and operational capabilities, and economic viability of specific operations, processes and methods based on information obtained about system performance before and after the implementation of alternative production methods substituting contentious inputs. The feasibility analysis will include sensitivity analyses, ranking and quantifying important influential factors as well as descriptive advantages and disadvantages of both the current situation and the proposed alternative situation.

A key objective of a feasibility study is to support decision-makers (here farmers) in determining whether or not to implement a specific alternative production method. The feasibility study is partly based on basic production data collected for the sustainability and LCA assessments, and partly on supplemental data concerning specifically operations data for usage scenarios. The feasibility study will include advantages and disadvantages of both the current production methods and the proposed new methods. For example, cost comparisons will involve estimating incremental costs as the difference between costs of current methods of operation and cost of implementing and operating new methods is likely to change in incremental steps.

A feasibility study comprises a number of specific components: 1) economic feasibility, 2) technical feasibility, 3) operational feasibility, and 4) schedule feasibility – see Figure 1. If necessary, additional components like conceptual feasibility (what do consumers think) and regulatory feasibility may be included.

Figure 1. Components of feasibility study

The conclusions and results from the feasibility study will evaluate the different alternatives in terms of implementation weaknesses and strengths as the basis for the decision makers to review and critically study the assumptions and prerequisites. An important point is that the stakeholders (farmers and others) must make the final decision as to whether the proposed alternative is feasible or not – using the information from the feasibility study.

Additionally, it must be noted that a feasibility study is not a business plan, for which they are often mistaken. The feasibility study outlines whether the proposed change is viable or not, while the business plan outlines the steps or measures to implement the proposed change; in other words, translating it into reality.

Table 1. Identified scenarios and case farms to be assessed according to T6.2, T6.3, and T6.4.

Senarie	Country	Number of case farms	WP	Action Area			Product	Input to be minimised	Alternatives
				Plant	Livestock	Soil			
1	Germany/DK	2	3	Horticultural appel			apple	S	resistant varieties
2	Turkey/Spain/ Greece	3	3	outdoor cultivation of olive/tomatoe/egg plant			olives/tomatoe/eggplant	S, Cu, mineral oil	resistant varieties
3	Germany/France	2	3	Agriculture/potatoes			Potatoe	Cu	Seed tube dressings eg. Phosphonate and chitosan, resistant varieties, foliar application of probiotic
4	UK	1	3	Agriculture/potatoes			Potatoes	Cu	Growing practice e.g. removal of foliage at first sight of blight
5	Spain/Germany	1	3	Nursery/greenhouse crops			tomatoes	Cu	potassium hydrogen carbonate, sulphur,
6	DK	1	3	Agriculture			Potatoes	Cu	pre sprouting, resistant varieties, defoliate
7	Germany	1	3	Agriculture and nursery				Mineral oils	Vegetable oils, Integrated pest management,
8	Italy/Turkey	2	3	Citrus			orange	Cu, S	Less copper, less sulphur, other plant based fungicides
9	UK/Norway	2	4		cows, pigs, poultry, lambs		meat/milk	Antibiotics	Plant based inflammatory, immune stimulants, anti-infectives, tannins
10	Italy	1	4		Cheese production		milk	Antibiotics	Plant based anti flammatory
11	Germany	1	4		Barn		meat/milk	Conv. Straw	Agroforestry supply chain products
12	DK	1	4		Pigs		meat	Antibiotics	herbs
13	Italy	3	4		cows, pigs, poultry		meat/milk	Antiparasitics	herbs /tannin
14	Norway/Poland	2	4		Barn animals		meat/milk	Conv. Straw	Bark as bedding
15	Spain, France, UK	3	5	Agriculture	Feed	agriculture and horticulture	plant /livestock products	manure/feed/medicine	Permaculture
16	DK	1	5	free land Tomato/strawberry		Soil cover	tomatoes, strawberry	Plastic	Photodegrable plastic from corn starch, crop covers, woven ground cover(Mypex)
17	Germany/ DK/ Norway	3	5	Cereals		fertilizer/mulch/marine waste	grain	Conventional manure	Digestat/recycled household waste/other annex I possibilities/fish waste etc.
18	UK	1	5	Planting/cutlings		Vegetable transplants	plants	Peat	Composted bark/wood, coir fibre, green waste compost, leaf mould, worm compost
19	Germany	1	5	Horticultural		Plant media	plants	Peat	Composted bark+wood, cori fibre peat, green waste compost, leaf mould, garden compost, worm compost, processing trees/waste fibre material in a extruder (ATB)
20	UK	1	5	Agriculture free land, Cabbage, carrot		Protected cropping (horticulture) -fertilizer	Tomatoes or other polytunnel crops	Animal manure	New cropping systems with innovative use of legumes and organic biogas digestate
21	Germany/ Denmark/Poland	3	5	Agriculture and horticulture		Fertilizer	Arable crops	Manure	New cropping systems with legumes and clover, household waste, organic biogas waste
22	UK	1	5			Field vegetables - weed control mulch	Vegetable crops	Plastic	Non fossil fuel derived biodegradable mulch
total		37							

3.2 Economic feasibility

Economic feasibility means validating whether a process is possible within the cost benefit constraints. A key method of analysing incremental changes in a production system is to use the principles of partial budgeting. Partial budgeting involves analysing increase/reduction of costs or increase/reduction of returns together with a summary of the net effect. For example, the costs of prevention for a “no-copper” potato scenario include relating direct costs in terms of work hours and energy consumption to yields and quality.

3.3 Technical feasibility

Technical feasibility means validating that a given alternative input can be implemented using a given technology. For example, in the case of organic transplant production without peat, it has to be assessed if system redesign in terms of growing media based on composted plant material, modified direct sowing, more precise weeding, etc. is feasible and can be applied.

3.4 Operational feasibility

Operational feasibility means deploying and operating a new project or process. In operational feasibility, we consider whether the new system (compared to the current system) be can implemented using existing man power and resources or not. For example, potential costs and technical challenges associated with handling alternatives to plastic covering of the soil.

3.5 Schedule feasibility

Schedule feasibility means validating that a process is possible within the time constraints. This involves assessing if the implementation of a specific new process of procedure can be applied within a certain time limit. For example, in terms of being ready for the market. This could be of lower importance in this project, as theoretically no specific timeline exists for the introduction of the alternative inputs.

However, practically it is important to know for the organic sector when justifying the continued use of a specific contentious input, that there is a timeline for the phase-out Within schedule feasibility the time for transition to the full implementation of the changed procedure/process can be considered and assessed and this can be used for policy advice. For example, for the contentious input copper this has been reduced to 4 kg/ha (6 kg/ha before) from 2019 with a 7-year limit, this in fact means in 2026 a new decision and scientific decision support is required.

3.6 Conceptual feasibility

Conceptual feasibility is a step that formally considers if the proposed alternative corresponds with the principles of organic farming and whether the proposed alternative method or process is acceptable to both farmers and their customers.

3.7 Regulatory feasibility

Regulatory feasibility formally considers if the proposed alternative corresponds with the rules and standards for the certification and labelling of organic food and any other regulation, including a check of any unintended consequences of regulation or conflicting regulations.

4. Case studies and feasibility

4.1 Case farms

In general, the feasibility study aims at finding and describing the factors that make the new alternative method being preferred to the standard method used in organic agriculture. This study is not a complete feasibility study. It is studies aiming at finding and describing the factors that effecting the production in terms of operational feasibility, usability, practicability, etc. compared to the standard method when a contentious input is phased out or reduced to very low input. The feasibility is clarified and described through several characteristic case farm examples. Seven farms were selected as case farms and have been analyzed.

The selected case farms were from Northern Europe (Denmark), Central Europe (Germany) and Southern Europe (Spain), respectively. Various branches of organic production are represented through the analyzed farms. The following branches are thus included

- Pig
- Poultry
- Vegetable
- Cereals
- Potato
- Orchard (Apple)
- Wine

The contentious input in focus is:

- External animal derived fertilizers (conventional animal manure etc.)
- Plastic folio
- Cu used in plant production
- S used in plant production
- Mineral oils used for pest control
- Anthelminthic and antibiotics

4.1.1 Case study -Pig

<u>Bian Holm, Ulvehøjvej Brørup, Denmark</u>

Organic pig farmer – sows, piglets, and slaughter pigs.

Producing with reduced amounts of antibiotics.

Brian Holm runs a full line production of organic outdoor pigs with sows, piglets and slaughter pigs. Slaughter pigs hold in porch stables. The mating section “løbeafdeling” for sows is in stable with access to outdoor areas. Otherwise, focus is on outdoor areas where the animals have the opportunity to seek shade and shelter by trees (poplars) that are planted in rows in the fields.

The production includes a total of 625 sows and gilts, 14,500 piglets and 12,000 fattening pigs. About 2,500 piglets are sold to other pig producers.

Slaughter pigs in stable with access to concrete outdoer area

The overall goal is to achieve a production completely without the use of antibiotics. However, this will hardly be possible to achieve one hundred percent, both due to animal ethics reasons, as a sick animal should not suffer unnecessarily but be treated if effective medicine is available, and the Danish legislation require that sick animals is treated if possible.

A way to avoid or reduce the consumption of medicines and antibiotics can be ensuring optimal production conditions. In that case the animals are less vulnerable and a basis for healthy animals are set up.

Brian Holm has achieved a low treatment index and relative low total use of medicine compared to the average in Denmark. He considers a number of factors to be crucial to his success in reducing the use of antibiotics:

- Outdoor production system with trees
- Outdoor farrowing
- Outdoor weaning
- Late weaning of piglets (8 weeks)
- On farm mixed quality feed
- Roughage
- Management

Besides this key points Brian Holm have focus on the welfare of his employed, as he experienced that satisfied and happy employee are more attentive. It is always important to pay attention to the behaviour of the animals as it indicates whether there are problems.

A big challenge in his organic outdoor production system is high mortality among the pilings. At the moment a mortality of 22 percent is seen and focus is on reducing this by improved design of the sow farrowing arks and management in general.

Conclusion

On the bases of the information gathered in and from the visit at Brian Holms farm it may be seen that the l pig production in Denmark with very low input of anthelminthic and antibiotics is feasible, as the production figures is in line with standard production figures, and no significant change in machine, energy and labour input are reported.

Sow farrowing arks in landscape with poplar trees.

4.1.2 Case study - Potato

Anders Stensgård, Fredrikshåbvej 44, Randbøl, Denmark

Organic potato grower – potato is the principal crop while cereal (spring barley, hybrid rue and oats) and clover grass are secondary crops. A minor part of the farmland is used for growing lupine and carrots.

Anders Stensgård runs an organic farm solitary with production of plants. In total the cultivation area at the farm is 671 ha. Potato is a very important crop and contributes significantly to turn over and income at the farm. Roughly one half of the potatoes are for consumption and the other half are for seedling and only a little part of the potatoes is for chips and industry.

To achieve a healthy crop and high yields crop rotation is used. For the potatoes a 5–6-year rotation period is used and about 10 – 12 percent of the fields are grown with potatoes. Not all the fields are suitable for growing of potatoes. 65 - 70 percent of the fields are used for growing of cereals while about 15 percent are used for growing of clover grass. The rest - about 10 percent is of the fields - are used for e.g., carrots and lupine and a minor part is perennial grass.

In organic potato production blight is one of the most serious crop diseases. When it occurs in a field it is speeding epidemic and stops the growth of the plants. If not threated, the infected leaves and plant tops must be removed to avoided damaged on the potato tubes in the soil. In many countries copper-based fungicides have been used in organic as well as conventional potatoes to control the blight. However, copper is a contentious input organic production and alternatives, or new cultivation methods are sought so that the use can be phased out. In some countries – e.g., Denmark - it is not allowed to use copper-based fungicides in organic potato production, and thus Anders Stensgård's production is without this continues input. Anders Stensgårds production is an example on how copper free potato production can be performed under Northern European climate conditions (Temperate Climate Zone).

Anders has shown that the production of potatoes is feasible without the use of copper. To optimize the production, a number of different approaches and tools are combined. Very important is the management and cultivation strategy. Important factors are the choice of variety, time for planting, weed control, handling, cleaning and sorting at harvest and the subsequent storage. Despite all optimal approaches, however, there are relatively large fluctuations in yields from year to year due to different weather conditions and varying plant disease pressures from year to year. Yields can thus vary between 150 and 300 tonnes per hectare.

Varieties - blight resisters

Choose of variety is one of the tools to reduce or delay the occurrence of blight. To reduce the occurrence of potato blight Anders goes for varieties with high resistance. Furthermore, a number of different varieties are grown - this year 7 different varieties - to spread the risk. However, the choice of variety is largely determined by the consumer demand, as new unknown varieties can be difficult to sell as the consumer and potato companies have strong preferences regarding variety name. Therefore, the well-known variety Sava is grown to a large extent due to consumer demand, but also because Sava is suitable for organic production due to early growth and reasonable disease resistance.

Choice of high a resistant variety and use of certified seed is one of the key tools to reduce potato blight.

This year two new varieties - Nuffi and Kuras - have been tested. Both varieties have high blight resistance and widespread infestation of blight occurred several days after infestation was found in other varieties in the neighbouring fields. Especially Nuffi showed good results in both yield and starch content. The yield per ha was 2-4 ton higher than average and the starch content was 1-2 percent point higher than average. The purchase price for certified seed was the same for the two new varieties as for traditional seed.

Soil treatment and fertilization

Prior to potato planting, stones are removed from the topsoil and beds for cultivation are set up by means of a standard stone picker with beds former. After formations of the beds, pig slurry is applied by a soil injector in the topsoil. Pig slurry is chosen because of high phosphor content and a high concentration of nutrients.

Potato planting

Early planting is practised as it is important with long as possible growing period before the growths is stopped due to infection of blight. The planting normally starts around marts 25 which is very early under Danish conditions. The early planting carries a risk of frost damage on the newly emerged plants. However, the experience is that frost-damaged plants quickly re-emerge and the loss is of minor importance. No special measures are taken, such as covering with fibre mesh or plastic foil to protect against frost. It is estimated that such measures will be disproportionately laborious.

The row distance is standard 75 cm.

Pre-sprouting of the tubes is not used. Heating up of the tubes prior to planting have been tested, but no clear effect has been observed, and therefore this method have been omitted.

Weed control

Weed control have a very high priority. Crops grown without strong competition from weeds are considered a prerequisite for healthy potato plants and a high yield.

Two standard machines are used for the weed control. A potato ridge plough is used in combination with a ridge band cultivator with inclined mounted star wheels. Working width of the machines are 3 metre, and the working capacity about 1 ha per hour. In total 6 treatments are performed throughout the growing season.

Einböck ridge band cultivator with inclined mounted star wheels is used for weeding.

Disease control/management

The early planting is considered to imply high risk of tube fungus, but it doesn't seems to be a problem. Use of an approved organic seed disinfectant have been tried but no effect was observed in the field.

The main damaging disease is blight. To avoid blight from the leaves to spread to the tubes great efforts are made to ensure firm and correctly shaped ridges with good coverage of the tubers. The fungus normally travels no more than 2-3 cm through the soil. Furthermore, the tubers are harvested 4-6 weeks after an attack has been found in the leaves. Infected plant tops are burned before the harvest of tubes to avoid infection of the tubes, as infected tubes will be destroyed by growth of mould.

Potatoes for seedling can normally be harvest before occurrence of blight. In this case a leaf chopper is used to stop growth and remove the top.

Harvest under dry weather conditions is a prerequisite for good quality in the tubes. Great efforts are being made to ensure clean potatoes. The potatoes are carefully sorted on the potato harvester, and they are furthermore cleaned and sorted again on a stationary sorter before storage. The potatoes are stored indoor in boxes. The storage take place in insulated buildings where there is the possibility of ventilation.

Indoor storage of the potatoes. Storage in insulated building with ventilation.

Conclusion

On the bases of the information gathered in and from the visit at Anders Stensgårds farm it may be seen that potato production in Denmark without copper is feasible. Blight can be a challenge and some year the blight result in reduced yields. With optimal strategy and good management reasonable outcome can be achieved. Extra labour and machine input are required but standard machinery and technique can be used.

4.1.3 Case study - Vegetable

Josep Lavall. Finca La Vall, 43512 Benifallet , Spain

La Vall is an agricultural farm dedicated to organic production located in Tarragona. The farm occupies a simple valley that, following the final course of the Canaletes, begins at the Assut de La Vall and ends at l'Ebre.

The production area for vegetables is 16 ha. On the farm, there is a bigger focus on pest and insects than diseases. The crops grown are sweet potatoes, sugar beetroots, watermelons, onions, sweet pepper, tomatoes, broccoli and melons. At the farm they are using intercropping systems with high percentage of herbs like basil. Because of the large area of nature surrounding the farm, there is a low pest risk. The farmer uses different resistant varieties. There is focus on phasing out copper and instead use of more environmentally friendly alternatives. Furthermore, plant oils like neem tree oil as alternative for mineral oil are used 1-2 treatments a year against larvae. Conventional plastic folio has been phased out, and instead bioplastic and paper mulch are used to increase yields and control of weed. In general, the yields are quite good.

Fertilizer

There are no livestock on the farm, but they have access to composted conventional cow manure as fertilizer for all the vegetables. Composting is a hygienic process to prevent unwanted inputs of antibiotics or antibiotic resistant bacteria and thereby avoid problematic inputs. The farm use the conventional cow manure compost because it is difficult to find the organic fertilizer.

The maximum allowed amount of organic fertilizer, (170 kg N/ha), is used. The yields of the different crops are high, which shows there is no deficiency of nutrients and the management is well controlled. The biodiversity is high due to the many different crops and the nature surrounding the fields.

In general, increasing the organic land share to 25% would help with availability of organic animal manure sources. Digestates e.g. from biogas production and other bio fertilisers, including struvite from human manure are also an option to provide the nutrients required for the yield levels achieved.

Plant protection / Fungus control / Copper alternatives

For the farmer It is important to achieve a sustainable, healthy, coherent and safe production of vegetables. There is a focus on minimizing the use of copper as plant protection products and instead using biological insecticide and fungicide. The farm has reduced the use of copper, with 90%. Often the phasing out copper cannot be done by replacing the active substance by another, less contentious. The problem with copper is the persistency in the soil, slowly making the ground toxic for fauna and sometimes even for animals grazing. In addition, copper is not very specific in its target, suppressing not only fungi, but also beneficial organisms giving biological control, like ladybug larvae and predatory beetles.

As an alternative to copper, the farmer uses potassium bicarbonate. This is a fungicide with no toxic effects to all types of organism, except the target ones, according to the

European Commission. The potassium bicarbonate is applied via spraying techniques so no additional products/facilities would be needed. He also use resistant varieties and use intercropping with herbs, diverting potential insect hazards and pest, herbs for possible synergetic effects, and plant and bacteria derived or natural repellents. Intercropping can give synergetic fertilisation by root contact between legumes and non-legumes. The herbs take 20% of the land use on the field, so they choose varieties and species, which they can sell afterwards.

Weed control / Plastic covering

For weed control the farmer uses mechanical hoes, harrows or hand weeding together with systemic crop rotation.

For covering the vegetables, he uses bioplastic from starch and paper mulch. He has experimented with many types and found some that work. They are both 2 - 3 times more expensive than conventional plastic. Nevertheless, since the bioplastic and paper mulch do not need to be recollected at the end, the workers save time on recollection, compared to conventional plastic, which needs to be recollected. Time is money! The quality of the bioplastic that he uses is of very good quality and lasts more or less as long as needed. The paper mulch is very susceptible to rain, so it can only be applied in dry season or used in areas/regions that do not get periodic rain. In general, paper mulch is best for crops that grow horizontally across the soil (e.g., sweet potato, melons, pumpkins), so that they lay on top of the paper, thus if it breaks a little, it still won't fly away with the wind since the vegetable is keeping it in place. The bioplastic and paper mulch use the exact same machinery as fossil-based plastic, thus will not increase use of additional products. Although installing the alternative mulch requires a little bit more time since they are both more fragile than fossil-based plastic, but nothing drastic. Maybe in the future, it would increase the production of potato starch and paper production if a larger population of farmers started using them.

Marketing and sales

The farm has its own web homepage where they promote the farm and their products. They would like to make their own "brand" of very sustainable vegetable products. It would take a lot of time and effort if such an initiative should be a success. Marketing and awareness campaigns must be conducted so that consumers are knowledgeable of the differences and benefits of alternatives.

Conclusion

Phasing out the fossil plastic folio for weed control is feasible when alternative products as non-fossil bioplastic and paper mulch are used. However, the alternative folies are more expensive. Phasing out copper 100 percent is difficult, but a significant reduction of 90 percent has been achieved by a combination of management measures, chose of healthy varieties and use of potassium bicarbonate as alternative fungicide.

The farmer thinks that the vegetable production is much dependent on mulch and fungicides/system changes. He already has a lower yield compared to conventional farmers, so phasing these out without a way to control weeds or fungi would not be feasible.

4.1.4 Case study - Cereal 1

Torben and Morten Matthiesen, "Jennelgård" Alslev Strandvej 4, 4800 Nykøbing Falster , Denmark

Torben and Morten Matthiesen runs 311 ha of organic plant production. The production was converted into organic farming in 1998. The soil is heavy clay soil. All the farmland is plowed, and all cereal straw is cut at harvest and applied to the soil. In 2021, the crop rotation scheme consists of 70 ha spring wheat, 69 ha spring barley, 43 ha oats, 37 ha peas, 32 ha grass for seed, 30 ha winter oilseed rape, ha sugar beets and 4 ha soyabeans. Typically, green manure (white clover) from at least 70 ha is used prior to growing winter oilseed rape, oats, spring wheat or spring barley. Moreover, 35 – 40 ha cultivated with catch crops (oil radish and honey herb) is. The catch crops increase soil carbon sequestration.

Focus is on the phasing out conventional manure. Phasing out conventional manure in organic farming is a recommendation from the Danish organic organizations as well as new EU-recommendations related to the new CAP-rules. The farmer sees the new recommendations as a way to develop organic farming future. He welcomes the development and thinks it is a pity if the demand for reduction of conventional livestock manure will affect farmers to give up organic farming. Not least because the Danish government have set a goal for a doubling of the organic area. The phasing out of conventional livestock manure is a decision that has have been well known and expected for several years. According Torben and Mathias farmers have had time to adjust, and they see the phasing out as a professional challenge that motivates.

Machines

The farm has their own machines for the basic work and contractors are used for e.g. applying of slurry and manure.

At the farm there is three modern tractors with GPS, 6 furrow moldboard plow, 4 m rotary harrow with seed box, 12 m roller harrow (at 16 km/hour a capacity of 250 ha/day), 8 m roller, 12 m weed harrow, 12 row inter-row cultivator, two 12 row lay down weeder for 12 people, 30 feet combine harvester and miscellaneous small machines and wagons.

For spring crops, manure is applied by trailed slurry tanker with injector. For winter crops and seed grass, manure is applied by slurry tanker with trail hoses. Chicken manure is spread with a muck spreader with a 15 m working width (double overlap securing an uniform spreading of the manure).

Fertilizer

Previously conventional manure has been used. Imported fertilizer consisted of 50 % manure from conventional farmers and 50 % organic manure from an organic egg producer near by the farm. From next year the farm will have more organic nutrients available when an organic colleague stops his production. This means that the farm will have the opportunity to import 800 tons of organic manure (laying hens). The manure has in general an average N-content of 20 kg N/tone. This means 16000 kg of N. Furthermore, from 2023 it will be possible to import digested slurry from one a new “Nature Energy” biogas plant at Lolland Falster. The biogas slurry consists of recycled nutrients, manure, deep litter, waste from the sugar factories (sugar beet pulp) and miscellaneous food waste. The location of the nearest plant is within 20 km’s distance from the farm. Together with the organic hen manure, the fertilizer supply meets the demand for the plant production.

The region where the farm is located benefits from having organic poultry and chicken manure available from local egg producers. In the last 2 years the farm has applied 65 kg imported N per ha and the farmer wants to show that it is possible maintain the yields with a lower import and supply of manure. According to Danish schemes for organic farming, the farm is allowed to apply up to 107 kg N per. The farmer doesn't think an increase of N supply to 107 kg N per ha would increase the yields substantially.

Cultivation practices and weed control

In recent years the weed control has become much more efficient. The sowing technique and point in time for sowing the organic crops are in line with conventional plant production. At the farm plowing is an important factor in the plant cultivation as it supports the weed control. Winter rape seed and clover grass are sown at the same time as crops for green manure, (white clover). For establishment of crops for green manure in oats, spring wheats and spring barley a seed rate of 2 kg white clover per ha is used.

It is extremely important that there is low weed pressure in the field prior to the establishment of crops for green manure. Fields with green manure crops is ploughed in the spring. N-min analyzes shows that between 50 to 100 kg N per ha can be fixed to the subsequent crop. Practice have shown that a well-established green manure crop may offer complete fertilizer for a subsequent spring barley. Establishment of catch crops and crops for green manure can be a challenge in the dry years, but in general the method has been a good tool in the organic nutrient supply. This year the clover has developed vigorously already now (15 dec).

It is planned to have cattle to graze the field. If such vigorously crops also is seen in next years, perhaps a harvesting of the crop could be done, and the biomass could be delivered to a biogas plant.

To achieve good weed control, it is important to have the right crop rotation. If there are weed problems in the field, action must be taken quickly. Here, peas for human consumption are a good crop. Usually, the crop is harvested around 1st of July, and due to the early harvest, it is possible to start weed control in a dry period and prior to the sowing of a winter crop, e.g., winter oilseed rape. Weed harrowing is the only weed control in fields with peas and beans.

In crops with heavy weed problems the roller harrow is used. Sugar beets are inter-row cultivated 3 – 5 times during the season. In addition, they are hand weeded to remove weed between the plants. Here a 12-row lay down weeder with 12 persons are used.

The workers are from Lithuania and hired by a contractor. The lay down weeder demands a slow forward speed, about 0,5-0,7 km per hour. When the sugar beets are harvested, the field are harrowed 1 – 2 times for weed control. Pest infestations can be extremely lethal. In 2021, the barley fly has cost 20-30 % of the yield, in both Denmark and other EU-countries.

The price for organic crops has been rising recently. For the time being the most important and most profitable crops are sugar beets, winter oilseed rape and peas. When it comes to grain, old varieties have been chosen. They may not have the highest yields but have a high sales price. In 2021 the winter wheat yield was 40 hkg per ha, but the profits from the production was 2000 DKK per ha more than the same variety grown in a conventional set up.

Conclusion

The feasibility for phasing out conventional manure in organic plant production strongly depends on the availability of alternative fertilizer. Torben and Mathias benefits from having organic poultry and chicken manure available from local egg producers and in the future, it will be possible to import digested slurry. However, the phasing out will require crop rotation with legumes and increased use of catch crops and green manure. When alternative organic fertilizer is available and optimal corporation are implemented, yields can be maintained. Change in crop rotation and use of green manure may increase labor and machine input.

4.1.5 Case study - Cereal 2

Ole Olsen, Hovkrog 1, Dysted Østergård I/S, 4684 Holmegaard , Denmark

The production area for Ole Olsen's farm is 300 ha. The farm is dedicated to organic plant production and located in South Zealand. For the farmer the nature values are important, and he have great interest for hunting.

The production was converted into organic farming in 1999. The farmland is clay soil. All the farmland is plowed, and all straw is cut at harvest and applied to the soil. In 2021, the crop rotation scheme consists of 47 ha of seed grass, 27 ha of winter rape, 16 ha of winter wheat, 64 ha of oats, 9 ha of horse beans, 26 ha of white clover, 59 ha of peas, 9 ha yellow mustard and 42 ha spring wheat.

A challenge is to optimize the production without import of conventional manure. Phasing out conventional manure in organic farming is a recommendation from the Danish organic organizations as well as an EU-recommendations in the new CAP schemes.

For the farmer it is the goal to achieve a yield level corresponding to 70 – 80 percent of conventional yield. He believes that organic farming will prosper, due to the Green Transition, but also driven by consumer demand. Right now, new CAP-rules are being negotiated in the EU, and the Government and organizations are discussing how large the subsidy for a reduced N level should be. The subsidy is currently about 500 DDK per ha. The Danish association for organic farming goes for about 650 DKK per ha. Maybe an even higher subsidy will be offered as part of promoting plan for organic farming. Ole believes that Denmark has huge export opportunities for organic products. This because Denmark is the only country having state authority control for organic products. In other countries, organizations or private companies are responsible for this

Machines

The farm has its own machines for the basic work and contractors are used for e.g. applying of slurry and manure.

At the farm there is two modern tractors with GPS, a 5-furrow moldboard plow, a 4 m rotary harrow with seed box, a 12 m roller harrow (at a speed of 16 km per hour the capacity is 250 ha per day), a 12 m roller, a 12 m weed harrow and 6 a m standard seed drill for sowing of e.g. clover for catch crop or green manure, a 30 feet combine harvester and miscellaneous small machines and wagons. A 6 m trailed disc cultivator are borrowed from a neighbor.

A contractor is hired for applying liquid manure. In spring crops, manure is applied by a trailed slurry tanker with injector. For winter crops and seed grass, manure is applied by means of a self-propelled Agrometer slurry spreader with dribble bar applicator trail hose system. In the future when they are going to use poultry manure, this also will be a job for the contractor. For spreading the manure, a modern muck spreader that is able to apply the manure precise will be used.

Fertilizer

Previously conventional manure has been used. The imported manure has consisted of manure from 5 conventional farmers as well as organic poultry manure from a farm with egg laying hens. From 2023 it is planned that the imported fertilizer will be biogas manure from Nature Energy in Køng (digested biogas manure fulfilling the organic requirements) as well as poultry manure from 12000 organic hens. According to standard figures the 12000 hens will produce 581 tone of manure which means 10687 kg N per year. The biogas manure consists of recycled nutrients, at least 25 percent degassed manure, waste from beets (sugar production) and other organic biomass, e.g., food waste. Nature Energy will establish slurry storage tanks at farmers within a radius of 25 km from the biogas plant. A 10-year contract has been made stating that the farm receives 7500 tons of biogas digest annually from the plant in Køng. Nature Energy build a 5000 m3 slurry tank on Ole's property and deliver the slurry free of charge. After a period of 10 years, the property rights of the slurry tank will be handed over to Ole for free. Economically It will be a great advantage to have the biogas digest delivered free of charge as road transport by lorry usually costs DKK 800 per hour. As the upstart of the Nature Energy plant in Køng is delayed, Ole will only be able to get 300 tones of manure in the spring 2022. Therefore, he will continue import some conventional manure in 2022. It is expected that the supply of biogas digest from Nature Energy will be as agreed for season 2023 so the conventional manure can be phased out completely.

Cultivation practices and weed control

In recent years the weed control has become much more efficient. The sowing technique and point in time for sowing the organic crops are in line with conventional plant production. A key factor for both weed control, nutrients matter and healthy crops is the crop rotation scheme. Green manure from at least 20 percent and catch crops on 74 percent of the total farmland area increases the carbon build-up in the soil. The farmer aims at having a crop rotation with 40 percent of winter crops and 60 percent of spring crops. To avoid plant diseases there must be 5 – 6 years growing break for peas, winter rapeseed and horse beans. The farmer considers phasing out winter wheat and replacing it with winter rye as the yields may be higher for rye. Lupines has been used in the crop rotation scheme, but this crop has been given up as the farmer finds it less suitable for his clay soil.

At the farm they practice sowing of winter rape and clover at the same time, - the clover as green manure. The goal is 70 rapeseed plants per square meter and sowing of 2 kg white clover per ha. (In order to sow such a small amount, the white clover is mixed with sawdust by sowing).

When sowing green manure crop in oats, spring wheat and horse beans, the farmer uses his own mixture of 2 kg white clover and 3 kg ryegrass per ha.

Weed control has a high priority and - as mentioned - is supported by a good crop rotation scheme. If there are weed problems in a field, action must be taken immediately. In that regard peas for human consumption are a good crop. Usually, the peas are harvested around 1st of July and then it is possible to start weed control in a dry period prior to sowing of a new crop, e.g., winter oilseed rape. In these fields, the farmer uses the trailed disc cultivator 2 - 3 times. This machine is very effective, and the treatment ensure good weed control. Generally, the weed harrow and roller harrow are used for weed control in the different crops.

Conclusion

The feasibility for phasing out conventional manure in organic plant production strongly depends on the availability of alternative fertilizer. For Ole it will be possible due import of organic poultry from local egg producers and import of biogas digested slurry.

However, the phasing out will require crop rotation with legumes and increased use of catch crops and green manure. When alternative organic fertilizer is available and optimal corporation are implemented, yields of 70 – 80 percent of conventional yield are expected. Change in crop rotation and use of green manure may increase labor and machine input.

4.1.6 Case study - Orchard (Apple and Poultry)

Munkebjerg organic orchard, Jette Jørgensen, Skovbyvej 64, 7080 Børkop, Denmark

Jette Jørgensen and her husband Bent runs an organic orchard with the production of apples. The production is completely without the use of the contentious inputs Cu and S. The applied fertiliser origin from the farm's own organic laying hens.

The overall goal is to achieve a sustainable, healthy and safe organic production completely without contentious input. The nutrients for the apple trees are delivered from the outlaying hens, which are fed with organic feed pellets supplemented by home grown roughage (barley/peas), and without using antibiotics.

Production and sale of apples.

The orchard comprises 16 ha. The production includes 12 to 14 different varieties of apples. The annual apple production is around 170 tonne or about 11 ton per ha. The marketing of the apples is primarily via the grocery chain NETTO (95 %). A minor part of the apples is sold directly (sales booth) in a road penance at the orchard. The apples sold at the sales booth can have different size and shape, which not fit into the standard requirements from NETTO.

The obtained price for the organic apples varies from year to year and are also dependent on variety. In 2021 in average the sales prices are 9 Kr/kg. This is about double of the price for conventional grown apples.

Figure 1. The system with rows of apple trees and the area for work machines. At right freshly picked apples in unsorted quality and sizes.

To obtain optimal yield of apples the soil quality and content of nutrients are essential, and therefor often soil samples is taken. They are analysed by a well-known laboratory (OK laboratory, Viborg). Sometimes samples of leaves are taken to clarify if pests or diseases are attacking the apples. Organic guidelines says that the use of phosphorus and potassium only is allowed on the basis of recommendation and approval from consultant. The only pest and insect control used is a rare spraying with baking powder against scab. To optimise the management, they use the Ring Pro program together with a Company from The Nederland's, (Awika Advice). Because the prohibition of pesticides the amount of apples being discarded is higher than apples grown in conventional orchards. Jette do not know how much more, but it is a part of the production and is offset by the higher selling price. In general, Jette finds the cultivation opportunities for organic apple production are quite well in this area of Denmark.

The farm was taken over in 1994 from Bent's grandparents. In 1995, they started up with 6,000 hens in the open field. In 1998, they converted to organic production with 9000 outlaying hens and in 2004 they expanded to 12,000 outlaying hens. The eggs are delivered to the DANÆG Company. The apple trees were planted in 2006 on 11 ha out of the farms total 40 ha. This area has also expanded, and today the orchard covers 16 ha. The rest of the field are leased out to another farmer in the neighbourhood.

Figure 2. Organic laying hens are delivering fertiliser (manure) to the orchard.

The Danish Agency for Agriculture certifies the farm. The farm is Global GAP certified and the production of eggs are GPM certified.

The 12,000 organic outlaying hens have access to arrears with apple trees. It applies to the 8 ha orchard closest to the buildings. The eggs are laid in the indoor building and collected every day. As mentioned, the solid manure (collected indoors in the hen house) are used as fertiliser for the apple trees. The allocation of manure is done by using a universal manure spreader driving along the rows. The applied amount of manure is 1.0 kg/tree = 30000kg/year. The rest amount of manure (in 2020 around 100 tonne) are exported to an organic farmer in Tønder, in the southern part of Denmark.

In the start-up phase years ago, Jette and Bjarne was using the concept "self-picking" of the apples. It had some advantages compared to workload, but people were damaging the trees. They broke the branches and threw away bad apples everywhere. Today they use permanent employees in the orchard. The workforce is Jette and Bjarne, (owners) and four flex employees played by Vejle Commune. They are working 20, 20, 15 and 6 hours/week.

Machines and weed control.

As the size of this orchard must be designated as small, the technological equipment are quite common, and no investment has been made in advanced high-tech machines. The tractors used are normal tractors, not vineyard tractors that usually used in big orchards.

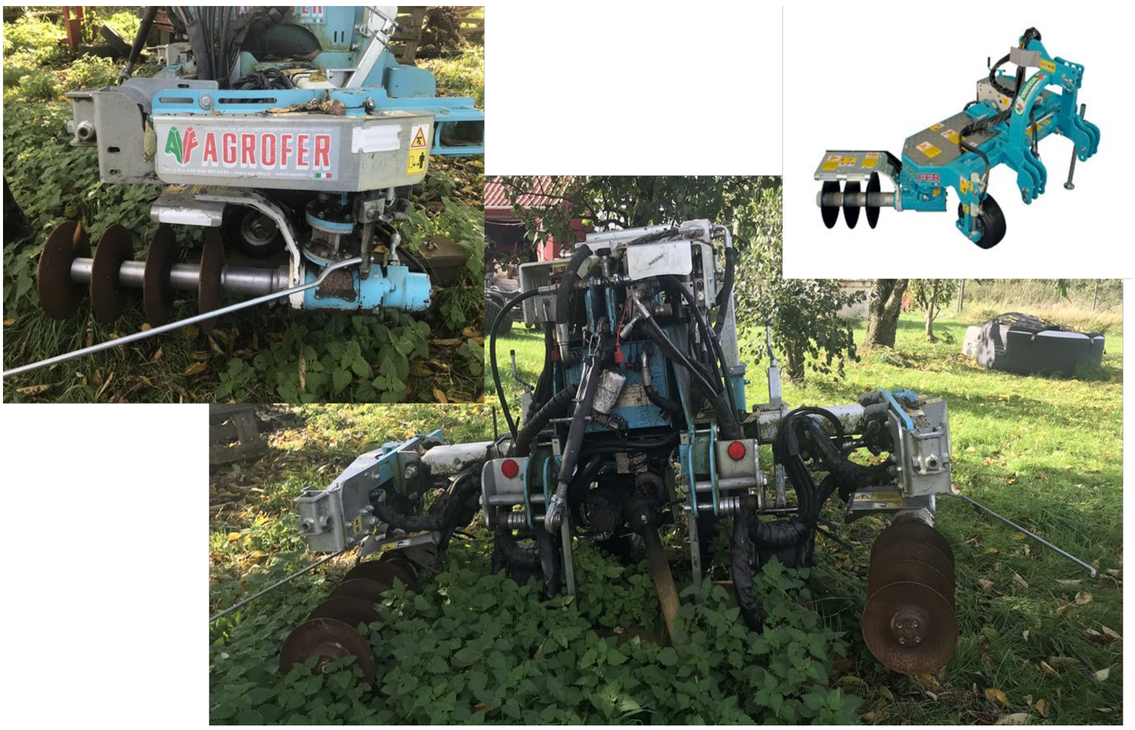

Figure 3. AGROFER ridging machine for inter-row weed control.

The standard tractors used courses that the width distance between the rows is 3.6 m compared to the 3.0 m for traditional apple orchards. Weed has to be controlled, and for that work, Bjarne has bought a front mounted Agrofer ridging machine. The Agrofer is made with quality materials and technological solutions of robustness and operational versatility, which make it ideal for working in the inter-row of vineyards, orchards or other crops arranged in rows. It takes two rows at a time, and it runs 4 – 5 times in the season. Time consumption about 20 hours/run for 16 ha. There is grass in the rows, which are being mowed when it is necessary. Typically, it is done while weed are being ridged in between the trees. (The ridging machine in the front and the grass mower at the back of the tractor).

Conclusion.

On the bases of the information gathered in the interview and from the visit at Jette and Bjarne's farm, there is no significant increase in machine and energy input. Labour inputs are high because much work is done by hand. Yield and sales prices are as for common organic apples although no spraying with S and Cu is used. Apple scab may occur, but her there are alternative organic approved fungicides.

4.1.7 Case farm – Wine

Demeter and Ecovin, Federal state Rheinland Pfalz osep Lavall. Germany

The farm produces grapes and wine on 18 ha cultivated area. There are no animals at the farm and no crop rotation scheme is practiced. The focus is to reduce copper and sulphur inputs. Instead, resistant strains are grown, and the amount of spray liquid is minimized by use of advanced technique for recycling the spray liquid that doesn't reach the plants. When using the advanced sprayer, they do not lose any copper that is not actually needed. They use only the amount that is really needed and not more.

Wines are usually around 30 years old. They started early on (over 20 years ago) to grow fungus resistant varieties as well. In a few years they plan to enhance fungus resistant varieties from now ¼ to 1/3 of total area.

Plant protection / Fungus control / Copper

For the farmer It is important to achieve a sustainable, healthy, coherent, and safe production of wine. The phasing out of the contentious input is based on personal desire for a more complete organic coherent production. The phasing out of the contentious input in this case is not based on legal regulations/requirements for organic production.

To achieve reduction copper input, fungus resistant vines has been introduced and in addition the old wines are treated with a minimum of copper. No switch possible have been observed. Reduction did not lead to loss of yields as they always applied as much as necessary but not more. However, the farmer has constantly to keep an eye on the weather and fungus pressure to optimize inputs and production.

Fungus resistant vines are not that expensive and easily available. The quality is very good as well. In general, the resistant varieties give the same yields, and the quality is just as good as for other varieties. The fungus resistant wines have their own quality (- their own taste profile -) and some of the chosen varieties have looser grapes and a lower ha yield.

Cu reduction in standard wines does not increase the production security. The use of fungus resistant varieties on the other hand does.

The spraying technique is very important to maximize the effect of the added excipients. Therefore, the farm has invested in a special recycling sprayer for wine, a LIPCO Type GSG-NV2 with 1000l tank – se figure 1.

In general, they have less work with the fungus resistant wines. With those fungus resistant wines, they usually only use the spray treatment 2 times per year (before and after flowering). This means much less fuel and workload for the machines (spray and tractor) as well as manpower. However, during rainy years (like last year) 2 times are not sufficient.

Figure 1. Special sprayer with equipment for collecting and recycling of excess spraying liquid.

Marketing and sales

There are not directly new markets for the produced wines but the wine from the farm is considered as a niche product that is gaining popularity. A large supermarket chain already is selling the wines. The current product is also almost sold out.

Quality is the same as well-known wines, but costumers still need to get used to the fungus resistant varieties. But this new market is growing now

Conclusion

The overall goal is to phase out copper, but so far, the focus is on minimizing the use of copper as plant protection. The introduction of fungus resistant varieties and the use of an advanced sprayer with equipment for collecting and recycling of excess spraying liquid have reduced the copper input significantly.

The market for organic wines is growing. The quality or the wines produced at Demeter and Ecovin with low input of copper is high, but costumers still need to get used to the brand.

5. Conclusion

5.1 Conclusions based on case farm studies

Plastic folio

Phasing out the fossil plastic folio for weed control is feasible when alternative products as non-fossil bioplastic and paper mulching are used. However, the alternative folies are more expensive. On the other hand the alternative folios are degradable and do not need to be recollected after use and thereby reduction in work is achieved.

Copper

In vegetable production phasing out copper 100 percent is difficult, but a significant reduction of 90 percent can be achieved by a combination of management measures, chose of healthy varieties and use of potassium bicarbonate as alternative fungicide.

In grapes for wine significant reduction can be achieved. Fungus resistant varieties are available and advanced sprayer technique can improve efficiency and avoid losses to the environment.

Potato production without copper is feasible in the northern European countries. Blight can be a challenge and some year the blight result in reduced yields. With optimal strategy and good management reasonable outcome can be achieved. Extra labour and machine input are required but standard machinery and technique can be used.

Sulphur

Phasing out S is feasible but may result in increased occurrence of apple scab. However, there are alternative organic approved fungicides on the market. No significant increase in machine and energy input are seen. In general labour inputs on studied farms were high because much work was done by hand. Yield and sales prices were as for common organic apples although no spraying with S and Cu was used.

Antibiotics and anthelminthic

A complete phasing out antibiotic is not feasible in most countries due to animal welfare legislation. A sick animal must be treated. However, the studies have shown that pig production with very low input of antibiotics and anthelminthic are feasible, as the production figures can be in line with standard production figures. Key factors are late weaning of piglets, quality feed and management. No significant change in machine, energy and labour input were reported.

Conventional manure

The feasibility for phasing out conventional manure in organic plant production strongly depends on the availability of alternative fertilizer. Digestates from e.g. biogas production, green waste compost and other organic bio fertilisers are withy used. The phasing out will require crop rotation with legumes and increased use og green manure. If alternative organic fertilizer are available yields can be maintained. Change in crop rotation and use of green manure may increase labour and machine input.