RELACS
IMPROVING INPUTS FOR ORGANIC FARMING

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1. Executive summary

The aim of the deliverable was to summarize the socio-economic and environmental impact assessment of the various alternatives strategies that have been considered and tested within RELACS. The comparative assessment of costs and benefits has identified various constraints and need for supportive policy actions for implementation. Realistic data on cost-efficiency and ease of adoption of novel tools and techniques are the essential base to develop phasing out scenarios of the contentious inputs. Overall, the majority of alternative strategies tested were more expensive but also more environmentally friendly compared to conventional, contentious inputs.

2. Introduction

The continued use of contentious inputs increasingly becomes a technical limitation in upscaling organic farming. Apart from the detrimental impact on the environment, usage of controversial inputs is also publicly criticized and presents a major risk for the further development of the organic sector. Phasing out controversial practices is thus a priority strategy to safeguard the achievements and investments of the actors and to ensure the future development of the organic farming sector. RELACS developed and explored novel solutions designed to reduce and eventually replace a range of contentious inputs in plant and livestock production. RELACS also aimed collecting the scientific information and feedback from the relevant stakeholders to provide a realistic assessment of their socio-economic and environmental impact.

The socio-economic assessment of the best performing alternative practices will provide the scientific basis to discuss the implementation of roadmaps for phasing out of contentious inputs, thus supporting relevant EU policies. It was essential to involve all relevant stakeholders at this stage to reach joint conclusions regarding the technical feasibility of solutions in the various climatic and socio-cultural situations of Europe.

The aim of this deliverable was to prepare a summary of the socio-economic and environmental impacts of the proposed alternative strategies when they are implemented at large scale.

3. Methods

RELACS consists of 6 research and technology work packages (WPs1-6), in which scientists, advisors and farmers are working closely together with industry partners. In each WP, all these stakeholders contributed to the development and the adaptation of the innovative solutions and strategies to reduce the use of copper (WP1), mineral oil (WP2), contentious fertilisers and manures (WP3), anthelmintics (WP4), antibiotics (WP5) and synthetic vitamins (WP6). Each of the WPs used a variety of methods to perform the cost-benefit and environmental assessment, depending on the nature of the alternatives and the stakeholders needs. These reports are written with data deriving from: i) workshops where scientists and wide range of stakeholders were present, ii) the national workshops, which facilitated discussions with advisors and policy makers, iii) input from farmers associations iv) input from the industrial partners in RELACS v) experimental work during RELACS, vi) literature search.

The results are summarized below.

4. Results

4.1 WP 1. Replacement of copper as plant protection product

Four alternatives were considered.

4.1.1 Licorice extract (LIC)

4.1.1.1 Economic feasibility

Licorice is a perennial shrub that is native to Asia and the Mediterranean region, it belongs to the family Fabaceae, and its members are commonly used as feed and food source. In addition to the therapeutic applications, today the roots and their extracts are commercially used by the following processing industries: pharmaceutical and food industries, as well as in the manufacture of functional foods and food supplements. It is native to Asia and Mediterranean regions but it has also been introduced to many countries, for example the USA where it is a weed of moist roadside sites. Licorice is also cultivated as a medical crop plant, particularly in former Soviet Union, Spain, the Middle East, China and Australia. The global market for licorice extracts is anticipated to expand to an increased demand in various end uses. Therefore, more and more licorice producing countries appear offering to ensure long-term supply stability and 100% raw material cycling and applying sustainable resource management to the collection.

Importantly, licorice leaf extract is produced at industry-scale with 'green solvents'. The extraction will become part of the value chain; the remaining material after extraction will be further used as fertilizer or may be composted. Further uses are under evaluation, but all materials will be used and/or recycled.

4.1.1.2 Environmental impact assessment

The ecotoxicological profile of the active ingredients and the non-active constituents of LIC has only been evaluated based on literature studies and a range of standardized assays for ecotox assessments. Since the full range of toxicity assessments required for dossier submission has not yet been conducted final conclusions cannot be drawn at this stage. But no toxicity in the foreseen concentration is expected because from literature it is known that in Mongolia the leaves are used as a tea substitute (Facciola 1990). Licorice leaf extract is expected to be qualified as low risk substance.

4.1.2 Larch extract (LAR)

4.1.2.1 Economic feasibility

Production of larch extract depends on availability of larch bark, saw dust and other side products. Competitive uses of larch bark may limit the availability of raw material or impact production costs. The extraction will become part of the value chain; the remaining material after extraction will be further used as fertilizer or high value material for composting and all materials will be used or recycled.

4.1.2.2 Environmental impact assessment

The ecotoxicological profile of the technical grade Larixyne, i.e. the active ingredients and the non-active constituents of Larixyne has been evaluated based on literature studies and a range of standardized assays for ecotox assessments. The full range of toxicity assessments required for dossier submission has not yet been conducted and therefore, final conclusions cannot be drawn at this stage. However, the available data indicate an unproblematic profile regarding human health and ecotoxicology and its constituents are highly degradable. In view of the historic use of larch wood in housings and the unproblematic decomposition of huge amounts of larch debris in alpine areas, approval of Larixyne as PPP is expected.

In comparison to copper, Larixyne is expected to have a lower tox profile especially in view of the low probability for accumulation in the environment. Larixyne is expected to qualify as low risk substance.

4.1.3 SUMB extract (SUMB)

4.1.3.1 Economic feasibility

As the product is obtained from woody perennials sustainable sourcing is possible and will contribute to maintenance of regional agro-ecosystems. Competitive uses of the source material may limit the availability and the price of raw material and may have impact on the production costs. Upscaling of the extraction and formulation process should not create technical challenges.

4.1.3.2 Environmental impact assessment

The ecotoxicological profile of the technical grade SUMB, i.e. the active ingredients and the non-active constituents of the extract has been evaluated based on literature studies and a range of standardized assays for ecotox assessments. The full range of toxicity assessments required for dossier submission has not yet been conducted and therefore, final conclusions cannot be drawn at this stage. However, the available data indicate an unproblematic profile regarding human health and ecotoxicology and its constituents are highly degradable. In view of the historic use of the product, approval of SUMB as PPP is expected.

In comparison to copper, SUMB is expected to have a lower tox profile especially in view of the low probability for accumulation in the environment. SUMB is expected to qualify as low risk substance.

4.1.4 Rare Sugar (RS)

4.1.4.1 Economic feasibility

This Rare Sugar is derived from a natural source that is available in large quantities, by simple chemical or enzymatic processes. The economic feasibility is not an issue when upscaling production.

4.1.4.2 Environmental impact assessment

Monosaccharides are important energy molecules and as such are vital to life. Sugars are mineralized through highly conserved metabolic pathways. Same as for the more common hexoses like glucose and fructose also this Rare Sugar is used as source of energy by most organisms. As a result, sugars do not occur in environmental compartments in their free from since they are rapidly incorporated in microbes (minutes) and mineralised or recycled as cell material. The absence of adverse effects of the Rare Sugar and its rapid incorporation in biological cycles is demonstrated in a range of standardized assays according to the data-requirements of 1107/2009.

The available data indicate compliance with the criteria for Low-Risk substances. The Rare Sugar is exempted from setting reference values (no ADI needed) and is proposed for inclusion in Annex IV of Regulation 396/2005 (no MRL needed). In view of the current use of the Rare Sugar and the fact that it is naturally present at low concentrations unconditional approval of the Rare Sugar as an active ingredient for PPPs is expected. In comparison to copper, the Rare Sugar has a significantly better profile in terms of environmental footprint. As energy molecule the properties of this Rare Sugar are basically opposite of copper whereas the sugar is of no toxicological concern and has no potential for accumulation in the environment. The Rare Sugar qualifies as low risk substance.

4.2 WP 2. Replacement of mineral oils as plant protection products

Three alternatives were considered.

4.2.1 Orange oil

4.2.1.1 Economic feasibility

The product is currently available in Europe because it was registered under Regulation (EC) 1107/2009. It is widely used in Spain, Italy and Greece not only on citrus, but also on zucchini and tomatoes.

4.2.1.2 Environmental impact assessment

The Citrus EO is considered at the moment the best alternative to paraffinic oils in Citrus pest control. The product reduces the risk compared to the use of mineral oils because it evaporates quickly from leaves when sprayed. On the other hand, there has been reports that application on some plant species has resulted in phytotoxicity, for example on strawberry and cabbage. Further research on this is required

4.2.2 *Clitoria ternatea* extract

4.2.2.1 Economic feasibility

The supplier confirms that BPA044I, once it will become available in the market, will be sold at end-user prices that are competitive. The product is currently not yet available in Europe because it needs to be registered under Regulation (EC) 1107/2009. This process is known to be demanding and lengthy, even in the case of biological products. BiPA is committed to prepare and submit the application dossier to the competent authorities in the near future. The product is already registered and in the market in Australia.

4.2.2.2 Environmental impact assessment

The use of BPA044I in whiteflies control represents an environmentally favourable and alternative solution to Mineral Oils. Mineral Oils are widely used against whiteflies, especially in organic farming but these compounds are considered as controversial by many consumers and stakeholders, due to their environmental toxicity. Furthermore, mineral oils result in negative effects on the aquatic life and on pollinators (European Food Safety Authority (EFSA), 2009). On the other hand, BPA044I, as biopesticide based on natural substances (plant extract) is considered more sustainable than mineral oils. The proposed use of BPA044I is unlikely to have an unintended effect that is harmful to animals, plants or the environment (APVMA, 2016). *Clitoria ternatea*, the plant from which the active substance is extracted, is known as animal feedstuff and is also used in human consumption and as traditional medicine. Establishment of residue limits (MRL) is not considered, as the substances are indistinguishable from natural food components and of no toxicological significance. In Australia, where the product is already in the market, BPA044I was granted the Southern Cross Certificate for organic input.

4.2.3 Vibrational disruption

4.2.3.1 Economic feasibility

A) Greenhouse: at the current stage of experimental prototype, a single VibroPlate costs around 150-200€ and a mini-shaker around 100-150€. However, the industrialization and the subsequent mass production would reduce the cost to less than half of it for the minishaker while the VibroPlate may not be reaching the volumes required for an effective industrial mass production.

In principle (although it has not been tested yet), we could hypothesize to protect a surface of 5 m^2 per mini-shaker, therefore the cost of one m^2 of greenhouse surface would be between 12 and 14 €. This value must be depreciated for 4-6 years of amortization which would be guaranteed by the producer. To this cost, it must be added the costs of installation and of energy supply. The device must be operated for the full period of a crop protection, 24 hours a day to be effective. The cost will depend on the energy costs due to the contracts with the energy provider, however, given the characteristics of the device, the energy consumption is comparable to that of a small light.

B) Open Field: In the field, a single mini-shaker can cover around 30-50m of row. Therefore, the planting density, the row length, the inter row distance and the shape of the field are important elements to calculate the number of mini-shakers in one orchard. One hectare of 100m x100m with and inter row of 2m would imply the use of at least 2 mini-shakers per row and then 100 devices/Ha which will cost 3000-5000€/Ha with an expected life of several years.

4.2.3.2 Environmental impact assessment

The usage of this prototype represents an innovative and environmentally sound alternative to Mineral Oils. Mineral Oils are one of the most used products against whiteflies, especially in organic farming. The use of mineral oils is seen as contentious by many consumers and stakeholders within the organic sector, due to their toxicity for the environment and because they come from non-renewable sources (Katsoulas et al., 2020). Furthermore, mineral oils have some important effects on the aquatic environment and on pollinators (European Food Safety Authority (EFSA), 2009). On the contrary, vibrations are chemical free, do not affect the environment and do not release noxious residuals. Vibrational signals do not involve the emission of radio waves or other types of waves and even the acoustic waves are minimal and not perceivable by humans and animals. Therefore, vibrations are transmitted in total silence and are barely perceivable by workers only when they touch the wires while they are not perceivable at all when they touch the plants. In addition, unlike chemicals, there is no regimentation at European level of the use of physical stimuli (semiophysicals) for pest control.

4.3 WP3. Replacement of contentious fertilizers and manures in plant production

4.3.1 Economic feasibility

The economic applicability of recycled fertilizers in organic farming was investigated with the use of a model for organic farms, which was created on the basis of linear programming and German data. This model was first used to simulate the use of recycled and conventional manures in different farm types under different fertilization scenarios. Furthermore, the on-farm utilization of the externally supplied nutrients nitrogen, phosphorus and potassium was investigated for three defined farm types with the help of the model. The farm types differ in respect to livestock (stockless vs. 40 milking dairy cows) and on what crops are cultivated (crop rotation based on cereal and legumes vs. crop rotation with root vegetables (potatoes and carrots)). Different fertilization scenarios were simulated. First a scenario without the use of external fertilizers was initially assumed. In the further scenarios, the use of conventional manures and recycled fertilizers was simulated. Among the recycled fertilizers were compost, digestate, sewage sludge, bone meal, and struvite available to replace the conventional manures (cattle manure, pig manure, chicken manure) and apatite. Both the conventional (except apatite) and recycled fertilizers were priced according to the prices of the pure nutrients. For the recycled fertilizers, the valuation price was also increased, thereby determining the maximum price at which use in organic farming would still occur.

The results show that recycled fertilizers can replace conventional manures at the same price valuation. However, a small contribution margin discount is associated with the fact that the recycled fertilizers bring less potassium and have to resort to the more expensive substitute patent potash. Among the recycled fertilizers, digestates from biogas plants and composts are preferably selected in all farm types, but more so in root crop farms, due to the potassium content. In contrast, struvites, which are primarily phosphorus fertilizers, are used to meet phosphorus needs even when prices are high in root crop rotations. Ultimately, from a purely economic perspective, the recycled fertilizer that can provide the nutrient most cheaply will be used. Whether the simple processes of anaerobic digestion and composting or the recovery processes of phosphorus from sewage sludge are more competitive depends on the production technology as well as regional market conditions. For phosphorus recovery technologies from sewage sludge, in particular, it remains to be seen how they will evolve and which process can recycle the nutrients most economically.

With a price for recycled fertilizers that also corresponds to a multiple of the valuation price, fertilization with recycled fertilizers and an associated increase in yield is still more favourable than abandonment in external fertilization. The on-farm recycling analyses also support the use of recycled fertilizers at high prices. The results show that on-farm utilization for the first available kilogram of off-farm phosphorus reaches a theoretical value of 673 € kg^{-1} P. For potassium, a lower but still high level of 80.7 € kg^{-1} K is reached and for nitrogen, the on-farm recovery is the lowest with a maximum of 13 € kg^{-1}. Thus, on-farm utilization for the first available external nutrients exceeds the market prices for nutrients from recycled fertilizers and an economic added value for organic farms can be created. Limiting yields due to a limited use of external fertilizers can therefore not be justified from an economic perspective and can only be attributed to a limited availability of external fertilizers. Approval of additional fertilizers is therefore necessary. In particular, sewage sludge and the fertilizers derived from it could contribute to a sustainable nutrient supply after approval for organic farming and at the same time increase the contribution margins in organic farming.

4.3.2 Environmental impact assessment

At farm level, we believe that RELACS recommendation has no environmnetal impact.

4.4 WP 4. Replacement of anthelmintics in livestock production

Two alternatives were considered

4.4.1 Heather grazing

4.4.1.1 Economic feasibility

Farmers participating in the heather trials did not identify any big economic impact associated to the use of heather as a parasite control measure. There were marginal costs increases, but they were not big enough to discourage them to continue testing heather use in the future. For example, there was a marginal increase in animal management costs associated to the time required to move the sheep to the heather patches, but it was not significant to assign a monetary value to it. For veterinary and medical costs, the only identified cost was the need for some tick control medication for sheep exposed to heather field, but the value was less than £0.92 per animal. Neither farmer identified any extra feeding or infrastructure costs. Regarding the performance of the animals, farmers did not observe increased or decreased economic benefits associated with heather. The management of heather itself did not result in additional costs, as farmers had available heather on-farm (and therefore did not need to source it or seed the area for the animals to have access to the product). These farmers did not really gain in labour costs when used heather for the animals, as they would not routinely burn heather for management as this did not align with their holistic management of the farm. If farmers engage in burning the heather to maintain it in its vegetative state, then having animals feeding on it would help saving on labour costs.

4.4.1.2 Environmental impact assessment

Farmers expressed the view that they did not have enough information to assess whether potential environmental impacts would be acceptable and would welcome further information about it. For example, they wondered whether burning heather (as is done for grouse management) would be required if the heather is being grazed and, if so, expressed they would worry about possible legal implications if the framework is not clear. They also raised concerns on the lack of information about the potential knock-on effects introducing heather on farm could have on local biodiversity and expressed their interest in studies that addressed this concern. Burning of heather is a practice utilised for gamebird and digital management, and although it is regulated there is a lot of discussion about its environmental impact; most farmers that are interested in alternatives and organic management are also very aware of their potential impact on the environment: https://www.heraldscotland.com/news/homenews/19617465.scots-ministers-climate-targets-at-risk-going-smokeunregulated-muirburn/. There were also questions on regulatory aspects for example, would it be legal to graze on heather if it is a conservation area.

4.4.2 Duddingtonia flagrans (DF)

4.4.2.1 Economic feasibility

The use of DF did not appear to have a large economic impact although when considered in relation to the use of heather more labour was needed (associated with the need to feed the animals daily). None of the farmers in the DF trials identified significant economic impacts that would discourage them from using DF to support their antiparasitic strategies. In general farmers identified an increase in costs associated with the labour and time requirements to ensure all sheep received their DF dose daily (around 10 minutes per animal for one of the farmers). The need to deliver the fungi daily also resulted in slight increases in feeding costs, as the fungi are usually delivered with concentrates. The extra costs ranged between £0.5/sheep and £2/sheep, which depending on the price of lamb sold, it could have an impact on the revenue around 0.6-2.5%. One of the farmers had to incur additional infrastructure costs, valued at £1/sheep. The farmers suggested that a slow-release product would overcome these issues. The farmers did not identify any savings in these operational items either. Finally, there were no penalties in body weight between control and treated animals, although in one case the animals that received the DF "had slightly better condition".

4.4.2.2 Environmental impact assessment

All stakeholders involved expressed concerns about the impact of DF on soil insects, such as dung beetle populations and other relevant insects on grazing pastures. This research has been done previously for DF and there is no significant effect of their use on any non- target organisms. As the information that DF does not affect non-target organisms is available, a good dissemination plan would help towards addressing these concerns.

4.5 WP 5. Replacement of antibiotics in livestock production

Two alternatives were considered.

4.5.1 Essential oils (Origanum and Litsea)

4.5.1.1 Economic feasibility

Through a series of farmers meetings, on-farm trials, and experience from groups of French farmers (Adage 35 and Fevec), a series of potential costs/expenses/additional workload was identified that could result from the use of these alternatives. It was considered that although the initial cost of EO may have been considered high, this can be reduced. We assessed the cost based on a purchase by the farmer in a pharmacy, in small quantities. If each farmer buys their own EOs, it is more expensive. If farmers organise a group order together with the vets, it would be less expensive. The cost of the antibiotic treatment is based on the main product used in France. With this product, in France the cost of an antibiotic treatment for mastitis control is around €18.1 whereas the cost of treatment with EOs is estimated around €8.1. The use of EO is cheaper, if the treatment is efficient, i.e. a single dose of EOs is adequate to control mastitis. This is currently evaluated in RELACS. As with other alternatives, the use of EOs should be considered as a tool to reduce the use of antibiotics, and not as a direct alternative to antibiotics.

4.5.1.2 Environmental impact assessment

The major benefit of using EOs for mastitis control is on reducing the impact of antibiotics on the environment (diffusion of antibiotics residues in manure), the human health and animal health and welfare. Antibiotic resistant pathogens are a major challenge in veterinary and human medicine and any measures to reduce their use will have a major beneficial impact on the environment. The main challenge for implementing EOs to replace antibiotics will be to educate veterinarians and farmers on the use EOs, and to clarify their regulatory status (MRL-Maximum Residue Limit, health plan, specific regulatory statuses for herbal plants, low Concern Natural substance/product).

4.5.2 Animal Health and Welfare Protocol (AHWP)

4.5.2.1 Economic feasibility

Data about health and welfare of dairy cows play different but highly important roles within the advisory as well as the scientific part of the RELACS-AHWP Protocol. The dataset comprises five parts: (1) Overall data of farm structure, (II) Milk recording data, fertility data, (III) Health and Treatment data, (IV) Health and Welfare data and (V) Farmer Field School (FFS) outcome data. Some of these datasets should already be available on each farm (I; III), while others need to be recorded additionally for the AHWP protocol depending on the farms' contracts with veterinarians and milk buyers or breeding organisations (II, III, IV). FFS (V) are based on groups of 5 to 7 farmers (one host and 4-6 advising guest farmers per meeting). A meeting comprised a farm walk and a structured indoor discussion including two problem areas pointed out by the host farmer and subsequent inputs from all participants and lasted about ½ day. Thus, FFS require an effort of about one day annually per farmer (plus preparation time for the host farmer) and about 2 days annually per FFS participating farm for the facilitator (preparation, participation, taking notes).

4.5.2.2 Environmental impact assessment

As for the essential oils, the major benefit is on reducing the impact of antibiotics on the environment (diffusion of antibiotics residues in manure), the human health and animal health and welfare. Antibiotic resistant pathogens are a major challenge in veterinary and human medicine and any measures to reduce their use will have a major beneficial impact on the environment. In contrast, essential oils cause no antimicrobial resistances and are 100% biodegradable in the environment.

4.6 WP 6. Replacement of synthetic vitamins in livestock production

4.6.1 Vitamin E

Based on a literature review, surveys of vitamin E status on organic dairy farms, experiments with vitamin E supplementation conducted within organic dairy farming systems, and the diet of major organic dairy farming types in Europe, RELACS has made a proposal for recommendation for dairy cows in organic dairy production. Organically managed cows and heifers should be supplemented during transition period, i.e. late gestation and early lactation. It is suggested that for dairy cows that are more than 30 days in lactation, where grazing pasture or grass clover silage is the main forage, no extra vitamin E supplementation is required. For grazing organically managed cows and heifers during the transition period, the supplementation can be reduced by about 50% relative to organic cows on conserved forages.

4.6.1.1 Economic feasibility

Where grazing pasture or grass clover silage is the main forage, RELACS recommendations of vitamin E supplementation are between 60 and 90% lower than the National Research Council 2001 and INRA 2018 recommendations when calculated over the whole production cycle, i.e. the period between one calving and the next. If other conserved forages are the main constituents of the diet, the RELACS recommendations are similar to the INRA 2018 and 45% lower than National Research Council 2001. Thus, the costs of vitamin E supplements should be reduced accordingly, both for farmers and feed industry.

4.6.1.2 Environmental impact assessment

At farm level, we believe that RELACS recommendation has no environmnetal impact.

4.6.2 Vitamin B2 (Riboflavin)

4.6.2.1 Economic feasibility

Riboflavin (vitamin B2) is an essential vitamin for all non-ruminants. Organic poultry feed must also contain riboflavin to avoid disturbances in energy metabolism, lipid oxidation protection, growth and neuronal control of the limbs. However, organic farming aims to minimise the use of artificial or isolated substances in animal feed. Furthermore, the ban on GMO-based substances requires GMO-free production lines for the microbiological production of riboflavin. Recently, a European GMO-free riboflavin product has replaced the former one, but at a significantly higher price. This is relevant because the high price of the current product is currently the most important hindrance for successful and broad application of GMO-free riboflavin components in European organic animal nutrition.

Against this background, riboflavin intake for organic poultry should be as low as possible, while not compromising animal health, welfare and productivity. The H2020 RELACS project developed experimental evidence for safe lower riboflavin intakes to organic poultry feed formulations. Broilers, layers and parents and their offspring were studied in separate approaches. For parents and for slow-growing broilers, a supplementation of 4.0 mg/kg proved to be a generally safe level, while for laying hens 3.0 mg/kg was sufficient. This confirms the safety of the riboflavin upper limit of the Bio-Suisse guidelines, which is very low in relation to the EU, and means a safe reduction of up to 50% for EU countries compared to previous formulations, which helps to substantially reduce the cost increase due to the GMO-free product. In addition, these studies confirm the full efficacy of the newly available GMO-free product.

A new wild-type, non-GMO microorganism overproducing riboflavin was identified via screening in order to provide an additional certified organic animal vitamin B2 supplement. The possibility of minimizing expensive media components was shown. Consequently, a fermentation strategy at laboratory scale was provided where a yield of 30 mg riboflavin per g dry matter of yeast cells was achieved, which is even more efficient than the production process used in the currently available GMO-free product. Thus, there is a tangible potential to developing a further riboflavin product for the European feed market, which would probably lead to decreasing prices.

4.6.2.2 Environmental impact assessment

At farm level, the RELACS recommendation has no environmental impact.

5. Conclusions

The RELACS project has shown that it should be possible to reduce the use of contentious inputs used in organic production, be it copper, mineral oils, fertilizers, antibiotics, anthelmintics or synthetic vitamins. However, a complete phase-out does not seem feasible, at least in the medium term.

The majority of the alternatives that were tested in RELACS may come at a higher cost but are much “greener” than the contentious inputs.

6. References

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