Deriving the True Value of Crop Farming

LIVING MANAGEMENT
CASE RSM

Executive Summary

Research question: *What are the most pressing issues for sustainable farming in the Netherlands, how do these affect creditors and how can we incorporate them to derive the true value of Dutch farms?*

Financial Value

There is a large incentive to move to organic farming from a financial perspective.

Integrated Value

All cases show an increase in integrated value when switching to organic farming.

Environmental Value

We find large environmental costs, even when merely considering the four most pressing environmental issues. These costs are not valued in traditional banking.

Policy Recommendations

More drastic measures and regulatory changes from the government and banks are required to circumvent huge environmental costs.

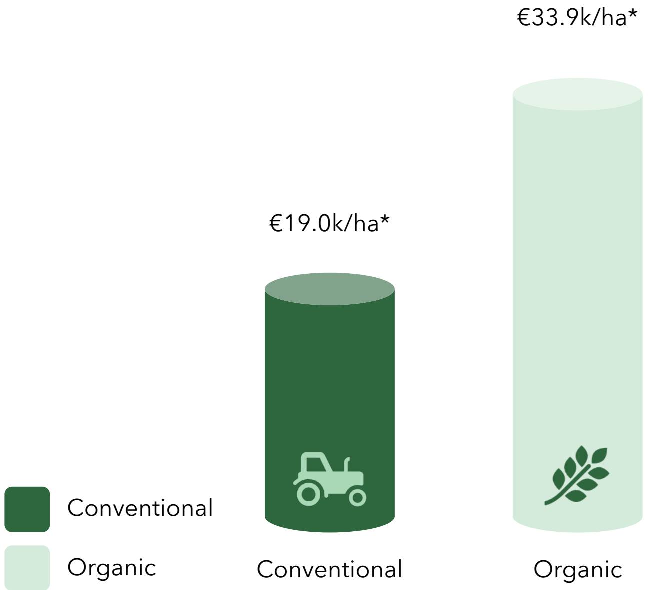
The Financial Factor

Financial Value – Overview

Value improvement of

x1.8

when moving from conventional to organic



The figure on the left shows the average financial value per ha for conventional and organic farming. The analysis indicates that the average value* increases by a factor of 1.8 from €19.0k to €33.9 per ha.

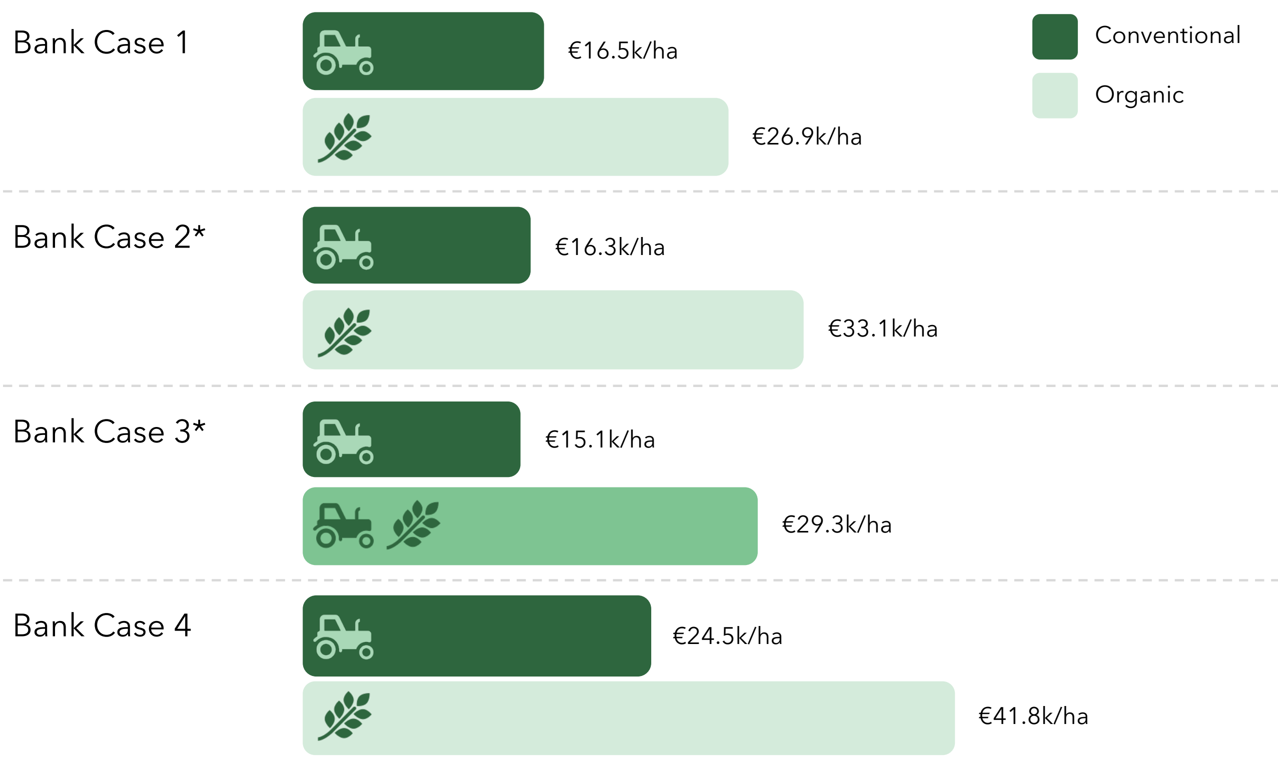
Switching from conventional to organic farming goes along with several changes in the financial items. First, revenues per ha increase significantly, which can be primarily attributed to higher prices charged for these products. Second, the cost of goods sold (COGS) of each crop increases. However, the change in COGS is relatively lower compared to the additional revenue generated per crop. Finally, operating costs decrease significantly for the organic farm.

From a financial perspective, it seems that the switch from conventional to organic farming leads to a more profitable utilization of the farmland. Although producing organic crops is more expensive, the additional revenue that the farm generates, due to higher prices, creates more value.

The average calculation excludes Bank Case 3, given that the farmer did not intent to switch entirely to organic farming but only appr. 50% of the operations.

Financial Value of Cases at Hand

Financial Value



Description

The value of organic farms is considerably higher than the value of conventional farms. From the analysis, it seems that the Bank Cases 1, 2 and 3 generate roughly similar values. Bank Case 4, however, is considerably more valuable. This difference can be primarily attributed to a better utilization of land and the farming of different crops.

Please note that the analysis of the different farms only includes the revenues generated by crops. All other revenue streams are disregarded.

The results from the analysis should be interpreted with caution. The growth rates from the Bank Case 2 are extrapolated and may significantly bias the other cases towards a more favorable value for organic farming.

**Bank Case 2 is the financed case, whereas Bank Case 3 is the not-financed one. Bank Case 3 transitions from conventional to a mix of conventional and organic.*

Underlying Assumptions

General Assumptions

The cases at hand are evaluated from a financial perspective to understand the difference in value between conventional and organic farming. The discounted cash flow method is applied to obtain the financial value. This model values the farms by forecasting and discounting the cash flows to arrive at a present value. Various assumptions are applied to the cases in order to determine the future cash flows. Bank Case 2 is the only case that forecasts revenues well into the future and distinguishes between the conventional and organic alternatives. The predictions in this case are used as guidance for the other cases:

1. The revenue growth rates from Bank Case 2 are extrapolated to the other three cases in order to forecast revenue. The growth rates are adjusted when necessary. Additionally, the growth rates include a one- to two-year hiatus for the organic alternative as the farm is adjusted and endures lower revenues as a result.
2. The operational costs from Bank Case 2 are extrapolated to the other three cases. These costs are adjusted when necessary. Additional costs incurred due to, for example, the lower use of pesticides have not been accounted for explicitly but are assumed to be implicitly taken into consideration due to the extrapolation stated above.
3. A conservative 2% long-run growth rate is applied.
4. A discount rate of approximately 5% is applied, which is a conventional discount rate for the agricultural sector.

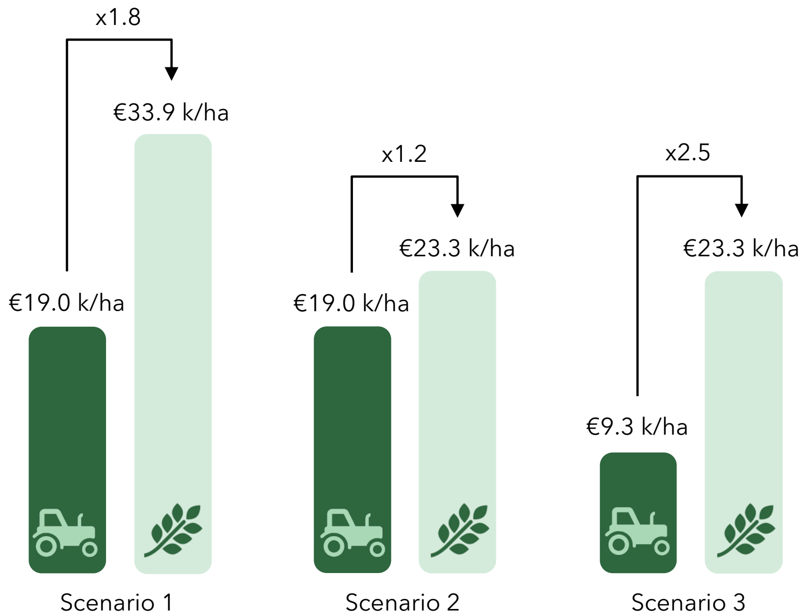
Caution! The calculation of the financial value of conventional farms assumes that the farmer will be able to grow the same amount of crops in perpetuity, which is highly optimistic given the degradation in soil quality and yield if farmers do not make the switch (see slide 9). The financial value calculation for organic farming assumes that the farmer can sell the entire yield at higher prices (organic products are commonly more expensive than conventional crops), meaning that there is no lacking demand and that the prices for these products do not decrease due to a demand and supply disequilibrium. The missing/low demand for organic products is one of the most constraining factors in the move towards organic farming.

Variability of Demand

Value improvement of

x1.2 - x2.5

when moving from conventional to organic



To illustrate the dependence of the financial value on consumer demand, the following three scenarios are quantified:

Scenario 1: The farmer can sell all organic products at higher prices as well as the conventional products at current market prices. Degradation of soil and the accompanying lower yield and hence, revenue in the long run, is ignored.
Scenario 2: The farmer cannot sell all organic products in the first years after the switch due to missing demand. We assume that 50% of all products can be sold after the two-year gap, where the demand is increased straight-line after that. No adjustments are made to the conventional case.
Scenario 3: The farmer cannot sell all organic products in the first years after the switch due to missing demand. We assume that 50% of all products can be sold after the two-year gap, where the demand is increased straight-line after that. Given the soil degradation due to conventional farming and the ensuing lower yield, the growth rate for conventional products is set to -1%.

The variability in the deltas demonstrates the large uncertainty in the quantification of the financial value. Despite this uncertainty, the deltas show the large economic benefits from incentivizing consumers to make more conscious purchasing decisions.

The Environmental Factors

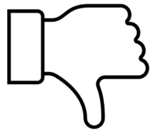
Explanation of the Environmental Factors

Biochemical Flows – Nitrogen & Phosphorous

Nitrogen (Chemical Element N) and Phosphorous (Chemical element P) are an essential nutrients for plant and animal growth.

Nitrogen and phosphorous are added to the soil through fertilizers to create optimal conditions for the crops to grow, thereby increase the productivity of a farm.

However, excess amounts of these essential nutrients can be washed away through rainfall and consequently leach into the groundwater.



The effect of unusually high nitrogen and phosphorous content in fresh water leads to excessive growth of certain plants and can thereby severely harm the biodiversity in lakes, streams or rivers.

Explanation of the Environmental Factors

Pesticides

Pesticides are important tool in agriculture to allow for high intensity farming with little loss to pests. The most common types of pesticides used in agriculture are insecticides (targeting insects), fungicides (targeting parasitic fungi and spores), herbicides (targeting weeds).

Pesticide residues and their metabolites are found in groundwater, surface waters and precipitation. That results in toxicity in the water and in the soils which harms biodiversity.

Additionally, the manufacturing of pesticides is an important factor through reinforcing the effects of climate change.

Greenhouse Gas (GHG) Emissions

Carbon dioxide (CO_2) is emitted through the use of fossil energy and through oxidation of soil organic matter.

Nitrous oxide (N_2O) is emitted during the storage and application of fertilizers and manures.
Direct N_2O is coupled to manure management, grazing, manure application, fertilizer use etc.
Indirect N_2O is associated with the production of inputs or N losses from faming systems (NO_3, NH_3 and NO_x).

Energy use and GHG emissions per ha in organic farming are often lower due to lower input use per ha. However, given the lower yields, there is a need to look at GHG emissions per unit product.

How do These Sustainability Issues Affect Creditors?

Current measures of the Dutch government to reduce the environmental footprint:

Nitrogen: €175 million transition fund to invest in sustainable farms, fodder with less protein and better fertilizer application. Limit of 504.4 million kg of nitrogen due to manure production.

Pesticides: Drain-water in greenhouses needs to be purified for at least 95% and requirements on quality of pesticide sprayers.

Phosphorus: Phosphorus rights determine how much manure a livestock farmer is allowed to produce. Limit of 172.9 million kg of phosphorus due to manure production.

GHGs: Carbon Tax of €30 per ton of CO2 for 2021 for the heavy industry. Increasing to €125 in 2030.

Scenario 1: The Dutch government makes no changes to current regulations.

Continuous degradation of the soil, lowering crop yields and thus, revenue and profitability of the farm in the long-run.

Scenario 2: The Dutch government increases the taxes for additives with negative environmental costs.

Additional costs that farmers face, which would decrease already thin margins quite dramatically.

Scenario 3: The Dutch government bans all additives with negative environmental costs.

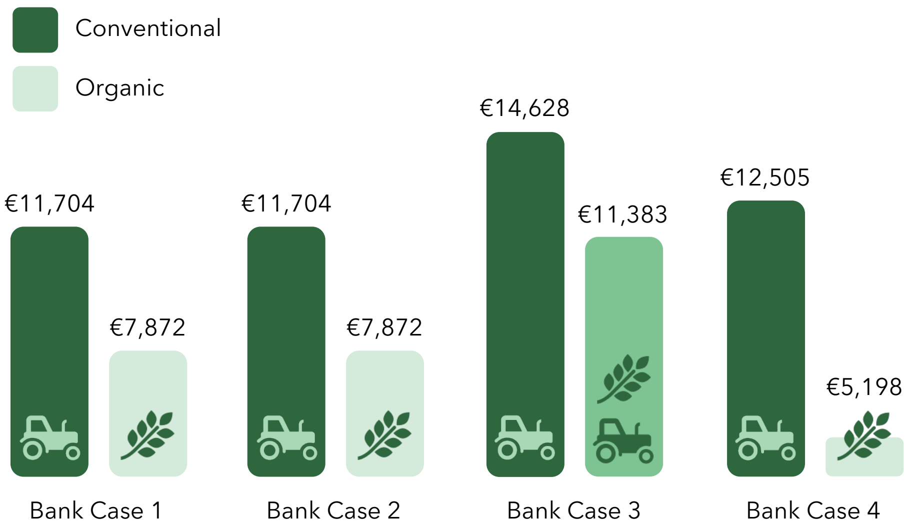
Lower crop yields per ha, implying that farmers will drastically reduce their profitability, given that a large fraction of the costs would still be incurred.

Direct effects on the farmer’s ability to service debt payments and hence, on the riskiness of the loan.

Environmental Value – Overview

41.31% *decrease in environmental costs*

€4,991 *per ha in environmental costs saved*



The figure shows the environmental costs per ha of arable land. The analysis shows that, on average*, environmental costs are decreased by 41.31% when switching from conventional to organic farming. Put differently, environmental costs of €4,991 per ha of arable land would, on average, be saved by helping Dutch farmers to switch to organic farming. A large fraction of this reduction is attributable to the dramatic decrease in the use of pesticides and lower GHG emissions. This comparison illustrates the dramatic effect that a switch to organic farming can have on the environment.

The large dissimilarity between Bank Case 4 and all other cases comes from the crops planted by the respective farmer. For example, the former does not plant wheat, which has one of the highest GHG emissions that do not significantly drop once the farmer switches to organic. In contrast, the farmer uses large parts of his land for potatoes, which produce very low GHG emissions once switched to organic farming.

**The average calculation excludes Bank Case 3, given that the farmer did not intent to switch entirely to organic farming but only appr. 50% of the operations.*

Environmental Value – Bank Case 1

Nitrogen: €94,596
Phosphorous: €18,794
Pesticides: €6,375
GHGs: €758,019

Total environmental costs: €877,783

Environmental costs conventional farming

Environmental costs organic farming

Nitrogen: €65,271
Phosphorous: €18,606
Pesticides: €1,022
GHGs: €505,468

Total environmental costs: €590,367

Total emissions saved: €287,417
Emissions saved per ha: €3,832 (-32.74%)

Environmental Value – Bank Case 2

Nitrogen: €78,199
Phosphorous: €15,537
Pesticides: €5,270
GHGs: €626,629

Total environmental costs: €725,634

Environmental costs conventional farming

Environmental costs organic farming

Nitrogen: €53,958
Phosphorous: €15,381
Pesticides: €844
GHGs: €417,853

Total environmental costs: €488,037

Total emissions saved: €237,598
Emissions saved per ha: €3,832 (-32.74%)

Environmental Value – Bank Case 3

Nitrogen: €84,171
Phosphorous: €18,356
Pesticides: €6,226
GHGs: €962,727

Total environmental costs: €1,071,480

Environmental costs conventional farming

Environmental costs conventional & organic farming*

Nitrogen: €113,828
Phosphorous: €29,746
Pesticides: €4,780
GHGs: €1,209,598

Total environmental costs: €1,357,951

Total emissions saved: N/A
Emissions saved per ha: €3,245 (-22.18%)

**The farmer attempts to keep the original land conventional and to buy additional land, which would be planted organically. Thus, the environmental value shown is partly conventional and partly organic. This case illustrates that even a partial switch to organic would already make a large difference in terms of environmental costs.*

Environmental Value – Bank Case 4

Environmental costs conventional farming

Nitrogen: €52,010
Phosphorous: €10,525
Pesticides: €3,570
GHGs: €459,113

Total environmental costs: €525,217

Environmental costs organic farming

Nitrogen: €35,887
Phosphorous: €10,419
Pesticides: €572
GHGs: €171,421

Total environmental costs: €218,299

Total emissions saved: €306,918
Emissions saved per ha: €7,308 (-58.44%)

Measurement and Assumptions

General Assumptions

The majority of the environmental pricing is based on estimates per ha of crop planted. Thus, we distinguish between the different crops planted (per ha) by the respective farmer. If not specified within the cases, we estimate the proportion of the total field (in ha) dedicated to the different crops based on the proportional revenue attained from these crops. For example, if 20% of the revenues are attained from wheat, we assume 20% of the total field to be planted with this crop. While this is a highly simplistic assumption, it aids in making a first distinction on the usage of the land. When the crops are too variable throughout the projection period or no information on revenue per crop is available, we do not distinguish between crops but use the total size of the field and average yield estimates.

The calculations assume that the farmer would make no future changes to his operations as the emissions are valued in perpetuity.

Measurement and Assumptions

Biochemical Flows - Nitrogen

Based on a three-year average, we assume 121.67 kg Nitrogen surplus per ha of crop land.

The percentage of Nitrogen that is leached from the surplus is assumed to amount to 10%.

When moving to organic farming, the amount of Nitrogen leached is assumed to decrease by 31%.

Steps to monetize Nitrogen leaching:

1. Based on the prior assumptions, we calculate the average Nitrogen leaching, given the size of the crop land.
2. Where applicable, we adjust the amount of Nitrogen leaching based on the crops that are grown.
3. To illustrate the difference between conventional and organic farming, we decrease the estimates from Step 2 by 31%. The results show the Nitrogen leaching, assuming the farmer has moved to organic farming. Where applicable, we adjust for the difference in leaching coming from a change in crops grown once moved to organic.
4. Nitrogen leaching is monetized using the following price:

   CE Delft pricing (in € per kg of pollutant): €3.11

Measurement and Assumptions

Biochemical Flows - Phosphorous

We assume 21 kg Phosphorous surplus per ha of crop land.

The percentage of Phosphorous that is leached from the surplus is assumed to amount to 9.65%.

When moving to organic farming, the amount of Phosphorous leached is assumed to decrease by 1%.

Steps to monetize Phosphorous leaching:

1. Based on the prior assumptions, we calculate the average Phosphorous leaching, given the size of the crop land.
2. To illustrate the difference between conventional and organic farming, we decrease the estimates from Step 1 by 1%. The results show the Phosphorous leaching, assuming the farmer has moved to organic farming.
3. Phosphorous leaching is monetized using the following price:

   CE Delft pricing (in € per kg of pollutant): €3.71

Measurement and Assumptions

Pesticides

We measure the impact of Pesticides on the environment in the context of global warming. The impact is expressed as an equivalent in kilogram of CO_2 (eCO_2) emissions per ha of crop land and includes the effect of toxicity as well as effects of the production processes.

The equivalent of CO_2 emissions depends on the different systems of crops and ranges from 3 kg eCO_2 for cereal or 9 kg CO2e for legumes to 58kg for vegetables.

When moving to organic farming, the amount of pesticides used is reduced but the extent also depends on the crop type. While cereal and legumes effectively reduce their use of environmentally harmful pesticides to 0, vegetables need about 80% less pesticides.

Steps to monetize the impact of Pesticides:

1. The average area per farm used for the different crop types as well as the change in the share of the crops from switching to organic production is calculated.
2. Based on the share of the crop types and the arable area, the eCO_2 per farm can be imputed.
3. The CO_2 equivalents for the pesticides use are monetized using the following price:

   CE Delft pricing (in € per kg of pollutant): €0.06

   This price is very conservative, especially considering the true prices required to achieve the 2°C goal.

Measurement and Assumptions

Greenhouse Gas (GHG) Emissions

The measurement ignores energy use and emissions downstream the value chain (e.g., CO_2 emissions associated with transportation of the goods to the final point of sale).

GHG emissions include direct and indirect CO_2 as well as N_2O emissions – all in CO_2 equivalents per crop.

Steps undertaken to estimate the value of GHG emissions for conventional and organic farming separately:

1. Given the size of the field dedicated to each crop (see general assumptions), we determine the yield per crop. Whenever the distinction on a per-crop-basis is not feasible, we use the average yield per ha of Dutch crop land, amounting to 44.33 tons and 27.29 tons per ha for conventional and organic farming, respectively.
2. Using the data from Step 1, we derive the GHG emissions per ha of farmland. When estimates per crop are not available, we use the average CO_2 equivalent of 120.00 and 130.00 kg CO_2 per ton of conventional and organic crop, respectively.
3. The GHG emissions are monetized using the following price:

   CE Delft pricing (in € per kg of pollutant): €0.06

   This price is very conservative, especially considering the true prices required to achieve the 2°C goal.

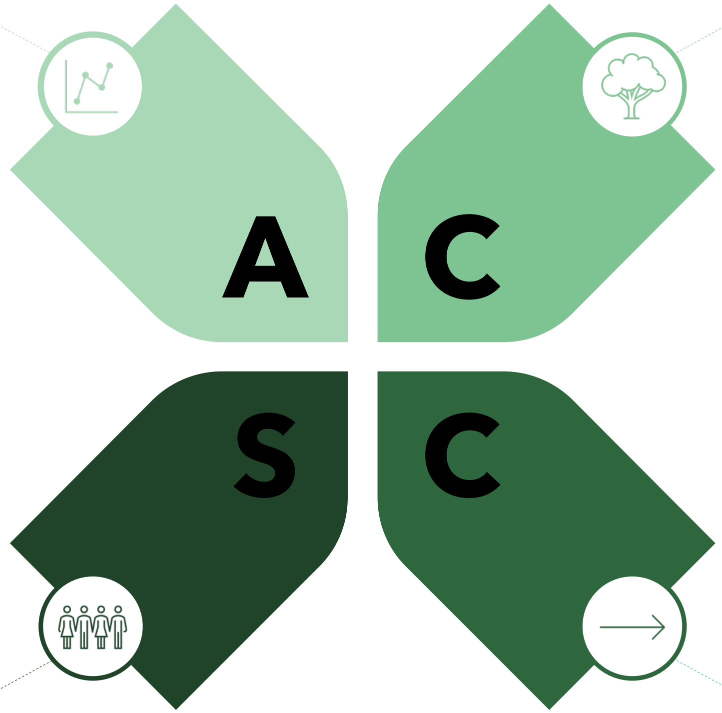
Methodological Limitations

Averages

The environmental value has been calculated on the basis of average emissions per crop in the Netherlands. Differences due to, for example, geography, soil and weather conditions have not been taken into consideration.

Carbon Capture

Many Dutch farmers are attempting to counterbalance their negative environmental impact through carbon capture. This has not been taken into account, given the limited information on the farmers themselves.



While being secondary factors, social sustainability factors may be taken into account in a more comprehensive study.

Social Impact

The calculations presume emissions to be constant throughout time once the farmer has made the switch to organic farming.

Constant Emissions


Integrated Value

Integrated Value Measurement

The integrated value calculations are derived by means of weighted summing, following:

$$\text{Integrated value} = \text{Financial value} + \beta \times \text{Social value} + \gamma \times \text{Environmental value}$$

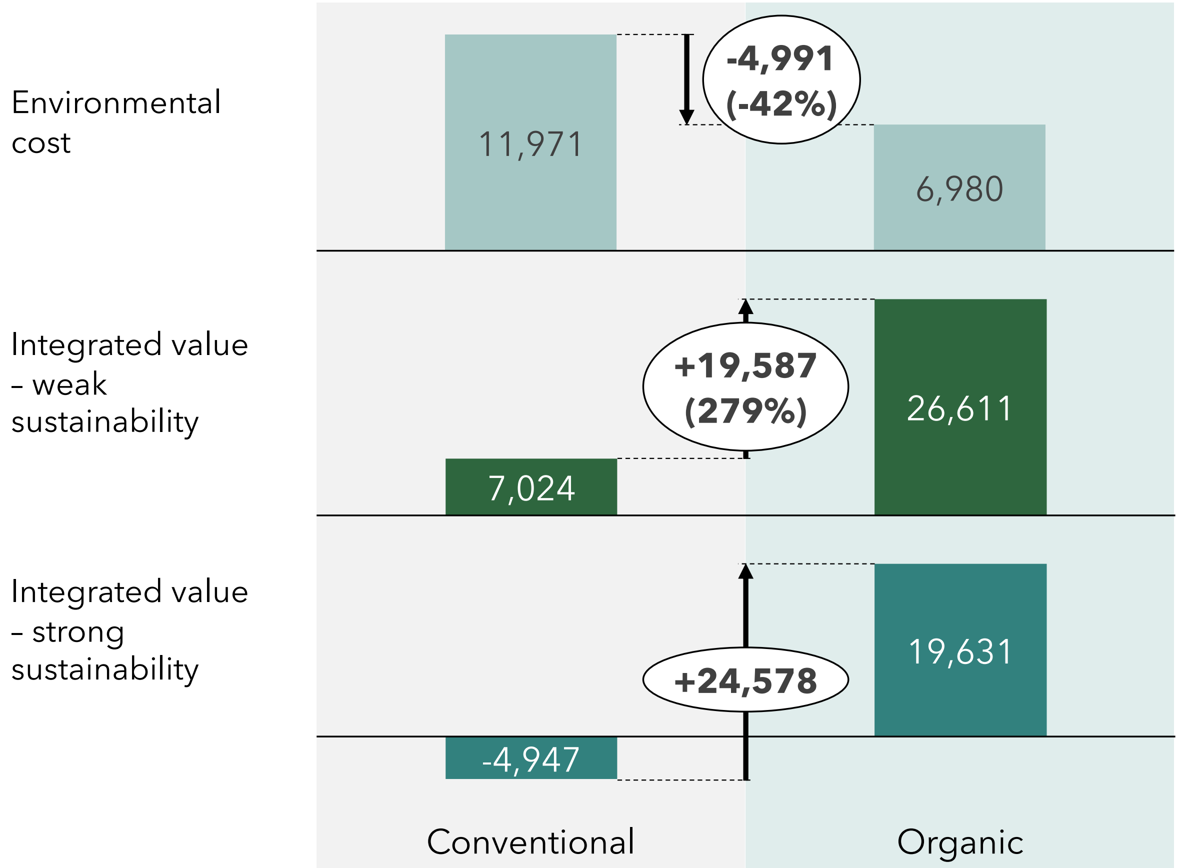
Given that we solely consider environmental factors, the integrated value calculation reduces to:

$$\text{Integrated value} = \text{Financial value} + \gamma \times \text{Environmental value}$$

In the following we will show the integrated value on a case-by-case basis. We show the integrated value with respect to weak sustainability which requires a weighting factor of γ equal to 1. Also, we depict the integrated value of the farms at hand considering "strong sustainability*", where we apply a weighting factor of γ equal to 2.

**Caution! This calculation is not strong sustainability per se. Strong sustainability requires social, environmental as well as financial factors to be positive. Here, the environmental factor is always negative, given that this study solely focuses on environmental costs.*

Integrated Value – Summary



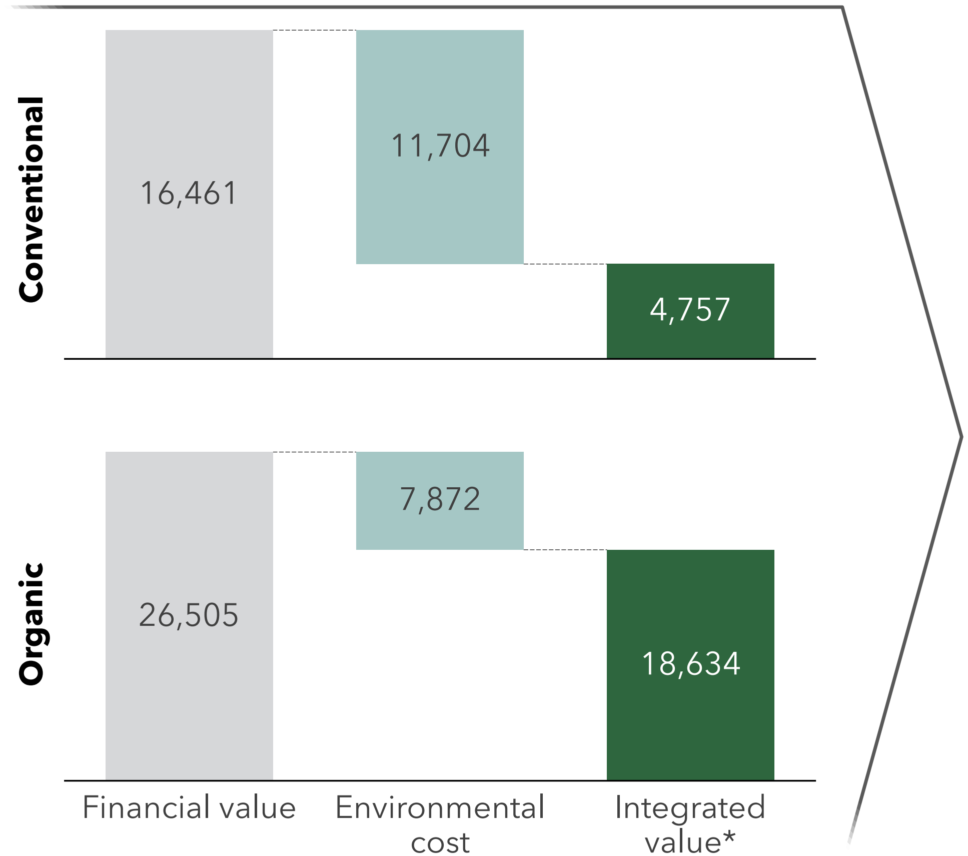
Average impact from switching to organic farming* per ha (in EUR):

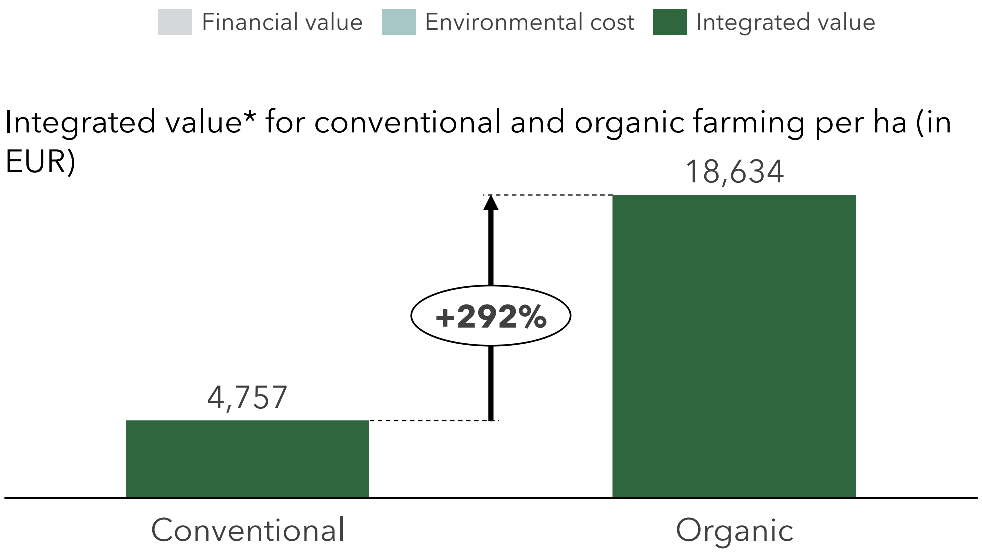
- The switch to organic farming reduces the environmental cost, on average, by 42% (4,991 EUR) per ha.
- On average, the integrated value with weak sustainability more than triples from switching to organic farming.
- With strong sustainability, the conventional farms are, on average, value destroying and hence, the switch is even more impactful.

*The average calculation excludes Bank Case 3, given that the farmer did not intent to switch entirely to organic farming but only appr. 50% of the operations.

Integrated Value – Bank Case 1

Impact of environmental costs per ha (in EUR)



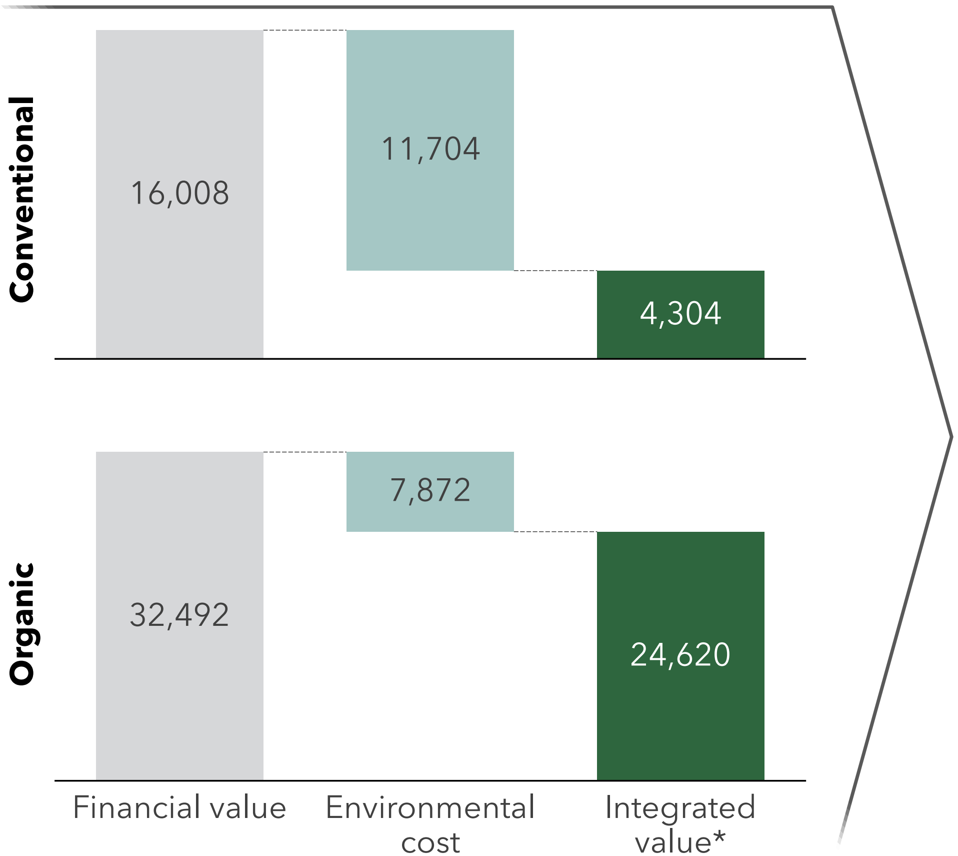


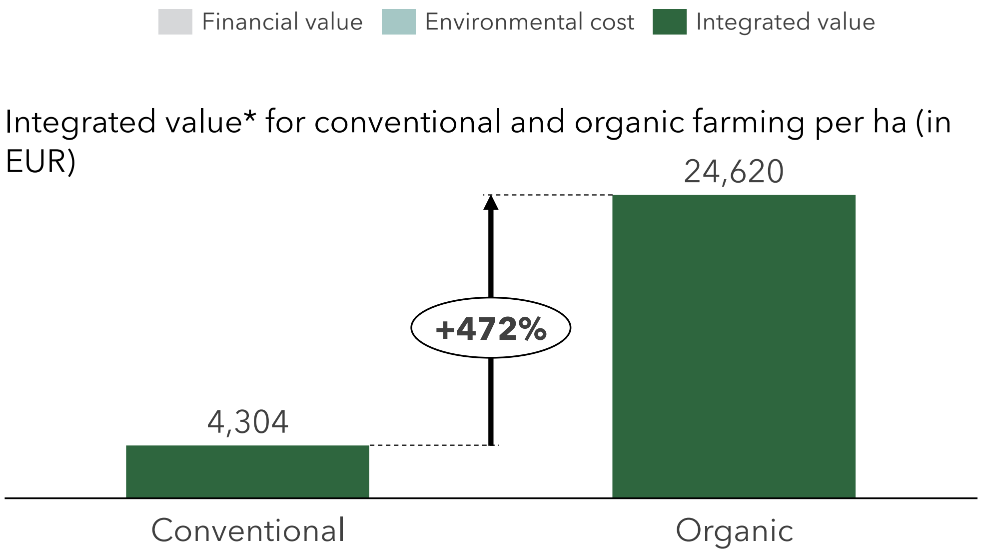
- The switch to organic farming reduces the environmental cost by 3,832 EUR (-33%) per ha.
- The switch increases the integrated value by 13,876 EUR (+292%) per ha.

*Weak sustainability is shown for the integrated value.

Integrated Value – Bank Case 2

Impact of environmental costs per ha (in EUR)



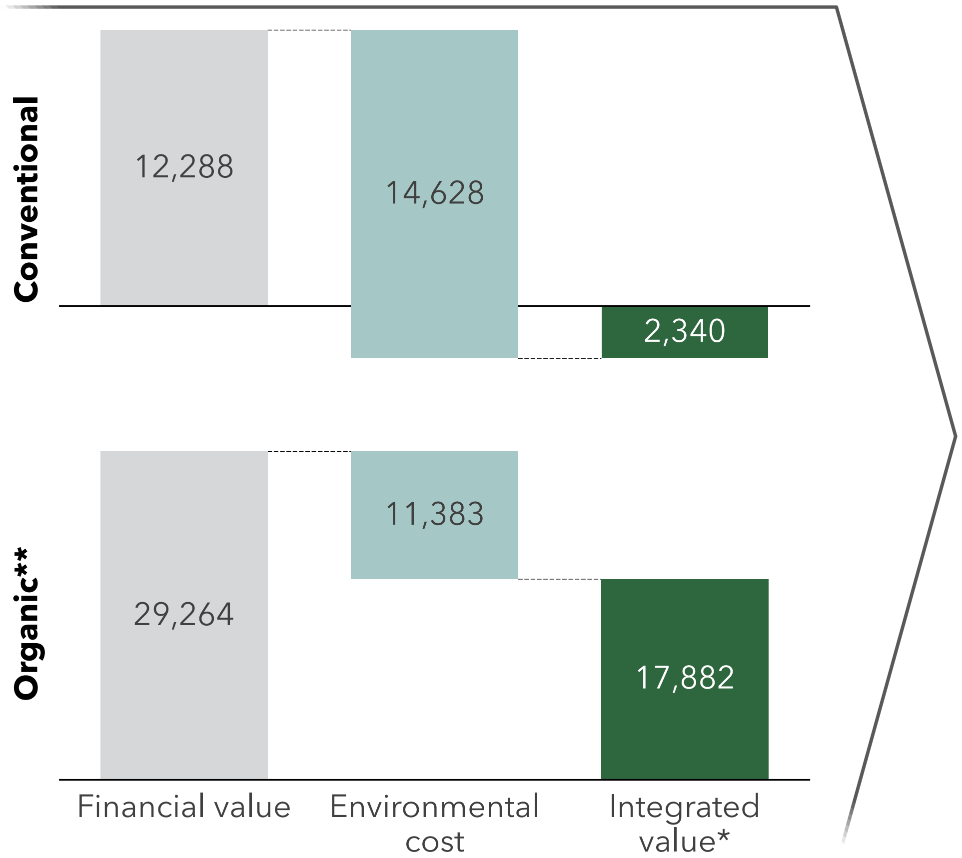


- The switch to organic farming reduces the environmental cost by 3,832 EUR (-33%) per ha.
- The switch increases the integrated value by 20,316 EUR (+472%) per ha.

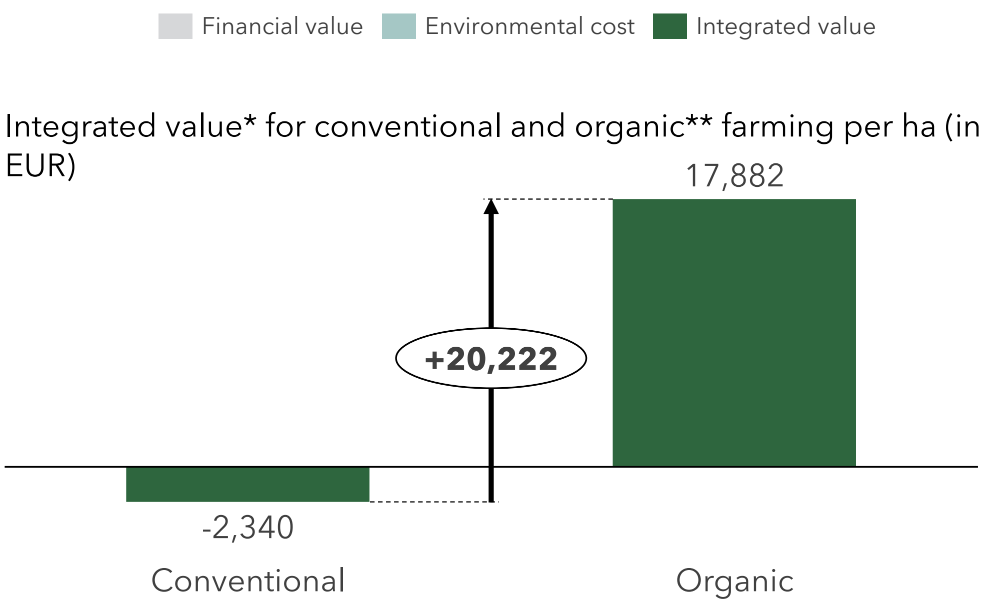
*Weak sustainability is shown for the integrated value.

Integrated Value – Bank Case 3

Impact of environmental costs per ha (in EUR)



Integrated value* for conventional and organic** farming per ha (in EUR)

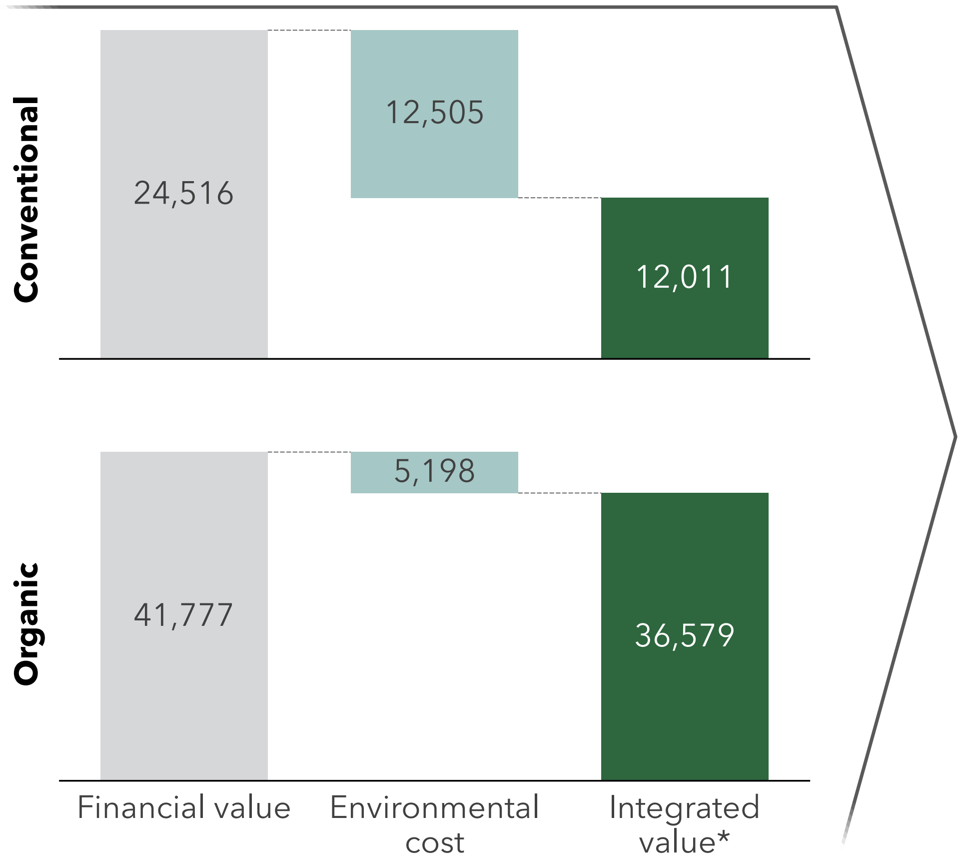


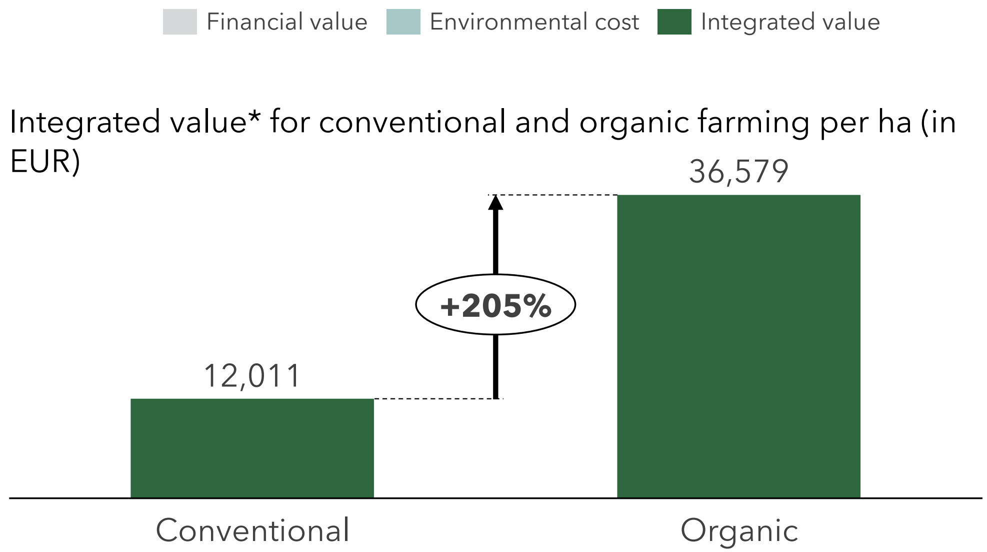
- The switch to organic farming increases the environmental cost by 3,245 EUR (- 22%) per ha.
- The switch increases the integrated value by 20,222 EUR per ha.

*Weak sustainability is shown for the integrated value.
** Switch to organic is only partial for this farm as approximately half of the arable area is cultivated conventionally.

Integrated Value – Bank Case 4

Impact of environmental costs per ha (in EUR)





- The switch to organic farming reduces the environmental cost by 7,308 EUR (- 58%) per ha.
- The switch increases the integrated value by 24,569 EUR (+205%) per ha.

*Weak sustainability is shown for the integrated value.


Sensitivities
&
Policy Recommendations

Sensitivities

Financial Value

The **long-term growth rate** is set to 2%.

Given the continuous soil degradation if the farmer does not make the switch to organic farming, it is quite reasonable to assume that the farmer's ground will, at some point, no longer yield products that are viable to sell. The effect shown above might be even stronger if one were to account for this fact.

Financial Value

Immediate **demand for organic products**.

The demand for organic products is assumed to be immediately present once the farmer switches to organic (- after the two-year gap). This is highly optimistic, given that the lack in demand is potentially one of the largest restraining factors for organic farming.

Financial Value

The **increase in costs** per farmer.

Additional costs due to, for example, lower use in pesticides are only accounted for implicitly. Also, farmers prove to be highly heterogenous in efficiency and hence cost structure. A more detailed analysis would be required that accounts for specificities of each farmer.

Sensitivities

Financial Value

The **discount rate** for the free cash flows is set to approximately 5%.

A constant discount rate across cases and time is simplistic due to demand issues and long-term risks if farmers do not make the switch to organic farming.

Environmental Value

The **field (in ha)** assumed to be attributed to the respective crops.

Given the large differences in environmental impact per crop, the environmental costs will be dramatically different once this parameter is changed.

Environmental Value

The **discount rate** is set to 3%.

Given that all environmental costs are valued in perpetuity, the discount rate largely impacts the environmental value obtained.

Policy Recommendations – Banks

Step 1

Repayment Schedule & Liquidity Ratios

Internal loan procedures must allow farmers to start paying interest on the debt two years after the taking out the loan, without any effect on financing costs. The investigation of liquidity ratios should factor this in as well.

Step 2

Integrated Value

The banks need to set a minimum target for integrated value that should be achieved by each client. Any project falling below this threshold after the loan and the respective structural changes should not be financed.

Step 3

Environmental Value

When financing the switch from conventional to organic farming, the banks should set a separate threshold for the decrease in environmental impact (e.g., 30%-40%).

Step 4

Incentives for Farmers

The banks should provide incentives for the farmers to further reduce their environmental impact. Loans and the respective financing costs should always be coupled with environmental targets.

Policy Recommendations – The Dutch Government

Step 1

Impact Definition

To further the reduction of environmental impact, the Dutch government firstly has to exactly define the environmental impacts and determine a price for these factors. This will allow for a common ground in evaluations across banks.

Step 2

True Pricing of Products

The Dutch government should require true pricing of all products. This will counteract the demand gap for organic products, surge the transition to organic farming and therefore, save many emissions. While subsidies and taxes would be a first step to incentivize the switch at the supply side, the impact of an increasing demand for organic products – given that their true price will be lower – will be much more forceful.

Step 3

Incentives for Banks

The Dutch government needs to adjust its supervisory mechanisms for banks that allow for the transition to organic farming. For instance, banks should be allowed to carry a lower capital charge with respect to these loans in order to make such investments more attractive.

Step 4

Banking Requirements

Banks should always be required to make an integrated value analysis. Each bank should have a maximum of environmental cost that can be incurred due to their financing activities. While being administratively burdensome (e.g., through integrated reporting), it is necessary to change the mindsets at each bank.

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