

Manual INTACT 1.0

INTERACTIVE AGROFORESTRY
COST-BENEFIT ANALYSIS TOOL



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PREFACE

This manual is intended to offer guidance for people who want to use the **INTERactive Agroforestry Cost-benefit Tool (INTACT)** version 1.0. In this manual, we zoom in on each step of INTACT by providing the objective, information requested by the user, background information, and Web tool Tips.

INTACT is part of the knowledge exchange platform "Agroforestry Planner," which is made up of several decision support tools. The information on which these tools are based is made available in the form of factsheets through the [Kennislloket](#) (Knowledge hub). From INTACT, you are therefore often referred to corresponding background information such as factsheets, reports, or other tools.

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INTRODUCTION TO INTACT

WHAT IS INTACT?

INTACT (**INT**eractive **Agroforestry Cost-benefit Tool**) is a dynamic decision support tool that allows you to interactively estimate costs and benefits for the trees and shrubs in your agroforestry project. Costs and benefits related to the crop and animal component are not adopted in INTACT.

You can access INTACT here: [Agroforestry Planner](#).

INTACT'S STRUCTURE

- INTACT consists of four modules (Figure 1). The user starts by filling out information about the plot and hourly wages which are needed for performing the calculations correctly. After this step is taken, INTACT makes sure that the user flows to the next module i.e. Part I Costs.
- The Cost module (Part I) guides the user to calculate costs step-by-step. These steps include costs related to: 1) Purchase of trees and shrubs, 2) Planting, 3) Protection from livestock and wildlife, 4) Management, and 5) Harvesting of nuts, and/or fruit. Together, these 5 steps flow into an indicative overview of the total expected cost of planting and managing the trees in an agroforestry system.
- The Benefits module (Part II) covers the expected fruit and nut yield of the trees and shrubs which were chosen in step 'Plant purchase'. Wood yield is covered on a separate screen.
- After you have gone through both the choices for costs and benefits, you arrive at Part III. This is where a cost-benefit analysis, based on your input for your agroforestry plot, is made. In this final step, a summary report is also generated, showing both the total overview of the costs and the cost-benefit analysis for a 20-year timeline.

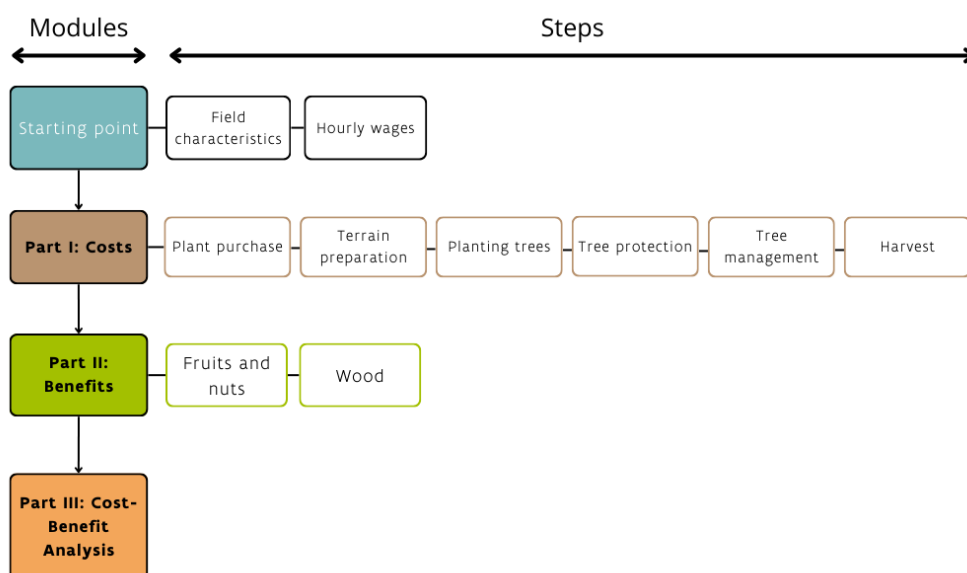


Figure 1. INTACT's structure is visualized by modules and steps. The user is guided through four different modules: 1) Starting point, 2) Costs, 3) Benefits, and 4) Cost-benefit analysis. Within the first three modules, steps are added for which information input from the user is requested. Module 4 marks the end of INTACT.



ASSUMPTIONS FOR INTACT 1.0

- Tree-crop and tree-animal interactions affecting tree yield are not considered. Positive side effects, such as natural pest control or nutrient recycling, are also not taken into account.
- INTACT was initially built to perform a cost-benefit analysis of an alley cropping system. Therefore, the user is asked to enter the number of tree rows. It is possible to calculate costs and benefits for other tree spatial arrangements (e.g. boundary planting, regular spread of trees, riparian buffer strips). The most important thing is that the surface underneath the trees is calculated well, so INTACT can calculate planting costs accordingly.
- Pricing for planting materials is based on tree nursery catalogues from 2023.
- The surface area of the plot is used to calculate the number of trees per hectare. This is useful information concerning subsidy applications.
- The surface area of the tree rows (i.e. tree strips) is used for calculations related to terrain modifications or other planting activities, e.g. deep ploughing or applying mulch. This distinction was made because, for example, activities such as deep ploughing only need to be applied to the tree area and not to the entire field.
- Labour time (time needed to complete a specific task such as mulching) is based on figures from Normenboek KWIN NL_2020 (WUR). This book adopts a standard hourly wage of 38 euros but this is not the case for INTACT: the user can select multiple hourly wages in INTACT. To solve this, the time needed to complete an activity (e.g. mulching) was taken in the model. The time needed for an activity is not automatically multiplied by 38 euros/h in INTACT but by using the user's hourly wage.
- Machine costs are based on the figures from Normenboek KWIN NL_2020 (WUR), but an adjustment of those figures was necessary each time to take out the labour costs here, as these are budgeted separately in INTACT (see previous point). Specifically when machines are used for a particular task, e.g. ploughing, the total costs (labour plus machinery costs to complete a task) were corrected by subtracting the labour cost from this. For example: an activity has a total cost of €100 and it takes two hours to complete it by a contractor who has an hourly wage of €38. Then, INTACT takes into account: $€100 - (2 \text{ h} * 38 \text{ €/h}) = €24$ for net machinery costs.
- INTACT calculates labour for terrain modifications based on an average reflecting three soil types (sand, loam, clay) from the Normenboek KWIN NL_2020 (WUR). At the moment, it is not possible to let the user choose a soil type to adapt the calculations.
- INTACT calculates fruit and nut yield linearly based on 1) the year at which maximum production of a certain species is reached, and 2) applying the "40-60-80-100% rule". This rule is a simplification of reality implying that yield linearly increases to the year at which the tree has reached its maximum production (peak year) and afterward the yield is constant. The other three percentages are used to calculate the yield in the three previous years before the peak year was reached. For example, if a tree species reaches its maximum production at year 10 (peak year), it matches 100% of the production (kg/y). The other percentages - 40%, 60%, and 80% - are linked to respectively 3, 2, and 1 year before the peak year. This means that at year 7 the yield is 40% of the maximum production, at year 8 the yield is 60% of the maximum production, and at year 9 the yield is 80% of the maximum production (kg/y at year 10). The maximum production (100%) will be applied from the first peak year until the end of the timeline (from year 10 until year 20 in this case). Note that the peak year is species-dependent which could be disadvantageous for certain trees (e.g. sugar maple) in a timeline of 20 years. Another point of discussion is that yields for slow-growing trees should be more gradually increasing than the 40-60-80-100% rule,



whereas this could be the opposite for fast-growing trees. We average this out by applying the 40-60-80-100% rule to all species. According to the AFP model (Marco Bijl), calculating tree yields by applying this rule is assumed to be close to reality.

- Benefits considered are freshly harvested fruits and nuts. Processed fruits and nuts are not included in INTACT 1.0.
- To understand how much wood can be produced after 20 years, wood yield is shown in a separate table at the final step. However, wood yield is not taken into account in the calculation of the cost-benefit analysis. The reason for this is that the financial value of wood yield is very volatile and we have yet to work out a more reliable methodology for this. We will improve the step for calculating wood yield for INTACT 2.0.
- We assume that the user completes the steps as accurately as possible to get a realistic estimate of the costs and benefits of his scenario. We advise the user to consult this manual if more background information and web tool tips are desired.
- Besides developing the interactive tool INTACT 1.0, ILVO developed a number of cost-benefit fact sheets for specific agroforestry systems and scenarios. For each of these factsheets (e.g. **Hazelnuts combined with laying hens; Walnuts combined with dairy cows; Food forests**), a separate calculation model was developed. Although key figures have been exchanged here and there, there is no 1-to-1 connection between the calculations in INTACT and those in the factsheets. The Food Forests Fact Sheet is largely based on input from food forest farmers, but to a small extent also on INTACT. For the other two fact sheets, only key figures were exchanged between the fact sheets' calculation models and INTACT.

DISCLAIMER

The figures used in INTACT are variable, and inflation-sensitive, depending on the context used and the availability of reliable information. As a user of INTACT, you are, therefore, also responsible for filling in realistic figures and are encouraged to adjust the values (e.g. selling price for fruit) of INTACT if you have found more recent data or if you already know the values for your scenario, so that a logical output can be generated. This is the strength of the interactivity in this tool.

Keep in mind that your input directly influences INTACT's output: INTACT generates an outcome that summarizes and visualizes all your choices. Therefore, the outcome of INTACT should be interpreted as directional but not binding advice. The outcome is thus only a supplement to, but not a substitute for, tailored advice and guidance for specific business and environmental situations.

The partners of the Consortium Agroforestry Flanders are not responsible for any consequences related to choices made through INTACT. With reactions, questions, or concerns regarding INTACT you can always contact us at info@agroforestryvlaanderen.be.



HELP BUTTONS IN THE WEB TOOL

Several help buttons have been added to the web tool. Click on the following icons for help and/or additional information:



In the right corner, you can click on this icon to read more about the meaning of this page and what input is required from the steps you need to take.



In the green text boxes, you can click on this icon which activates a pop-up with an explanation about the mentioned parameter. In the grey text boxes, you can enter values. You should use a period and not a comma for decimals.

Click here!

When you see this button, you can click on it to activate a pop-up that shows helpful images and/or tips.



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STEP 1. GENERAL INFORMATION

The objective of the step *General Information* is to collect information about the plot where you plan to plant trees, and labour.

INFORMATION REQUIRED FROM USER

- Surface area (ha)
- Number of trees present
- Length and width of the tree rows or tree strips (m)
- Hourly wage for technical staff, seasonal workers, and your own labour (€/h)

BACKGROUND INFORMATION

It is important to distinguish the surface area of the plot (field level) and the surface area of the tree rows. The first step in INTACT is, therefore, to enter general information about your plot including 1) the surface of your plot, and 2) information about the tree rows (the length, width, and number of tree rows). Figure 2 visually supports distinguishing the surface area of the plot and of the tree rows.

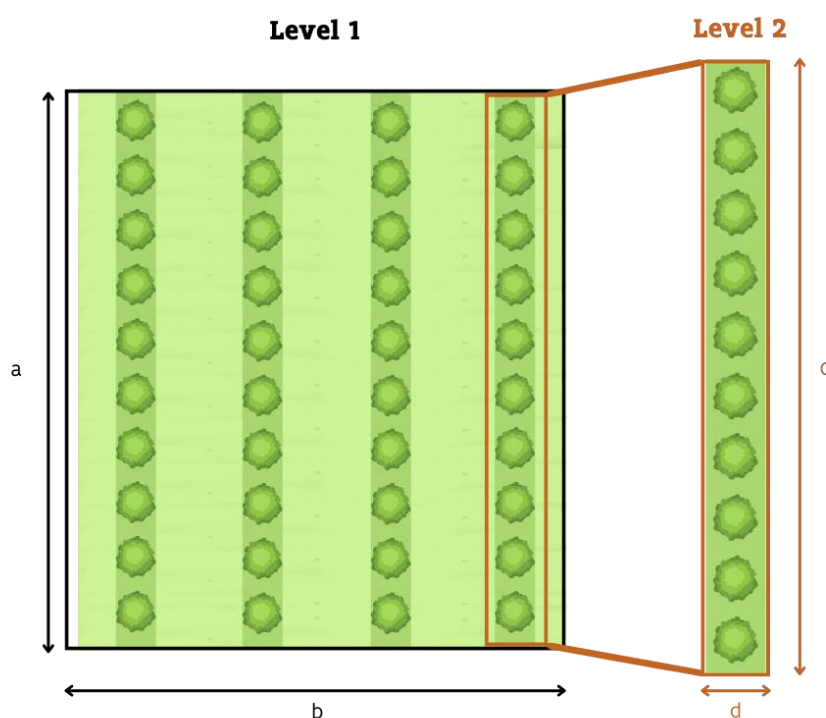


Figure 2. This illustration was created to distinguish the surface of the field and the surface of the tree rows. Level 1: Field with four tree rows, Level 2: one tree row, a: field length (m), b: field width (m), c: tree row length (m), d: tree row width (m).

By entering information about the tree rows, INTACT will automatically calculate the surface area of the tree rows.

- The surface area of the plot is used to calculate the number of trees per hectare;
- The surface area of the tree rows, or tree strips, is used for calculations related to terrain modifications or other planting activities, e.g. deep ploughing or mowing the tree row.



On this screen, you also enter the hourly wage you assign to technical staff, seasonal workers and your labour. On the following cost screens, you can choose to outsource labour, or you indicate whether there is 'own labour' or 'external labour'. INTACT then automatically links the correct hourly rate to your choice. In the case of external labour, a pre-calculated hourly rate including 20% overhead of 38 euro/hour (rounded) per technical employee (Normenboek, 2020), 25 euro/hour per seasonal employee (expert survey, 2023), and 0 euro/hour for own labour is calculated, unless you enter a different amount in these fields.

WEB TOOL TIPS

Enter values in the grey text boxes. It is possible to adjust the values on the right hand side (Contractor and Seasonal labour).

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MANUAL

Create a scenario for your agroforestry project by going through each step. In the final step, the costs for your scenario are clearly summarized.

Basic information Purchase Planting Planting Planting Planting Support Protection Protection Management Harvest Harvest Overview

Step 1: Basic information:
For decimal numbers: use a period, not a comma

Your plot:

Enter the area of your plot (ha)

Number of trees already present on the plot

Expected area under trees (ha)
Need help calculating the area under trees? [Click here!](#)

Enter the number of tree rows

Length of tree row (in meters)

Width of tree row (in meters)

Expected area under trees (in hectares)
Adjust this value if necessary

Below is the wage information for three different types of wages. You can adjust these amounts yourself depending on your own situation. Make sure you specify the wage in euros per hour.

Contractor (€/hour) 38

Seasonal worker (€/hour) 25

Own labor (€/hour)

Next >>

STEP 1B. PLANT PURCHASE | COSTS

The objective of the step *Plant Purchase* is to select tree species to calculate the price of the planting material.

INFORMATION REQUIRED FROM USER

- Select tree species
- Determine for each selected tree species the following criteria:
 - The type of planting material
 - The size of the planting material
 - The cultivation method
 - Number of trees/shrubs

BACKGROUND INFORMATION

INTACT has a list of tree and shrub species (Appendix I) from which you can select the species of your interest. For each tree species, the type, size, and cultivation method of the planting material should be chosen accordingly.

THE TYPE OF PLANTING MATERIAL.



Depending on the chosen tree species, you can choose from saplings, cuttings, shrubs, low-stemmed trees (stem branches at knee height), half-stemmed trees (stem branches at hip height), or high-stemmed trees (stem branches above 2 meters high). For each type of planting material, different sizes and cultivation methods are available (Table 1). The size and cultivation method will be explained in the next two paragraphs

Table 1. Type of planting material for which specific sizes and cultivation methods were taken into account in INTACT.

Type	Length dimensions (cm)	Thickness dimensions (cm)	Other size	Cultivation method
<i>Saplings</i>	60/90, 100/125 of 125/150			Bare root
<i>Cuttings</i>	60/90, 100/125 of 125/150			Bare root
<i>Bush</i>			3+ branches; container 2-3 L; container 5-8 L	Bare root or container
<i>Low-stemmed tree</i>		6/8		Bare root, wire root ball, or container
<i>Half-stemmed tree</i>		6/8		Bare root, wire root ball, or container
<i>High-stemmed tree</i>		6/8, 8/10 of 10/12		Bare root, wire root ball, or container

THE LENGTH AND SIZE OF PLANTING MATERIAL

For each type of planting material, the size can either be determined by the length or height of the plant or the thickness of the stem.

- The **length or height measurement** is given in centimetres (cm). For example, in the case of saplings, this is 60/90 cm, 100/125 cm, and 125/150 cm. This means that the plant is 60 to 90 cm, 100 to 125 cm, and 125 to 150 cm tall, respectively.
- The **thickness measure** of the plant is determined by measuring the circumference of the stem at 1 meter from the ground (round arrows in Figure 3). The thickness sizes 6/8, 8/10, and 10/12 mean that the stem circumference is 6 to 8, 8 to 10, and 10 to 12 cm, respectively.

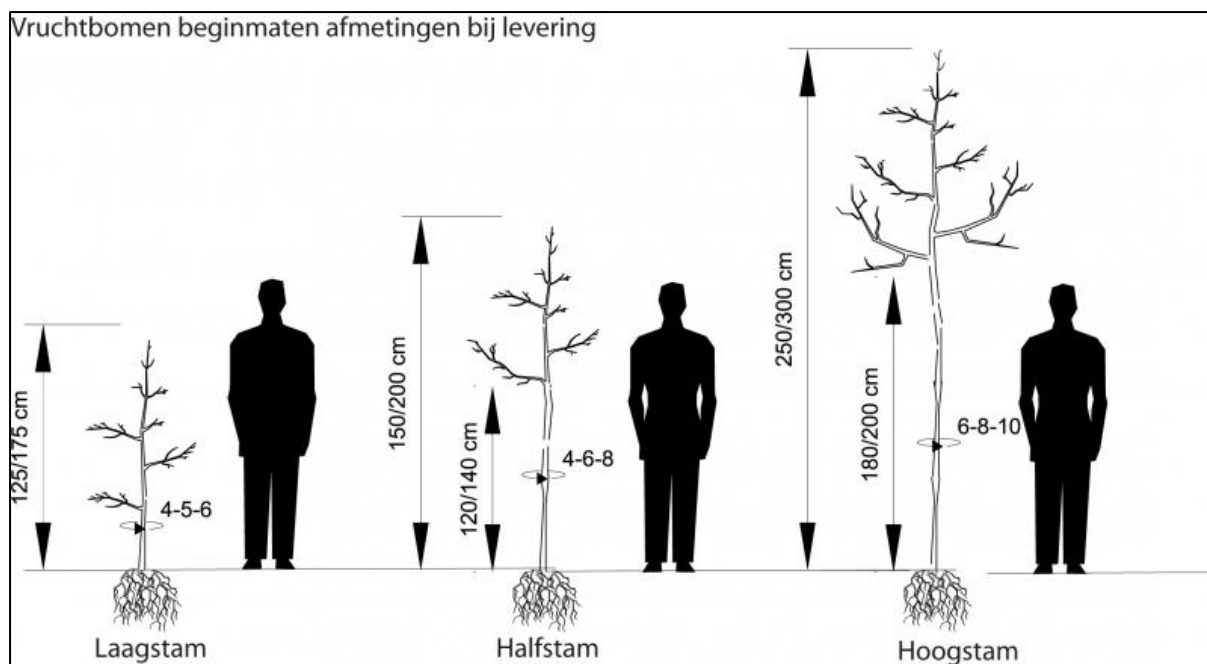






Figure 3. Tree nurseries offer low-stemmed (left image), half-stemmed (middle image), and high-stemmed trees (right image) for fruit and nut species, depending on the tree species. To illustrate, the difference between these three tree stocks is shown. The length (vertical arrows) and thickness measurement (circular arrow) are shown for apricot (*Prunus armeniaca*). © Boomkwekerij de Bruyn ([Advies \(boomkwekerij-debruyn.com\)](http://advies.boomkwekerij-debruyn.com))

THE CULTIVATION METHOD OF PLANTING MATERIAL

The cultivation method of planting material is determined by the tree nurser. We distinguish four different types, namely bare root, root ball, wire root ball, and container. Each cultivation method has its disadvantages and advantages which is why they are further explained in Table 2. Note that the cultivation method has a direct impact on the price of the planting material.



Table 2. General types of cultivation methods generally offered by a nursery with associated advantages, disadvantages, and comments (Link 6, 7 and 11; Appendix IV).

Bare root	Root ball	Wire root ball	Container
			
*	*	*	*
Advantages			
Cheap	Good price-performance ratio	Good price-performance ratio	High quality
Roots are stimulated to grow well	Catches on quickly	Catches on quickly	Does not have to be planted immediately after delivery
Easily transportable			Roots cannot be damaged during transport
			Low chance of plants dying
Disadvantages			
Can only be delivered and planted when the tree is at dormant status	Can only be delivered and planted when the tree is at dormant status	Can only be delivered and planted when the tree is at dormant status	Expensive
Roots are sensitive and prone to drying out	Roots are prone to drying out during transport	Roots are prone to drying out during transport	Waste due to plastic pots
Chance of 5 -10% of the plants will die	Chance of 5% of the plants will die	Chance of 5% of the plants will die	
Take extra care during transport and planting.			
Remarks			
Do not plant during frost and excessively wet periods	Do not plant during frost and excessively wet periods	Do not plant during frost and excessively wet periods	Do not plant during frost and excessively wet periods
Plant between November and April	Plant from the end of September until May	Plant from the end of September until May	Possible to plant year-round
			Availability at tree nurseries mainly from October until May

* Illustrations by © Boomkwekerij De Bruyn ([Advies \(boomkwekerij-debruyen.com\)](http://advies.boomkwekerij-debruyen.com)).

TRANSPORT COSTS

For transport costs, an average price of EUR 100 per delivery is used, but this price is only an indication. Transport costs depend, among other things, on the size of the order, the number of kilometres between your plot and the tree grower, and whether you are a regular customer. You can adjust this price in INTACT.



WEB TOOL TIPS

Click on the white text box to activate the tree species list. Scroll down and click on the tree and/or shrub species of your interest. You can also type words in the text box to fasten your searching process, e.g. type apple.

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Create a scenario for your agroforestry project by going through each step. In the final step, the costs for your scenario are clearly summarized.

Manual

Basic information Purchase Trees and shrubs Planting Site operations Planting Planting trees Planting Mulching Planting Support Material Protection individually Protection Collective Management Harvest Harvest By hand Overview

Step 1B: Purchase trees and shrubs

For decimal numbers: use a period, not a comma

Which tree species do you want to plant?

You can search for the name of the tree (Dutch or Latin) by typing in the text field. To remove one tree species, click on the brown cross next to the name of the tree. To remove all tree species, click on the black cross at the top right of the text box.

Click here to show a list of trees

- Currant - White currant (Ribes rubrum)
- Currant - Blackcurrant (Ribes nigrum)
- Abeel - Red poplar (Populus canescens)
- Abeel - White poplar (Populus alba)
- Apricot (Prunus Armeniaca)
- Almond (Prunus dulcis)

Next >>

Next, you need to specify for each species the following information: the type, tree size, growing method, and the number of trees you want to plant. Click on the drop-down menus in the white cells to select the type, size, and growing method. You have to enter a value in the column "number" (e.g. 100 if you want to plant 100 apple trees). Click on the green button **Calculate** to calculate the price per tree.

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Apple (Malus domestica) Pear Varieties (Pyrus communis)

Sweet chestnut (Castanea sativa) Walnut - Walnut (Juglans regia)

Choose the number, type, length-thickness size and cultivation method per tree

For more explanation about a specific term, place your cursor on the icon.

Click on 'Calculate' after entering the number per tree species to refresh the 'Overview of tree calculation' section.

Tree	Type	Length, thickness	Growing method	Number	Price per tree	Total per tree species
Apple	-	First choose a tree type	First choose a length/thickness		0.00	0.00
Pear Varieties	-	First choose a tree type	First choose a length/thickness		0.00	0.00
Sweet chestnut	-	First choose a tree type	First choose a length/thickness		0.00	0.00
Walnut - Walnut	-	First choose a tree type	First choose a length/thickness		0.00	0.00
Total						0€

Calculate



STEP 2. TERRAIN PREPARATION | PLANTING COSTS

Step 2 entails planting costs which are divided into 4 chronological steps: 1) Terrain modification (site preparation), 2) Planting trees and shrubs, 3) Applying mulch, and 4) Installing tree support material.

The objective of the step *Terrain preparation* is to calculate the costs of preparing the terrain before trees can be planted.

INFORMATION REQUIRED FROM USER

- Select a terrain modification method
- Select who is responsible for labour:
 - Technical staff
 - Own labour

BACKGROUND INFORMATION

Before the trees can be planted, it is often necessary to prepare the site. You can choose between five typical terrain modifications (Table 3). Your soil type affects the number of labour hours required, but this tool does not take your soil type into account. The model uses an average for the number of labour hours for tillage on sandy, clay, and loamy soils. As a result, labour hours and costs may differ if you are tilling your plot in reality. For field tillage, the hourly rate for technical staff (38 euros/hour or an amount chosen by you) or the hourly rate for own labour is used. Costs that are not labour-related are the applied rates of equipment (80% of turning costs) and material costs are exclusive of VAT (Normenboek 2020).

Table 3. Five types of terrain modification with activities and supplies are described for each. Also included is a recommendation for the number of staff required (Normenboek 2020).

Terrain modification methods	Description of activities	Machinery or equipment needed	Number of staff needed (# persons)
Loosening soil and preparing it for sowing	3 actions: Ploughing (working depth 25 cm); Harrowing (working width up to 300 cm); Tilling (working width up to 300 cm)	Tractor 45-55 kW with two-sided roller plough; tractor 25-35 kW with harrow; and tractor with tiller.	1
Deep-tilling	Deep-tilling (working depth up to 1 m)	Tractor 45-55 kW with duck/goose foot (1 or 2 tines)	1
Sowing tree strip	Unplanted land, ready for sowing, sowing grass seed and herbs, incl. seed purchase.	Tractor 45-55 kW with seeder, working width 250 - 300 cm.	1
False seedbed technique	3 actions: Ploughing (working depth 25 cm); Harrowing (working width up to 300 cm); Tilling (working width up to 300 cm)	Tractor 45-55 kW with two-sided roller plough; tractor 25-35 kW with harrow; and tractor with tiller.	1



No terrain modification	If your site is already ready for tree planting, terrain modifications may not be necessary.	-	-
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WEB TOOL TIPS

Click on 'yes' if you want to choose a specific terrain modification method. Do not forget to specify the labour costs (own labour is yes, outsourcing labour is no).

Step 2: Planting
What site operations do you wish to carry out before planting the trees?

Loosen the bottom Yes No

Deep stirring Yes No

Sowing tree strip Yes No

False seedbed Yes No

Will I be doing the work myself for this step Yes No

Overview of site preparation costs

The calculation below is based on the estimated area under the trees (0.60ha)
N/A = not applicable

Yes/No	Description	Total costs (€/plot)	Labor required (hour/plot)	Of which labor costs (€/plot)
Yes	Loosen the soil and prepare it for sowing	451.50	7.38	73.8
No	Deep stirring	N/A	N/A	N/A
No	Sowing tree strip	N/A	N/A	N/A
No	False seedbed	N/A	N/A	N/A
Total		451.50	7.38	73.80

Next >>

STEP 2. PLANTING TREES | PLANTING COSTS

The objective of the step *Planting trees* is to select a planting method for which the costs can be calculated.

INFORMATION REQUIRED FROM USER

- Select a planting method
- Select who is responsible for labour:
 - Technical staff
 - Own labour

BACKGROUND INFORMATION

There are 3 options for planting trees in INTACT, namely:

1) MANUALLY (WITH HAND TOOLS)

Digging the planting holes manually is done with hand tools. This option results, in general, in a higher number of labour hours compared to the motorized auger and digging a trench.

2) MOTORIZED AUGER

A motorized auger is generally commonly used, partly because of the lower number of labour hours (Figure 4a). Nevertheless, both techniques (manual and motorized auger) share the same operations (Table 4).



3) DIG A TRENCH AND PLANT TREES/SHRUBS IN IT (YOU CHOOSE THE NUMBER OF TREES PER METER)

For planting long rows of trees and/or a large plot, digging a trench (ditch) can be an attractive option (Figure 4b). For this, trench digging is combined with the same operations in Table 4 except for 'setting out planting spots' and 'making planting holes'. The total cost is calculated based on the total length of the tree row(s) and the number of trees to be planted.



Figure 4. Trees were planted with a motorised auger at an agroforestry plot at ILVO (a). Another option is to plant trees in a trench (b; © Kees van Zelderren).

LABOUR

The labour hours required depend on the type and size of trees and shrubs. For this reason, labour costs have been calculated separately for 1) saplings, cuttings, planting, and shrubs, 2) thickness size 6/8, 3) thickness size 8/10, and 4) thickness size 10/12. As you have specified the tree species type and size, this will automatically be taken into account during this step.

Table 4. Planting activities applied for planting trees manually, and with a motorized auger (Normenboek 2020).

Planting activities from Normenboek	Saplings, cuttings, and bushes	Trees – thickness size 6/8	Trees – thickness size 8/10	Trees – thickness size 10/12
Setting out planting spots	Yes	Yes	Yes	Yes
Apply mulch	Not applicable	5 kg compost per tree	5 kg compost per tree	5 kg compost per tree
Unloading, possibly ensiling and loading trees	Yes	Yes	Yes	Yes
Making planting holes	Dimensions planting hole: 20 x 20 cm	Dimensions planting hole: 40 x 40 cm	Dimensions planting hole: 50 x 50 cm	Dimensions planting hole: 60 x 60 cm
Planting trees	Yes	Yes	Yes	Yes



WEB TOOL TIPS

Click on the cells in the table where you see a down arrow to activate a drop-down menu. The blue cells contain numbers corresponding to the number of trees/shrubs of a specific species you entered in the previous step. It is possible to adjust these numbers, e.g. to 0 if you don't want to apply something.

Tree (Length/thickness size)	Planting method	For how many trees?	Perform the work yourself?	Planting cost (€/tree)	Working hours (hour/lot)	Labor costs (€/plot)	Total costs (€/plot)
Apple (standard)	-	25	Yes	N/A	0.00	0.00	0.00
Pear Varieties (standard)	Manual	50	Yes	N/A	0.00	0.00	0.00
Sweet chestnut (size 10/12)	Motorized earth auger	75	Yes	N/A	0.00	0.00	0.00
Walnut - Walnut (size 8/10)	Digging a trench	100	Yes	N/A	0.00	0.00	0.00
Total				0.00	0.00	0.00	0.00

STEP 2. MULCHING | PLANTING COSTS

The objective of the step *Mulching* is to select a type of mulch after which the costs can be calculated.

INFORMATION REQUIRED FROM USER

- Select a type of mulch
- Enter the number of trees for which you want to apply mulch
- Select who is responsible for labour:
 - Technical staff
 - Own labour

BACKGROUND INFORMATION

Covering the soil with a layer of mulch material (e.g. compost or wood chips) combats weeds and dehydration. In this tool, you have the option to choose from green compost or wood chips. Each type of material has its advantages and disadvantages. Compost has a lower purchase price per cubic meter, but a layer of at least 1 cm will need to be added annually (Link 4; Appendix IV). Wood chips, on the other hand, have a higher purchase price per cubic meter, but a new layer only needs to be added every 4 years (on average). Another disadvantage of wood chips is that the top layer can partly blow away in strong winds (Link 1; Appendix IV).

If you have chosen green compost or woodchips, this will automatically be included in management.



Compost



© [Veencompost in vrac \(m³\) – CNSV](#)

Wood chips



© [Boschips 1° keuze 10/50 \(m³\) – CNSV](#)

WEB TOOL TIPS

Click Green Compost if you want to apply green compost and Woodchips if you want to apply woodchips. It is possible to click none, one or both of the boxes. Then indicate whether you want to do the work yourself or outsource it. In the table, you again see the number of trees or shrubs listed in blue cells, whose values you can adjust according to your situation.

AGRIKOBENRIJ VLAANDEREN

Handhaving

Basis informatie Aankoop Bomen en Struiken Aanplant Terreinbewerkingen Aanplant Bomen planten Aanplant **Planten** Aanplant Struikplanten Bescherming Individueel Bescherming Collectief Beheer Oogst Oogst Met de hand Totaal overzicht

Stap 2: Terreinbewerkingen
Op welke manier wil je je bomen van mulch voorzien? Kies één type mulch uit per boomsoort.

Kies een type mulch Arbeid zelf uitvoeren?

Groencompost Ja Nee
 Houtsnippers Ja Nee

Groencompost							Houtsnippers								
Boom / struik	Voor hoeveel bomen? ?	Hoeveelheid m³/boom	Prijs (€/m³) ?	Prijs (€/perceel)	Arbeidskosten (€/boom)	Totale arbeid (h/perceel)	Totale kosten (€/perceel)	Boom / struik	Voor hoeveel bomen? ?	Hoeveelheid m³/perceel	Prijs (€/m³) ?	Prijs (€/perceel)	Arbeidskosten (€/boom)	Totale arbeid (h/perceel)	Totale kosten (€/perceel)
Appel (<i>Malus domestica</i>)	25	0.18	28	4.90	0.56	1.40	31.68	Appel (<i>Malus domestica</i>)	25	0.18	47	8.23	14.00	1.40	48.98
Peer-Variëteiten (<i>Pyrus communis</i>)	50	0.35	28	9.80	0.56	2.80	63.35	Peer-Variëteiten (<i>Pyrus communis</i>)	50	0.35	47	16.45	28.00	2.80	97.95
Tanne kastanje (<i>Castanea sativa</i>)	75	1.20	28	33.60	1.28	9.60	217.20	Tanne kastanje (<i>Castanea sativa</i>)	75	1.20	47	56.40	96.00	9.60	336.15
Walnoot - Okkernoot (<i>Juglans regia</i>)	100	1.10	28	30.80	0.88	8.80	199.10	Walnoot - Okkernoot (<i>Juglans regia</i>)	100	1.10	47	51.70	88.00	8.80	307.70
Totaal		2.83			79.10		511.33	Totaal		2.83		132.78			790.78

Herbereken kosten groencompost

Herbereken kosten houtsnippers

Volgende >>



STEP 2. TREE SUPPORT MATERIALS | PLANTING COSTS

The objective of the step *Tree support materials* is to choose support material suitable for your chosen trees.

INFORMATION REQUIRED FROM USER

- Select tree support materials
- Enter the number of trees for which you want to tree support materials
- Select who is responsible for labour:
 - Technical staff
 - Own labour

BACKGROUND INFORMATION

It is recommended that trees are supported by materials such as bamboo sticks or (lodging) poles to prevent the tree from falling due to strong winds and to help the tree develop a strong root system in the first years after planting. The table below recommends support materials for each tree type. It is possible to change the number of bamboo sticks or (lodging) poles (column 1) to a maximum of 4 per tree. Regarding the lodging poles, an untreated chestnut tree pole of 1 meter or 2.5 meters high has been used, as indicated in the tool.

Table 5. Recommended support material by tree type.

Number of bamboo sticks or (lodge) poles per tree (minimum)	Number of bamboo sticks or (lodge) poles per tree (advise)	Tree type	Support material type
1	1	Sapling	Bamboo stick + tree strap
1	1	Cutting	Untreated lodge pole (1 m) + tree strap
1	2	Low-stemmed tree	Untreated lodge pole (1 m) + tree strap
1	2	Half-stemmed tree	Untreated lodge pole (2,5m, ø6/8 cm) + tree strap
2	2	High-stemmed tree size 6/8	Untreated lodge pole (2,5m, ø6/8 cm) + tree strap
2	2	High-stemmed tree size 8/10	Untreated lodge pole (2,5m, ø6/8 cm) + tree strap
2	3	High-stemmed tree size 10/12	Untreated lodge pole (2,5m, ø6/8 cm) + tree strap



WEB TOOL TIPS

During the step Purchase trees and shrubs, you could select the type of planting material. Based on the types of planting material you selected, support material is advised here. For example, Low stem 2 means that 2 support stakes are advised for low-stemmed trees. You can adjust the numbers in the grey text blocks. The table again shows the number of trees or shrubs in blue cells, whose values you can adjust according to your situation.

Agroforestry V.LANDSCHEP

Create a scenario for your agroforestry project by going through each step. In the final step, the costs for your scenario are clearly summarized.

Basic Information | Purchase Trees and Shrubs | Planting Site operations | Planting Planting trees | Planting Mulching | **Planting Support Material** | Protection Individually | Protection Collective | Management | Harvest | Harvest By hand | Overview

Step 2: Planting

What support material do you want to provide for the trees?

First choose the number of poles per tree type. If in doubt, leave the recommended figures. Then you choose whether you want to apply the support material for how many trees (blue field).

Place your cursor on a field title for more information.

Low stem	2
Half-stem	2
Standard 8/10	2
Standard 10/12	3

Perform the work yourself? Yes No

Support material overview

Tree / Bush Type, Length or thickness measure	Number of trees ?	Number of posts (per tree)	Total costs (€/plot)	Required labor hours (hour/plot)	Of which labor costs (€/plot)
Apple Low stem, Standard	25	2	218.50	1.50	13.83
Pear Varieties Half-stem, Standard	50	2	1580.00	3 p.m	150.00
Sweet chestnut Standard, size 10/12	75	3	3555.00	33.75	337.50
Walnut - Walnut Standard, size 8/10	100	2	3160.00	30.00	300.00
Total			8513.50	80.25	801.33

Boommatten
Tree sizes

Groot
Large

Klein
Small

Geschild steunmateriaal
Suitable support materials

Paal 2.5 m
Pole 2.5 m

Paal 1 m
Pole 1 m

Bamboestok
Bamboo stick

How can one provide suitable support material for optimal growth? The golden rule: The bigger the tree, the thicker the required post.

Next >>



STEP 3. INDIVIDUAL TREE PROTECTION | COSTS

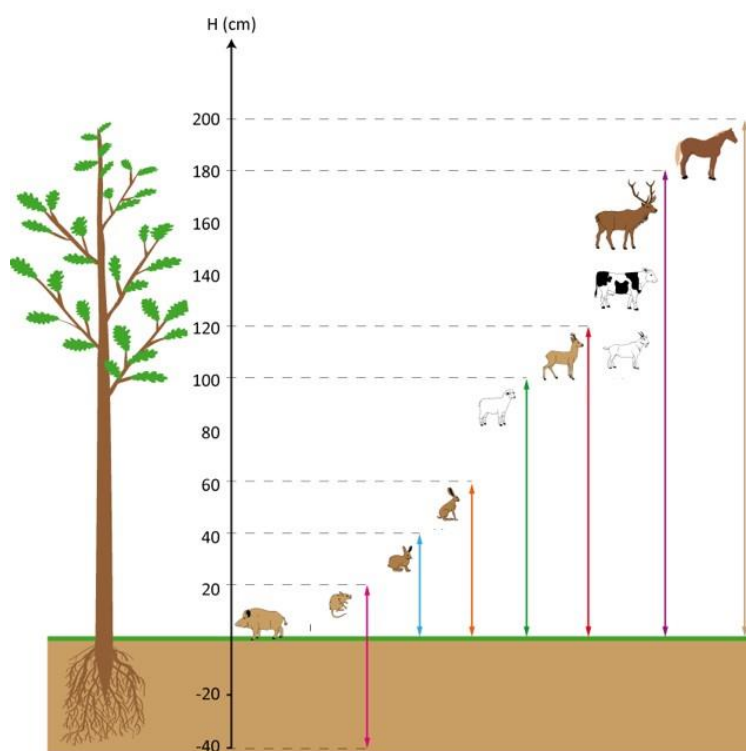
The objective of the step *Individual tree protection* is to indicate which animals have access to the agroforestry plot in order to select the right tree protection material.

INFORMATION REQUIRED FROM USER

- Select which animals have access to the agroforestry plot
 - Farm animals
 - Wildlife
 - Both
- Enter the number of trees for which you want to apply tree protection material
- Select who is responsible for labour:
 - Technical staff
 - Own labour

BACKGROUND INFORMATION

Animals can damage the trees, especially if trees are young and unprotected. It is important to choose tree protection that offers protection against animals that have (unwanted) access to your plot. Figure 5 shows how high (or how deep underground) protection should be per animal species. To illustrate, for deer, cows, and goats protection should be 180 cm high. There are two methods to protect trees, they can be protected individually and/or collectively. Individual tree protection is placed near and around the bark, while collective protection can protect tree groups, tree rows, or an entire plot. Collective protection can be, for example, an electric fence protecting a row of trees, but it can also be a wildlife fence around the plot.



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Figure 5. For each species, the height (cm) up to which protection must be placed for the tree to remain protected is indicated. For mice and voles, protection must be also placed underground (up to 40 cm deep) (Link 5; Appendix IV).



INDIVIDUAL TREE PROTECTION TYPES

INTACT has a list of individual tree protection types from which you can make a selection. Select the species you want to protect the trees from. A filter is then applied, with the tree protection types of interest appearing. In the case of multiple species, select protection against the largest species. An exception is mice (including voles), for which a root cage is necessary. 'Wildlife-large' refers to deer, roe deer, and other large wildlife species. 'Wildlife-Small' includes rodents, such as hares and rabbits, and other smaller wildlife. Again, mice are an exception, as a bark protector (tree tube) does not provide sufficient protection against mice. More information on types of protection can be accessed at [Boombescherming \(Kennislaket\)](#).

Note! You can decide which type of protection you want to take for each tree type. This is relevant because you may have chosen different tree types, and thus different tree heights. In INTACT, you can select different types of tree protection for your chosen trees. For each individual tree protection type, the animals to which it offers protection can be seen in Table 6. For example, 100 saplings need to be protected from voles and rabbits. Looking at Table 6, the best choice would be to use a fine-mesh metal wire (below-ground) and biodegradable tree tubes (aboveground).

Table 6. Overview of possible individual tree protection types and to which animals they show protection.

Quantity	Individual tree protection types	Repels/offers protection from specific animals
0	Only tree support material (2. Planting - step 4)	No protection materials/I already have protection materials
0	3 or 4-pole construction	Horses, cattle, goats, sheep, pigs, red deer and roe deer
0	3 or 4-pole construction + fine-mesh metal wire (with hexagonal meshes of max. 13-16 mm)	Horses, cattle, goats, sheep, pigs, red deer and roe deer <i>Also for wild boars, mice and rabbits.</i>
0	Tree tube - 1.2 m	Goats, sheep
0	Bark harness Semaco - 1.75 m with repelling spikes	Goats, sheep
0	Protector Cactus - 1.2 m x 1 m	Goats, sheep, pigs, roe deer
0	Protector Cactus - 1.6m x 1 m	Horses, cattle, goats, sheep, pigs, red deer and roe deer
0	Protector Cactus - 1.7m x 1.2 m	Horses, cattle, goats, sheep, pigs, red deer and roe deer
100	Fine-mesh metal wire (with hexagonal meshes of max. 13-16 mm)	Mice and voles
0	Single or double-mesh net (120 cm)	Rabbits, hares, and mice
100	Biodegradable tree tube	Rabbits, hares, and mice
0	Spiral guard - 75 cm	Rabbits, hares, and mice



WEB TOOL TIPS

In the table, you can click on the cells where an arrow points down to activate a drop-down menu. Based on your chosen species(s), different types of protection will appear. Click on the type of protection that suits your situation.

Step 3: Tree protection

You can protect your trees individually or collectively.
 First choose which animal(s) have access to the plot, then choose exactly which animal per tree type.
 You can then choose a protection type and adjust the number of trees to be protected if necessary.

[Click here](#) for a visual catalog of the protection types.

Perform labor yourself for this step? Yes No

Tree/hub	What has access to the plot?	Which animal is it?	What type of protection?	For how many trees?	Total costs (€/plot)	Required labor hours (hour/plot)	Of which labor costs (€/plot)	Of which material costs (€/plot)
Apple	-	first choose a category	first choose an animal	25	0.00	0.00	0.00	0.00
Pear Varieties	-	first choose a category	first choose an animal	50	0.00	0.00	0.00	0.00
Sweet chestnut	Cattle Wild Comb	first choose a category	first choose an animal	75	0.00	0.00	0.00	0.00
Walnut - Walnut	-	first choose a category	first choose an animal	100	0.00	0.00	0.00	0.00
				Total	0.00	0.00	0.00	0.00

[Next >>](#)

By clicking on the green *Click here* button, an overview of relevant tree protection types will appear.

[Click here](#) for a visual catalog of the protection types.

To block

- 3-post construction**
Click here for more information
- 4-post construction**
Click here for more information
- Protective sleeve - 1.2 m**
Click here for more information
Photo: © Guide technique de l'agroforesterie - Lambert (GDJF-ast)
- Bio-degradable tree tube**
Click here for more information
Photo: © Agroforestry vlaanderen
- Tree harness Semaco - 1.75 m with repellent pins**
Click here for more information
Photo: © Agroforestry vlaanderen
- Single or double mesh net - 120 cm**
Click here for more information
Photo: © Agroforestry vlaanderen
- Protector Cactus - 1.2 m x 1 m**
Click here for more information
Photo: © Oobierbe - Pieter Van Runtst
- Protector Cactus - 1.6m x 1 m**
Click here for more information
Photo: © Oobierbe - Pieter Van Runtst
- Protector Cactus - 1.7m x 1.2 m**
Click here for more information
Photo: © Oobierbe - Pieter Van Runtst
- Spiral duct - 75 cm**
Click here for more information
- Fine-meshed metal wire with hexagonal mesh of max. 13 to 16 mm**
Click here for more information
Photo: © Agroforestry vlaanderen
- Classic 3-post construction + fine-mesh metal wire with hexagonal mesh of max. 13 to 16 mm + spiral tube (75 cm)**
Click here for more information
- Classic 4-post construction + fine-mesh metal wire with hexagonal mesh of max. 13 to 16 mm + spiral tube (75 cm)**
Click here for more information



STEP 3. COLLECTIVE TREE PROTECTION | COSTS

The objective of the step *Collective tree protection* is to indicate which animals have access to the agroforestry plot in order to select the right tree protection material.

INFORMATION REQUIRED FROM USER

- Select the type of collective tree protection
 - None
 - Barbed wire
 - Electrical
 - Petrus cross
 - Ursus fence
 - Wildlife fence
- Enter the number of trees for which you want to apply tree protection material
- Enter the length and width of the tree row
- Enter the number of tree rows or which you want to apply tree protection material
- Select who is responsible for labour:
 - Technical staff
 - Own labour

BACKGROUND INFORMATION

The options for collective tree protection are 1) Electric fence, 2) Barbed wire fence, 3) Petrus Cross (also called tree group), 4) Ursus fence, and 5) Wildlife fence (Table 7 and Figure 6ab). A Petrus Cross is a type of tree protection that is ideal for a pasture, as it allows grazing in the tree row without allowing animals to get too close to the trees (Figure 7). The difference between an Ursus fence and a wildlife fence is in the height and thickness of the wire, with wildlife fencing having thicker wire than classic Ursus or sheep wire.

Choose collective tree protection that matches the arrangement of the trees. For example, if you have ten apple trees on a meadow with cows, a Petrus Cross (Figure 7) could be a suitable option. If in doubt, seek advice from the seller of the tree protection or visit a farmer with experience with trees in the field.

Table 7. The five collective tree protection types, where you can select the fence type. Then you can select the type of collective tree protection.

Collective tree protection (yes/no)	Collective tree protection type	Type of wire used
No	None	None
No	Electric fence	Electrified wire
No	Barbed wire fence	Barbed wire
Yes	Petrus Cross/Tree Group	Electrified wire
No	Ursus fence	Ursus wire
No	Wildlife fence	Square-meshed wire



Barbed wire fence	Electric fence	Ursus and Wildlife fence*

Figure 6a. Examples of fence protection types (Link 5; Appendix VI). The difference (*) between Ursus wire and square-meshed wildlife fence is in the thickness of the wire, but they look the same.

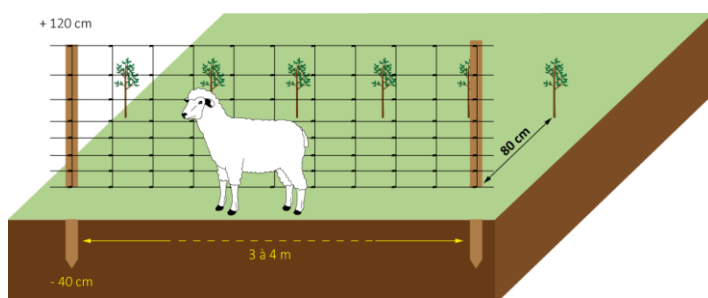


Figure 6b. Example of Ursus or Wildlife fence with a sheep.



Figure 7. Petrus Cross for a tree row on a pasture (Link 3; Appendix VI)



WEB TOOL TIPS

Once you click on a type of collective tree protection, you can enter the tree rows' length (m) and width (m). This determines the perimeter. If you would like to protect several tree rows, you can also enter the number of tree rows. The costs will appear after you have entered values in the grey text boxes.

Step 3: Tree protection
You can protect your trees individually or collectively.

To remove a type of protection, click on the red icon (left).

Add collective protection

SELECTED OPTION

Fence with two parallel barbed wires
Peter's Cross/Tree Group
Ursus fence
Cama fence

Number of trees to be protected: 100
Length of tree row (m): 100
Width of tree row (m): 3
Number of tree rows: 10

Perform the work yourself? Yes No

Type of fence	Example	Required other items (Required)	Local costs (€/row)	Material costs (€/row)	Total costs (€/row)
			53.15	3560.99	4092.47
Total			53.15	3560.99	4092.47

Next >>



STEP 4. TREE MAINTENANCE | COSTS

The objective of the step *Tree maintenance* is to select activities and at which years you want to apply these activities.

INFORMATION REQUIRED FROM USER

- Select which activities you want to adopt (yes/no):
 - Applying mulch
 - Mowing
 - Weed control
 - Pruning for annual maintenance
 - Pruning fruit trees
 - Watering
 - Monitoring
- Select who is responsible for labour:
 - Technical staff
 - Seasonal workers
 - Own labour

BACKGROUND INFORMATION

Tree maintenance is important for developing vital trees and shrubs, and avoiding unwanted effects on the other components of your cultivation system. Think e.g. of competition for light or water, weeds, or hindrance during certain operations. It is important to select activities necessary for the vitality of the trees, for reaching your production goals, and for meeting your field conditions. The tree maintenance activities are explained below:

COMPOST

See "Mulching".

WOOD CHIPS

See "Mulching".

MOWING AROUND THE TREES

This activity involves mowing grasses and herbs around trees. The calculation is based on one employee using a brush cutter (3.0 kW) (Normenboek 2020).

WEED CONTROL

This activity involves hoeing and/or chopping grasses and herbs in the tree rows. The calculation is based on one employee using hand tools (Normenboek 2020).

PRUNING

INTACT includes two types of pruning: 1) pruning for annual maintenance and 2) pruning of young high-stemmed fruit trees. This is eminently a simplification of reality: the type of pruning depends on the life stage of the tree (Table 8), the objective of pruning, and the tree species. Therefore, keep in mind that the desired type of pruning (and the labour required) may change over the years.



Table 8. Five types of pruning according to the life stage of the tree (Link 8; Appendix VI).

Type of pruning	Aim	Measures
Pruning after planting*	Increase survival rate of the young tree	<ol style="list-style-type: none"> 1. Shortening stem branches 2. Tying off 3. Root pruning
Topiary	Forming balanced tree canopy with good and firm structure	<ol style="list-style-type: none"> 1. Select shape 2. Select stem branches 3. Shortening stem branches 4. Stimulate growth
Maintenance pruning	Balance between growth and fruit bearing	<ol style="list-style-type: none"> 1. Thinning out twigs 2. Rejuvenate fruitwood 3. Fruit thinning
Renovation pruning	Bring neglected and/or old trees back to fruiting stage	<ol style="list-style-type: none"> 1. Shorten stem branches 2. Thinning out dense crown and branch bundles
Conservation pruning	Life extension of very old trees	Shortening and thinning of the crown according to the load-bearing capacity of the trunk

**In good quality planting material, care has already been taken at the nursery to ensure that the crown and root ball are balanced and that no problem branches are present. Corrective pruning at planting is therefore basically not necessary. Only branches damaged during transport, storage, or planting can be pruned. This is avoided by treating the planting material with due care (Link 10; Appendix VI)*

INTACT does not take these life stages into account and works with a well-established average for calculating pruning time. For annual maintenance pruning, the pruning time averages 6.5 minutes per tree. For this, one person is assigned and he will prune with pruning shears. For pruning (young) high-stemmed fruit trees, the pruning time averages 54 minutes per tree. For this, one person is assigned and he will cut with pruning shears. In practice, motorized equipment can be used to speed up the pruning process. Advice on the pruning regime (how often to prune a tree, e.g. annually or every three years) and pruning materials is best asked from the nursery from whom you bought your planting material. Some organisations or tree nurseries offer pruning classes, which can also be helpful.

WATERING TREES

This activity involves adding water to tree beds (i.e. 100 liters of water per tree for trees spaced 6-8 m apart in the tree row). For this, an employee is used with a tractor (25-35 kW) with a 5000-litre water tank (Normenboek, 2020). Of course, there are other ways to water your trees and shrubs, but INTACT assumes this is a fairly common and efficiently applied practice in alley cropping systems.

We aim to add more irrigation types in INTACT 2.0.



WEBTOOL TIPS

In the green text blocks, you see all kinds of activities related to tree management. Once you click yes, 20 boxes appear (these represent the years after planting, e.g. 5 is year 5 after planting) that you can click on. By clicking on the boxes, you can specify the years in which you want to apply a specific activity. The pre-filled values are guidelines, but you can adjust them.

Step 4: Management
For the management and aftercare of your trees, you can choose from the following relevant activities. Select the desired activities by clicking 'yes' and then indicate in which years you want to carry out these activities.

Perform the work yourself? Yes No

Adding mulch (green) Yes No
applied to year: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Adding mulch (wood chips) Yes No
This step includes wood chips in section 3. Prun! Without chipping wood chips in that step, no management costs can be calculated here.

Skid Yes No

Wood control Yes No

Pruning Yes No

Add stable manure Yes No

To water Yes No

Mosscontrol No Standard Low Both
manuring area

ORA-01403: no data found ORA-06512: at 'AGROFORESTRY_F_GENERATE_OUTPUT_TABLE_P', line 153

Next >>

At the activity *Pruning*, an extra feature is added to select pruning materials.

Step 4: Management
For the management and aftercare of your trees, you can choose from the following relevant activities. Select the desired activities by clicking 'yes' and then indicate in which years you want to carry out these activities.

Perform the work yourself? Yes No

Adding mulch (green) Yes No
applied to year: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Adding mulch (wood chips) Yes No
This step includes wood chips in section 3. Prun! Without chipping wood chips in that step, no management costs can be calculated here.

Skid Yes No

Wood control Yes No

Pruning Yes No

Prun! to year: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Choose additional material to pruning costs. Please note: This cost will be charged for the first year (planting year).

(Choose one or more options):

- Skidding
- Skidding chains (20€)
- Electric pruning chains (750€)
- Hand pruning saw (45-140€)
- Pole saw (160-200€)
- Pruning chains (27€)

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Next >>



STEP 5. HARVESTING FRUITS AND NUTS

INTACT breaks down harvesting costs into 1) Mechanical harvesting of nuts, and 3) Harvesting nuts and fruits by hand.

The step *Harvesting* aims to calculate costs related to harvesting your selected trees.

INFORMATION REQUIRED FROM USER

- Choose the harvesting method
- Select who is responsible for labour:
 - Seasonal labour
 - Own labour

MECHANICAL HARVESTING OF TIMBER

A sawmill may offer services to cut down trees on site with special machinery, deducting costs incurred from the timber revenue. Hence INTACT even approximates costs by setting them to 0. On the timber yield page, you should enter a correct timber price (€/m³) that includes harvesting costs. If you do not intend to cut down the trees on your plot, you can enter a timber price of 0 €/m³.

MECHANICAL HARVESTING OF NUTS AND FRUITS

For the mechanical harvesting of nuts and fruits you are directed to a specific factsheet: [Oogst van Nuts: welke mechanisatie is aan de orde?](#). The online tool MIMOSA (available through [Agroforestry Planner](#)) is developed by an intern at ILVO and is built into INTACT to calculate costs regarding mechanical harvesting.

MANUAL HARVESTING OF NUTS AND FRUITS

For manual harvesting of nuts and fruits, the yield (kg/tree/year or kg/shrub/year) is divided by the picking performance (kg/h) to obtain the labour hours per tree or shrub. The picking performance was obtained from the Berekentool, among others, using average picking performance if no species-specific information was available (Table 9). This involves multiplying the number of labour hours per tree or shrub by the hourly wage you entered.

Table 9. Average picking performance (kg/h) taken if not available for a specific species.

	Berry bushes	Fruit trees	Nut trees
Picking performance	4,82 kg/h	39,46 kg/h	19,38 kg/h

The cost of harvesting fruits and nuts is determined annually over 20 years. This allows for an annual allowance for increasing yields and increasing labour hours once the trees and shrubs set more fruit as they mature.



OVERVIEW OF TOTAL COSTS

The total overview (Figure 9) shows you on the one hand the investment costs at the year of planting (year 0) and on the other hand the annual operational costs after planting. You can make a screenshot of this overview for inspiration and as a guideline for the cost estimation of your future agroforestry plot. Keep in mind that the prices used in INTACT only give you an indication. In reality, costs are highly variable, so (regional) prices can change annually or sometimes monthly. You should at all times check carefully with your local tree nursery, construction market, or other companies to get the most recent cost prices. An updated cost estimate is significant for submitting a grant application. NB. you cannot use a screenshot of INTACT to submit the grant application.

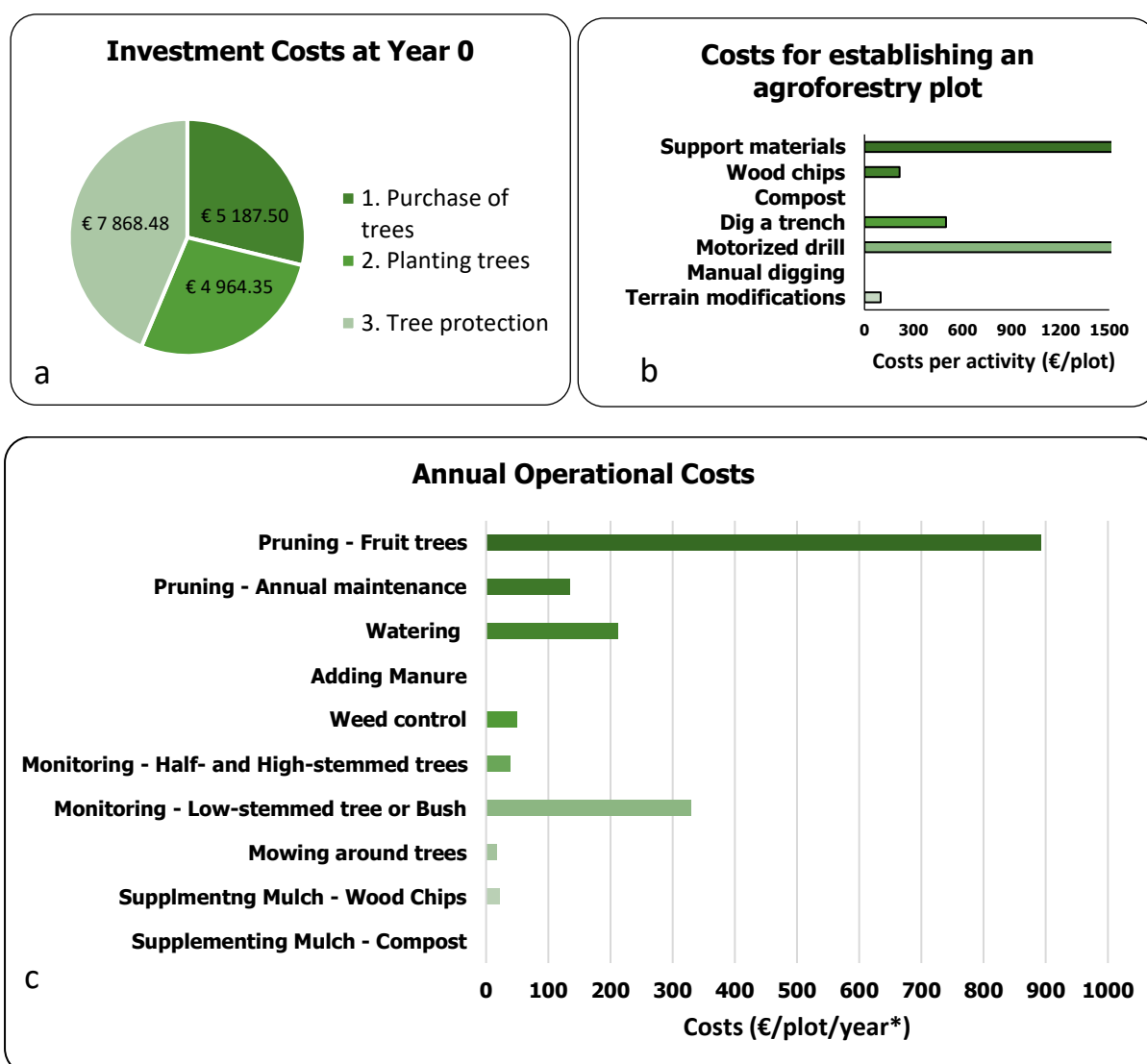


Figure 8. Summary of a) investment costs for main costs at year 0, b) costs broken down by activity that contributed to planting, and c) operational costs by activity. Pay close attention to the units here; a and b are expressed in euros per plot, while operational costs are expressed in euros per plot per year (based on the number of years you clicked on).



WEB TOOL TIPS

This page summarises your choices for costs. Not satisfied? Then you can go back to a specific step now to adjust something. Are you satisfied? Then take a screenshot so you can save this summary to your PC.

The screenshot displays the 'Overview of the costs to realise your scenario' page in the Agroforestry - INTACT Cost-Benefit Analysis web tool. The interface includes a progress bar at the top with steps: Basic information, Purchase, Planting, Planting, Planting, Planting Support, Protection, Protection, Management, Harvest, Harvest, and Overview. The main content area is divided into several sections:

- Investment costs:** A table showing costs for land preparation, equipment, and other initial expenses.
- Operational costs:** A table showing costs for various activities like fertilization, weeding, and pest control, broken down by activity, total costs, and labor.
- Harvest:** A table showing costs for harvesting and processing.
- Tools:** A table showing costs for tools and equipment.
- Total investment costs:** A summary table of all investment costs.
- Charts:** Three charts are displayed: a pie chart showing the distribution of costs, and two horizontal bar charts showing costs per hectare and per year.

At the bottom right, there is a button labeled 'Next: Benefits overview >>'. The browser address bar shows the URL: <https://bdbnet.bdb.be/pls/apex/f?p=147:14:11909610871491:::>



FRUIT AND NUT YIELD | BENEFITS

The objective of the step *Fruit and Nut yield* is to select the selling price (€/kg) for each tree species to calculate fruit and nut yield for your scenario.

INFORMATION REQUIRED FROM USER

- Selling price of fresh fruit (€/kg)
- Selling price of fresh nuts (€/kg)

BACKGROUND INFORMATION

The yields or benefits for fruits and nuts are based on data from the models: the AFP model, Food Forest Calculation Tool 3.0, and the Berekentool. In doing so, expert consultation has supplemented the data but keep in mind that the yields used are only indicative and may change in reality.

Yields are calculated in (kg/tree) or (kg/shrub), then multiplied by the selling price. Thereby, the selling price for nuts is based on the selling price of fresh, unprocessed nuts. The user of INTACT is encouraged to adjust the selling prices for fruits and nuts to fit to your region or scenario.

CALCULATING FRUIT AND NUT YIELD

You will see your chosen tree and shrub species at the yield screen for fruits and nuts. You can use the pre-filled sales price (€/kg) if you don't know the sales price yourself or want to adjust the sales price. For the latter, pay attention to using the correct units, i.e. price per kilogram.



WEB TOOL TIPS

This page shows your chosen tree and shrub species and the corresponding yields for fruits and nuts. In the table you see blue numbers, this is the sales price (€/kg). You can leave or replace the pre-filled sales price. Just make sure this is the price per kilogram.

Overview of returns from your scenario

Yields: Nuts, fruits

The average price per unit per product has already been entered.
If necessary, adjust this price and [click here](#) to recalculate the yield per year.

Annual revenue in € : Nuts and Fruit

Tree	Product	Price €/unit	Year																					
			0 (planting)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Apple <i>Malus domestica</i>	Apple	2,56	0	0	0	0	0	0	0	691	1037	1382	1728	1728	1728	1728	1728	1728	1728	1728	1728	1728	1728	
Pear- Varieties <i>Pyrus communis</i>	pear	2,16	0	0	0	0	864	1296	1728	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160
Sweet chestnut <i>Castanea sativa</i>	chestnut	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	660	990	1320
Walnut - Walnut <i>Juglans regia</i>	walnut (fresh nuts)	6	0	0	0	0	0	0	0	2400	3600	4800	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
Total revenue			0	0	0	0	864	1296	1728	5251	6797	8342	9888	9888	9888	9888	9888	9888	9888	9888	9888	10548	10878	11208

WOOD YIELD | (BENEFITS)

The objective of the step *Wood yield* is to select two timber prices after which estimations for wood yield can be given.

INFORMATION REQUIRED FROM USER

- Timber price (€/m³) for the main volume (stem).
- Timber price (€/m³) for additional biomass (branches).
- Be aware that wood prices are fluctuating continuously.

BACKGROUND INFORMATION

Wood quality has a direct effect on pricing. For INTACT 1.0, we distinguish harvestable wood into 2 categories: main volume (i.e. stem) and additional biomass (i.e. branches). Depending on the tree species, the main volume is categorized as quality wood or biomass wood. Yet this is a bit short-sighted if we look at practice because marketing wood is a very complex story in which quality classes exert a major influence on the wood price (€/m³). For instance, there is a large difference (factor 10 or more) between the low-quality grades and the top grades (A or F). In practice, therefore, there are many more classes than quality wood and biomass wood used in INTACT. Quality wood is classified into 4 (5) classes. With biomass, you have a large proportion that will serve as firewood (certainly small volumes) but there are also a few factories that buy wood to make board material from it (West Fraser Genk and



Unilin in WVL). And so then you have niche markets for all the special items. For some species, there are indeed applications better than biomass, but that is a niche market. In the appendix, there is an overview of each tree species and what the ratio is of biomass and quality wood. There is also an additional niche market column here. More specifically, birch, alder, and poplar can indeed be sold as quality wood. Birch and alder are also more likely to be in niche markets. For poplar, there is more than one niche market for both sawn wood and veneer (for the highest quality).

MARKETING WOOD

In Belgium, about 99% of the logs are sold standing, i.e. the buyer has to go into the forest and cut the logs, saw them, and sort them into homogeneous packages that are all suitable for a particular processor. At the timber yard, this has already been done and only the best trees there are sold log by log via an auction. INTACT obtained timber prices of only a few tree species from a timber park coordinated by the Forest and Nature Agency ([Vierde Woodpark zorgt voor lokale verwerking van Vlaams Wood | Agentschap voor Natuur en Bos](#)). A disclaimer must necessarily be mentioned here:

- The timber quality of trees coming from an agroforestry plot could be dissimilar from trees growing on a timber farm. More research into wood quality from agroforestry systems is needed.
- Be aware that the timber prices used in INTACT are based on the average timber price obtained from four annual timber plots (2019 to 2022).
- Be aware that wood prices can fluctuate even monthly.

WOOD GROWTH CALCULATION

Dynamic wood yield (m³/year) was calculated with an expert and wood densities were obtained from scientific papers. Dynamic yield was calculated based on trees' diameter growth (cm/year). Data on diameter growth or 'DBH growth' can be obtained by measuring **tree** diameter at **breast height**. In this way, there is consistency in measuring tree diameter. DBH growth is tree species-specific and this could be calculated for 18 tree species using allometric formulas from the literature.

As these are complicated calculations and INTACT provides more than 18 tree species, only these curves can be used. The growth rate of all other tree species from INTACT's species list was therefore considered in consultation with an expert. For instance, rough birch (*Betulus pendula*) was not on the list of 18 tree species, but we know it is a fast-growing tree species. In collaboration with an expert, we therefore chose to use the same DBH growth curve for the rough birch as that of poplar, as this is also a fast-growing tree species. If the expert did not know a particular tree species in terms of growth rate, there is no DBH growth curve available. There is also no DBH growth curve available for shrubs, as shrubs generally have a different biomass growth rate than trees which could lead to erroneous results.

After selecting a suitable DBH growth curve for possible tree species, these curves were converted to biomass growth curves (kg/year). To calculate wood volume growth, the biomass growth curves were divided by the tree species-specific wood density (kg/m³). This gave us the wood increment per year (m³/year). Although a DBH growth curve was not available for every tree species, a specific wood density of almost every tree species was found and applied. The tree species are then divided into slow-growing species and fast-growing species in INTACT, after which the marketable volume of wood can be calculated:



1. **Slow-growing species:** generally, 40% of the total wood volume consists of the branch-free trunk (main volume) and 40% consists of additional biomass, such as branches. 80% of the wood volume can therefore be harvested/marketed.

2. **Fast-growing species (biomass wood only):** for species such as poplar, alder, birch, and willow, 80% of the total wood volume is assumed to be biomass wood.

In INTACT, tree species are categorized by main volume (quality wood or biomass wood) and additional biomass, as there is a large price difference between these two types of wood. Thus, cumulative wood volume growth is split into quality wood and/or biomass wood. The appropriate wood volume should be multiplied by the appropriate wood price (€/m³). Thus, to determine the yield of quality wood and biomass wood, the following calculations were used:

a. Yield_slow growth species = $[0.4 * \text{total wood volume at year 50} * \text{price_qualitywood}] + [0.4 * \text{total wood volume at year 50} * \text{price_biomasswood}]$

b. Yield_quick-growth species = $[0.8 * \text{total wood volume at year 20} * \text{price_biomasswood}]$

Finally, using the above calculations, the timber yield was calculated for 20 years and/or for 50 years after planting.

CALCULATING WOOD YIELDS OF THE TOOL

Before explaining the wood yields, it is important to reflect again on the fact that there is no standard market price for wood. INTACT calculates with an average quality wood price of €278.48/m³ and biomass wood price of €17.50/m³ which you can use as a reference if you have not had the opportunity to look up the wood price yourself. This includes the cost of harvesting. You will see your chosen tree species appear and you can adjust the wood price for each tree species, as this is strongly recommended.

Since the wood yield is very uncertain, it was decided not to include it in the cost-benefit analysis. However, you can find the wood yield on the final screen in a separate table for year 20 and year 50, giving you an indication of how much the wood from your trees might yield after 20 or 50 years.

More time will be spent on this section for INTACT 2.0. Once more prices are known, fast-growing trees will be able to be harvested e.g. for biomass wood and their yield will be included in the cost-benefit analysis. We hope for your patience and if you have any questions you can always contact us at: info@agroforestry.vlaanderen.be.



WEB TOOL TIPS

Below the nut and fruit yields, there is a table for wood yields. For each tree species, you need to fill in the price for biomass wood and the main volume (often quality). If you do not plan to sell wood, enter 0. Please note that wood yields are not included in the cost-benefit analysis of INTACT 1.0.

Yields: Wood

The average price per m³ tree species has already been entered.
If necessary, adjust this price and [click here](#) to recalculate the yield per tree species.

A tree species with **this background color** is generally not used for timber production.

Total timber yield per plot (€)

Selected tree and shrub species	Average wood price €/m ³		Marketable volume €/plot	
	For biomass wood	For main volume	Yield after 20 years	Yield after 50 years
Apple	17,5	278,48	399.97	4175.44
Pear Varieties	17,5	278,48	813.97	0.00
Sweet chestnut	17,5	278,48	505.79	0.00
Walnut - Walnut	17,5	278,48	1932.96	18602.93
Total revenue			€3652.69	€22778.37

[<< Back to scenario](#) [Next: Cost-Benefit An](#)

It is therefore strongly recommended to contact a particular processor such as a local sawmill for the most updated wood price. You can then enter this price in INTACT. If you cannot look this up, you can use the timber prices from Table 10. Note that these are only the prices of a few common tree species.

Table 10. This table shows timber yields of different tree species for 4 consecutive years in the period 2019-2022. Give attention to how much wood prices fluctuate over the years.

Average yields for fine strains sold by auction (€/m³)

Tree species (LA)	Tree species (NL)	2019	2020	2021	2022	Average
<i>Quercus robur</i>	Native oak	€ 416.00	€ 520.00	€ 438.00	€ 667.00	€ 510.25
<i>Quercus robur</i>	Upper stems of native oak	€ 206.00	€ 206.00	€ 110.00	€ 382.58	€ 226.15
<i>Quercus rubra</i>	American oak	€ 236.00	€ 245.00	€ 171.00	€ 342.76	€ 248.69
<i>Quercus rubra</i>	Upper stems of American oak	€ 206.00	€ 206.00	€ 110.00	€ 99.43	€ 155.36
<i>Castanea sativa</i>	Sweet chestnut				€ 305.58	€ 305.58
<i>Robinia pseudoacacia</i>	Acacia				€ 321.81	€ 321.81
<i>Fagus sylvatica</i>	Beech		€ 230.00	€ 133.00		€ 181.50
Average		€ 266.00	€ 281.40	€ 192.40	€ 353.19	€ 278.48

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FINAL STEP: COST-BENEFIT ANALYSIS

The objective of the final step is to show a cost-benefit analysis based on your input for your agroforestry scenario.

INFORMATION REQUIRED FROM USER

Not applicable

BACKGROUND INFORMATION

The cost-benefit analysis will appear after you have completed all the Cost and Benefits modules. For this manual, we have performed a cost-benefit analysis as an example to explain how to interpret the output. There are two types of output. Firstly, a table gives insight into the annual costs incurred and annual benefits obtained for 20 years. This provides a detailed outcome of the figures. Secondly, a graph provides visual support of which the numbers are based on the figures from the table.

Several *terms* count on this page which is defined in the glossary (Appendix III) and/or the formula section (Appendix VIII).

INTERPRETING THE COST-BENEFIT ANALYSIS TABLE

The table's top row shows the timeline, i.e. number of years after planting. The first column shows terms including *benefits* (dark green), *costs* (orange), and *free cash flow* (light blue). *Free cash flow* is calculated by subtracting the costs of a specific year (e.g. year 1) from the revenues of the same year. Regarding investment decision-making, the *discounted cash flow* with a 4% *discount rate* (grey) and cumulative cash flow are important. The *free cash flow* is multiplied by a *discount rate* because this will give insight into evaluating the present value of future cash flows. In other words, the *discount rate* reflects how much your money is valued now in comparison with the future. This is crucial for risk assessment and to decide on whether your investment is desirable or not. For forestry projects, the discount rate is set as 4% which is equal to the minimal acceptable rate of return of similar projects. In INTACT, a discount rate of 4% was used to obtain the *discounted cash flow*.

Table 12. An example of the costs and benefits for the first 5 years after planting the agroforestry plot. The colour of the cell and text refers to a negative (red) or a positive (green) value.

	Year 0 Planting year	Year 1	Year 2	Year 3	Year 4	Year 5
Benefits						
Annual yields of Fruits and Nuts	€ 0.00	€ 0.00	€ 997.50	€ 1 928.25	€ 2 643.00	€ 3 920.25
Cumulative yield	€ 0.00	€ 0.00	€ 997.50	€ 2 925.75	€ 5 568.75	€ 9 489.00
Costs						
Annual costs	€ 21 313.77	€ 717.14	€ 740.95	€ 1 669.24	€ 609.05	€ 726.70
Cumulative costs	€ 21 313.77	€ 22 030.91	€ 22 771.87	€ 24 441.11	€ 25 050.16	€ 25 776.86
Free Cash Flow	-€ 21 313.77	-€ 717.14	€ 256.55	€ 259.01	€ 2 033.95	€ 3 193.55
Discounted Cash Flow	-€ 21 313.77	-€ 689.56	€ 237.19	€ 230.26	€ 1 738.62	€ 2 624.87
Discount Rate (for Forestry)	4.00%					
Cumulative Cash Flow	-€ 21 313.77	-€ 22 003.33	-€ 21 766.14	-€ 21 535.88	-€ 19 797.26	-€ 17 172.39



Other financial metrics are necessary to evaluate the profitability of your agroforestry project. Based on the figures from Table 12, the *Net Present Value* (NPV), *internal rate of return* (IRR), *initial investment cost*, *payback year*, and *cost-benefit ratio* are calculated for your scenario (Table 13).

Table 13. An example of the financial metrics evaluating the example scenario used for this manual.

Net Present Value (NPV)	€ 37 200.72
Internal Rate of Return (IRR)	13%
Investment cost (excl. VAT and without subsidies)	€ 21 313.77
Payback year	11
Cost-Benefit Ratio	1 : 2.67

NPV: IS YOUR SCENARIO A GOOD IDEA FINANCIALLY?

The first metric to discuss is the net present value or *NPV*, which answers the question: 'Is your scenario a good idea financially?'. As the *NPV* compares the present value of its expected cash inflows with the present value of its expected cash outflows, this metric determines whether your investment will generate returns that exceed the initial investment, considering the time value of money (Vipond, 2023). In other words, the *NPV* resembles how much future money is worth the investment is worth today compared to its initial costs. For a profitable business, the *NPV* should be positive. If the *NPV* of your scenario turns out to be positive, it indicates that your agroforestry project's rate of return will be above the discount rate. However, a negative *NPV* suggests that your agroforestry project may not be economically viable; you will lose money when you adjust it for today's value (Fernando, 2024b). When your scenario has a negative *NPV*, we advise you to reconsider the choices that you have made in the beginning. However, be aware that only fresh products are adopted as benefits in INTACT which could affect your outcome if you desire to sell other products such as processed goods and/or social services.

IRR: WHAT IS THE ANNUAL PERCENTAGE RETURN THAT YOU CAN EXPECT FROM THIS INVESTMENT?

The *IRR* answers the question: 'What is the annual percentage return that you can expect from this agroforestry scenario's investment?' While using the same calculations for *NPV*, the difference lies in setting the *NPV* equal to zero for the *IRR* calculations. By doing so, we can find the growth rate that makes your investment break even. In addition, the *IRR* identifies the annual growth rate that your investment is expected to generate (Vipond, 2023).

Thus, the *IRR* shows how quickly your money is expected to grow each year from the initial investment which is why the preference goes to the investment with the highest *IRR* (Fernando, 2024c).

INVESTMENT COST: HOW MUCH DOES THE INITIAL INVESTMENT COST?

The *investment cost* is simply the initial investment at year 0. It is important to mention that the investment cost was calculated without VAT and without using subsidies. Ideally, your investment cost is as low as possible.



PAYBACK PERIOD: WHEN CAN YOU EXPECT YOUR INITIAL INVESTMENT BACK FROM THE AGROFORESTRY PROJECT'S EARNINGS?

The *payback period* reflects when you can expect your initial investment back from your scenario's earnings. In INTACT, this is shown as year X after planting. As Year 0 is the year of planting, note that a *payback year* of e.g. 11 (Table 13) resembles a *payback period* of 12 years. In Figure 9, the *payback period* is visualized with a black arrow, indicating the moment when the cumulative cash flow exceeds costs for the first time since starting the project (Figure 9).

COST-BENEFIT RATIO: IS THE BENEFIT OF THE AGROFORESTRY PROJECT WORTH THE COST?

The cost-benefit ratio is an indicator used to determine the viability of cash flows generated from your agroforestry project. It resembles the ratio between how much cost you put into your investment and how much proportionally rolls out as a return. A ratio of 1:2 means you earn back twice as much as you invested. However, 1:0.5 means that the plan is not profitable because you will earn back half your investment.



INTERPRETING THE GRAPH

The graph on your screen shows the cumulative costs, benefits, and free cash flow versus time (i.e. years after planting). From these three lines, we can read two things: 1) the *breakeven point*, and 2) the *payback year* (and period).

The *breakeven point* is the moment when no loss but also no profit is made. Figure 9 clearly shows when the *breakeven point* is, namely at the point that the blue line intersects with the red line. The breakeven point is indicated by a blue arrow. In this scenario, the *breakeven point* is reached at approximately 9 years after planting the trees.

The *payback year* is indicated by a black arrow, showing the point at which cumulative cash flow exceeds 0 for the first time. The *payback year* is reached approximately 11 years after planting the trees.

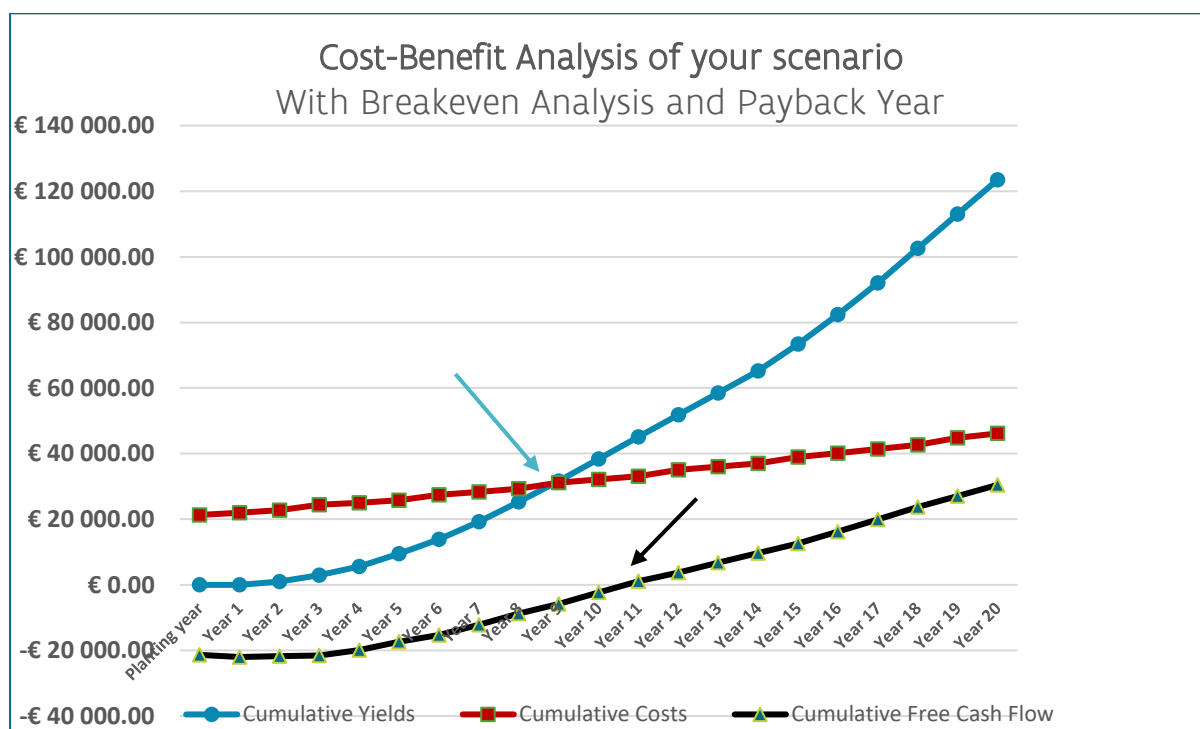


Figure 9. An example of the cost-benefit analysis for the first 20 years after planting trees on an agroforestry plot. The blue arrow indicates the breakeven point, whereas the black arrow shows the payback year.



WEB TOOL TIPS

The table shows the annual costs and benefits. Tip: take a screenshot of this page.

Autonomie Vlaanderen

Cost-benefit analysis:

Cost-benefit analysis of your agroforestry scenario
scroll to the left if you do not see the last years of the overview.

	Year 0 (planting)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Years 21-50		
Income																								
Fruits and nuts	0.00	0.00	0.00	0.00	884.00	1298.00	1728.00	2251.00	2787.00	3342.00	3908.00	3988.00	3988.00	3988.00	3988.00	3988.00	3988.00	3988.00	3988.00	3988.00	10548.00	10878.00	11208.00	0.00
Wood	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3652.69	22778.37	
Total per hectare	0.00	0.00	0.00	0.00	432.00	648.00	864.00	2625.50	3385.50	4171.00	4944.00	4944.00	4944.00	4944.00	4944.00	4944.00	4944.00	4944.00	4944.00	4944.00	5274.00	5439.00	7430.34	11309.19
Cost																								
Costs for your agroforestry	425.00	0.00	0.00	0.00	2162.85	176.47	233.29	500.00	2785.20	1000.00	1250.00	1250.00	3295.20	1250.00	1250.00	1250.00	3295.20	1250.00	1250.00	1250.00	1250.00	3295.20	1250.00	1250.00
Total per hectare	212.50	0.00	0.00	0.00	1081.42	88.24	117.65	250.00	1397.60	500.00	625.00	625.00	1647.60	625.00	625.00	625.00	1647.60	625.00	625.00	625.00	625.00	625.00	1647.60	625.00
Balance / balance sheet																								
Total income	0.00	0.00	0.00	0.00	864.00	1296.00	1728.00	5251.00	6787.00	8342.00	9888.00	9888.00	9888.00	9888.00	9888.00	9888.00	9888.00	9888.00	9888.00	10548.00	10878.00	14860.69	22778.37	
Total costs	425.00	0.00	0.00	0.00	2162.85	176.47	233.29	500.00	2785.20	1000.00	1250.00	1250.00	3295.20	1250.00	1250.00	1250.00	3295.20	1250.00	1250.00	1250.00	1250.00	3295.20	1250.00	1250.00
Free cash flow	-425.00	0.00	0.00	0.00	-1298.85	1119.53	1492.71	4751.00	4001.80	2742.00	8638.00	8638.00	6592.80	8638.00	8638.00	6592.80	8638.00	8638.00	8638.00	8638.00	9298.00	9623.00	13565.49	21528.37
Discounted free cash flow	-425.00	20700.36	19904.19	18138.64	18402.54	17694.75	17014.18	16359.79	15730.57	15125.55	14543.00	13964.42	13446.56	12929.38	12432.10	11953.94	11494.17	11052.09	10627.01	10216.28	9825.27	9447.37		
Cash flow (cumulative)	-425.00	-425.00	-425.00	-425.00	-1723.80	-604.30	888.40	5639.40	9641.20	16983.20	25621.20	34259.20	40852.00	49490.00	58128.00	66766.00	73358.80	81396.80	91294.80	100922.80	112488.30	134016.60		

Net Present Value 32353.34€
Internal rate of return (IRR) 21.7%
Investment cost (excl. VAT and without subsidy) €425
Payback year 6

Once you scroll down, you will see a graph visualising the numbers from the table. You can click the green button to change from plot level to per hectare.





APPENDIX

I. SPECIES LIST FOR TREES AND SHRUBS

Species list in alphabetical order of Latin name. For each species, the harvestable product(s) is indicated. There are 3 main categories: wood, nuts and fruits.

Other harvestable products will be provided in the newer version of INTACT (INTACT 2.0).

English name	Latin name / Scientific	Fruits/Nuts	Wood
Maple - Field	<i>Acer campestre</i>		Quality, biomass
Maple - Norway	<i>Acer platanoides</i>		Quality, biomass
Maple - Sycamore or planetree	<i>Acer pseudoplatanus</i>		Quality, biomass
Maple - Sugar	<i>Acer saccharum</i>	Syrup*	Quality, biomass
Kiwiberry	<i>Actinidia Arguta</i>	Fruit	
Kiwi	<i>Actinidia chinensis</i>	Fruit	
Horse chestnut	<i>Aesculus hippocastanum</i>	Nuts	Quality, biomass
Alder - Italian	<i>Alnus cordata</i>		Biomass
Alder - Common	<i>Alnus glutinosa</i>		Biomass
Alder – European gray	<i>Alnus incana</i>		Biomass
White alder variety	<i>Alnus incana 'Aurea'</i>		Biomass
Juneberry, serviceberry or shadbush	<i>Amelanchier lamarckii</i>	Fruit	
Red chokeberry	<i>Aronia arbutifolia</i>	Fruit	
Pawpaw 'Davis'	<i>Asimina triloba</i>	Fruit	
Silver birch	<i>Betula pendula</i>		Biomass
Downy birch	<i>Betula pubescens</i>		Biomass
Hornbeam	<i>Carpinus betulus</i>		Quality, biomass
Sweet chestnut	<i>Castanea sativa</i>	Nuts	Quality, biomass
Sweet chestnut - ennobled	<i>Castanea sativa (veredeld)</i>	Nuts	Quality, biomass
Sweet chestnut 'De Lyon'	<i>Castanea sativa 'De Lyon'</i>	Nuts	Quality, biomass
Yellow dogwood	<i>Cornus mas</i>	Fruit	
Red dogwood	<i>Cornus sanguinea</i>	Fruit	
Hazel and cultivated varieties	<i>Corylus avellana</i>	Nuts	Quality, biomass
Hazel - ennobled	<i>Corylus avellana (veredeld)</i>	Nuts	Quality, biomass
Turkish hazel	<i>Corylus colurna</i>	Nuts	Quality, biomass
Hawthorn – Two-tiered	<i>Crataegus laevigata (oxyacantha)</i>	Fruit	
Hawthorn	<i>Crataegus monogyna</i>	Fruit	
Quince	<i>Cydonia oblonga</i>	Fruit	
Silverberry or Oleaster	<i>Elaeagnus x ebbingei</i>	Fruit	
European spindle or Common spindle	<i>Euonymus europaeus</i>		



Green beech	<i>Fagus sylvatica</i>		Quality, biomass
Red beech	<i>Fagus sylvatica atropunicea</i>		Quality, biomass
Fig	<i>Ficus carica</i>	Fruit	Quality, biomass
Common ash	<i>Fraxinus excelsior</i>		Quality, biomass
Buckthorn	<i>Hippophae rhamnoides</i>		
Holly	<i>Ilex aquifolium</i>		
Walnut - Hybrid	<i>Juglans hybride / intermedia</i>	Nuts	Quality, biomass
Walnut - Black	<i>Juglans nigra</i>	Nuts	Quality, biomass
Walnut - Persimmon	<i>Juglans regia</i>	Nuts	Quality, biomass
Walnut – Persimmon ennobled	<i>Juglans regia (veredeld)</i>	Nuts	Quality, biomass
Walnut 'Broadview'	<i>Juglans regia 'Broadview'</i>	Nuts	Quality, biomass
Walnut 'Buccaneer'	<i>Juglans regia 'Buccaneer'</i>	Nuts	Quality, biomass
Honey berry	<i>Lonicera edulis kamtschatica</i>	Fruit	Quality, biomass
Goji berry	<i>Lycium barbarum</i>	Fruit	Quality, biomass
Apple	<i>Malus domestica</i>	Fruit	Quality, biomass
Apple – cultivated varieties	<i>Malus domestica cv</i>	Fruit	Quality, biomass
Medlar	<i>Mespilus germanica</i>	Fruit	
Mulberry – White mulberry and cultivated varieties	<i>Morus alba</i>	Fruit	
Mulberry – Black mulberry and cultivated varieties	<i>Morus nigra</i>	Fruit	
Poplar - White	<i>Populus alba</i>		Biomass
Poplar – Canadian or Hybrid Black	<i>Populus canadensis robusta</i>		Biomass
Poplar - Grey	<i>Populus canescens</i>		Biomass
Poplar - Black	<i>Populus nigra</i>		Biomass
Poplar - Italian	<i>Populus nigra italica</i>		Biomass
Aspen - Quaking	<i>Populus tremula</i>		Biomass
Apricot	<i>Prunus armeniaca</i>	Fruit	Quality, biomass
Wild cherry	<i>Prunus avium</i>	Fruit	Quality, biomass
Sweet cherry	<i>Prunus avium</i>	Fruit	Quality, biomass
Sour cherry	<i>Prunus cerasus</i>	Fruit	Quality, biomass
Plum	<i>Prunus domestica</i>	Fruit	Quality, biomass
Almond	<i>Prunus dulcis</i>		
European birdcherry	<i>Prunus padus</i>		Quality, biomass
Peach	<i>Prunus persica</i>	Fruit	Quality, biomass
Nectarine	<i>Prunus persica nucipersica</i>	Fruit	Quality, biomass
Blackthorn	<i>Prunus spinosa</i>		Quality, biomass
Pear – Wild pear	<i>Pyrus communis</i>		Quality, biomass
Pear varieties	<i>Pyrus communis</i>	Fruit	Quality, biomass
Nashi pear	<i>Pyrus pyrifolia</i>	Fruit	Quality, biomass



Oak – Sessile, Cornish, or Irish	<i>Quercus petraea</i>	Nuts	Quality, biomass
Oak – English, European, or Common	<i>Quercus robur</i>	Nuts	Quality, biomass
Oak – Northern red	<i>Quercus rubra</i>	Nuts	Quality, biomass
Buckthorn – European, Common, Purging	<i>Rhamnus cathartica</i>		
Buckthorn – Alder	<i>Rhamnus frangula</i>		
Currant – Black	<i>Ribes nigrum</i>	Fruit	
Currant - White	<i>Ribes rubrum</i>	Fruit	
Gooseberry	<i>Ribes UVA-CRISPA</i>	Fruit	
Jostaberry	<i>Ribes X NIDIGROLARIA</i>	Fruit	
Black locust	<i>Robinia pseudoacacia</i>		Quality, biomass
Blackberry	<i>Rubus fruticosus</i>	Fruit	
Raspberry	<i>Rubus Idaeus</i>	Fruit	
Wine raspberry	<i>Rubus Phoenicolasius</i>	Fruit	
Willow – White var.	<i>Salix alba Belders (var.)</i>		Biomass
Willow - Goat	<i>Salix caprea</i>		Biomass
Black elder	<i>Sambucus nigra</i>		
Red elderberry	<i>Sambucus racemosa</i>		
Whitebeam - Common	<i>Sorbus aria</i>		
Rowan or Mountain Ash	<i>Sorbus aucuparia</i>		Quality, biomass
Service tree or Sorb tree	<i>Sorbus domestica</i>	Fruit	Quality, biomass
Whitebeam - Swedish	<i>Sorbus intermedia</i>		Quality, biomass
Wild service tree	<i>Sorbus torminalis</i>	Fruit	Quality, biomass
Linden – Small-leaved	<i>Tilia cordata</i>		Quality, biomass
Linden – Large-leaved	<i>Tilia platyphyllos</i>		Quality, biomass
Elm – European white	<i>Ulmus laevis</i>		Quality, biomass
Elm - Wych	<i>Ulmus spp.</i>		Quality, biomass
Blueberry - Highbush	<i>Vaccinium corymbosum</i>	Fruit	
Blueberry - European	<i>Vaccinium myrtillus</i>	Fruit	
Lingonberry	<i>Vaccinium vitis-idaea</i>	Fruit	
Wayfaring tree	<i>Viburnum lantana</i>		
Guelder-rose	<i>Viburnum opulus</i>		
Common grape vine	<i>Vitis vinifera</i>	Fruit	

*Since maple syrup is an interesting by-product, it has been chosen to include it as well. However, in a period of 20 years, maple syrup cannot be harvested.



II. AVAILABLE TREE SPECIES FOR DETERMINING WOOD GROWTH

DBH growth curves of these tree species were available:

1. *Acer pseudoplatanus*
2. *Aesculus hippocastanum*
3. *Corylus avellana*
4. *Fraxinus excelsior*
5. *Juglans regia*
6. *Malus domestica*
7. *Populus x canadensis*
8. *Prunus avium*
9. *Pyrus communis*
10. *Quercus petraea*
11. *Quercus robur*
12. *Robinia pseudoacacia*
13. *Salix spp.*
14. *Sorbus aucuparia*
15. *Sorbus torminalis*
16. *Tilia cordata*
17. *Tilia platyphyllos*
18. *Ulmus spp.*

The DBH growth curves may not be shared at the request of the expert.

Wood densities were obtained from McPherson, E. G., van Doorn, N. S., & Peper, P. J.

(z.d.). *Urban tree database* [Data set]. Forest Service Research Data Archive.

<https://doi.org/10.2737/RDS-2016-0005>



III. GLOSSARY COST-BENEFIT ANALYSIS

Term	Definition in the context of INTACT	Link	Reference
Annual yields	The total amount of money generated by the sale of fruits, nuts, and/or wood in a specific year. In other words, revenue at year X. Unit: €	Revenue vs. Income: What's the Difference? (investopedia.com)	I
Cumulative yields	Total revenue from a specific year plus total revenue from previous years. Unit: €		
Annual costs	Total costs from a specific year. Unit: €		
Cumulative costs	Total costs of the specific year plus total costs incurred in previous years. Unit: €		
Free cash flow (FCF)	The cash generated by your agroforestry project is calculated by subtracting annual yields from annual costs. Unit: €	Free Cash Flow (FCF): Formula to Calculate and Interpret It (investopedia.com)	III
Discounted cash flow	Future cash flows are discounted to their present value. Here, the financial value of money is thus adjusted for the influence of time and the quality of a potential investment is determined. Unit: €	Discounted Cash Flow (DCF) Explained With Formula and Examples (investopedia.com)	II
Discounting rate (forestry)	This is used to calculate the present value of future cash flows. It reflects the opportunity	Cost of Capital vs. Discount Rate: What's the Difference? (investopedia.com)	VI



	<p>cost of investing capital in your agroforestry project. The height of the discount rate used in INTACT is based on forestry investments, which is 4%. This is based on the risk associated with your investment.</p> <p>Unit: %</p>		
Cumulative cash flow	<p>The sum of free cash flow generated by your scenario over a specified period, calculated over 20 years. This provides insights into the liquidity and overall financial performance of your scenario in INTACT.</p> <p>Unit: €</p>	<p>Free Cash Flow (FCF): Formula to Calculate and Interpret It (investopedia.com)</p>	III
Net Present Value (NPV)	<p>The NPV, a financial metric, compares the present value of its expected cash inflows with the present value of its expected cash outflows. It helps in determining whether your investment will generate returns that exceed the initial investment, considering the time value of money.</p> <p>A positive NPV indicates that your agroforestry project is expected to generate value, while a negative NPV suggests that your agroforestry project may not be economically viable.</p> <p>Unit: €</p>	<p>Net Present Value (NPV): What It Means and Steps to Calculate It (investopedia.com)</p> <p>NPV Formula - Learn How Net Present Value Really Works, Examples (corporatefinanceinstitute.com)</p>	IV; XI
Internal Rate of Return (IRR)	<p>The expected compound annual rate of return that will be earned on your agroforestry project.</p> <p>Unit: %</p>	<p>Internal Rate of Return (IRR): Definition, Examples and Formula (corporatefinanceinstitute.com)</p>	V



Investment	<p>The total amount of money invested in your project.</p> <p>Unit: €</p>		
Payback year and period	<p>The payback period refers to the amount of time needed until the investment reaches a breakeven point. Hence, it is more desirable to invest in your project if the payback period is short.</p> <p>The <i>payback year</i> in INTACT refers to the moment at which cumulative cash flow exceeds 0 for the first time since starting the project.</p> <p>Unit: years after planting</p>	<p>Payback Period Explained, With the Formula and How to Calculate It (investopedia.com)</p>	VI
Breakeven point	<p>The point at which there is no profit but also no loss. This is the intersection of cumulative costs and cumulative revenues.</p> <p>Unit: N.A.</p>	<p>Breakeven Point: Definition, Examples, and How to Calculate (investopedia.com)</p>	IX
Cost-benefit ratio	<p>The ratio between how much cost you put into your investment and how much proportionally rolls out as return. A ratio of 1:2 means you earn back twice as much as you invested. However, 1:0.5 means that the plan is not profitable because you will earn back half your investment.</p> <p>Unit: N.A.</p>	<p>Benefit-Cost Ratio (BCR) - Overview, Formula, Example (corporatefinanceinstitute.com)</p>	X



IV. REFERENCES

On the website of Agroforestry Vlaanderen, two websites were consulted frequently while developing INTACT. The [Knowledge Hub \(Kennisloket\)](#) is an online library where information (e.g. factsheets, videos, articles, etc.) is bundled per theme. Secondly, the [Agroforestry Planner](#) was used to host INTACT alongside other decision support tools that are relevant to agroforestry systems.

Instead of offering one bibliography, references are grouped into:

- References: Local figures & tools;
- References: Practical information and figures;
- References: Financial terms;
- Tips about marketing wood.

REFERENCES: LOCAL FIGURES & TOOLS

Figures and information have been collected up to 2023, they have been used to build INTACT. Figures come from:

- "Actieclusters" led by ILVO. This is a group of farmers and experts who gather to discuss topics around a relevant theme within agroforestry. For example, there is a group that discusses nut production and another group discusses fruit production. During these discussions, data is shared which is then used in calculations in INTACT;
- Belgian and Dutch tree nurseries, organisations, and companies;
- Experts;
- Input from Consortium Agroforestry Vlaanderen;
- Knowledge hub (kennisloket) Agroforestry Vlaanderen;
- Normenboek NBL 2020 Van Hall Larenstein University of Applied Sciences, KWIN NL 2020 (WUR). This handbook summarizes labour (time and costs) for forestry management-related activities.

In addition, external calculation tools used as input and/or inspiration are:

Tool name	Purpose	Open access	Author or organisation	Links
<i>AgroForestry performance (AFP)</i>	To create a business plan for new agroforestry projects.	No	Marco Bijl (FSG) Marco.bijl@telenet.be <i>The Netherlands</i>	Forestry Service Group, forest related climate services. (nvforest.com)
<i>Berekentool</i>	To calculate costs for establishing and maintaining food forests.	No	Louis de Jaeger louis@eatmoretrees.org <i>Belgium</i>	Louis De Jaeger - The Official Website of Louis de Jaeger
<i>Voedselbos rekentool 3.0</i>	To calculate costs for establishing and	Yes (v4.0)	Daan Groot (HAS) d.groot@has.nl	Rekentool Voedselbossen - WUR



maintaining food forests.		The Netherlands	
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3. [Boombescherming - Obs'Herbe \(obssherbe.be\)](https://obssherbe.be)
4. [Compostgebruik is ideaal voor aanplant van bomen \(vlaco.be\)](https://vlaco.be)
5. [Guide technique de l'agroforesterie \(transagroforest.eu\)](https://transagroforest.eu)
6. [Haagplanten: blote wortels, kluit of in pot? \(garmundo.nl\)](https://garmundo.nl)
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TIPS ABOUT MARKETING WOOD:

- Ecopedia uses good terminology for quality wood, so it is advisable to visit this website ([Definition of quality wood | Ecopedia](#)).
- There are indeed figures on timber prices, they appear annually in Silva Belgica. See annex for the 2023 figures for the known species (oak etc.) and firewood (all on logs).
- As for those niches, roundwood auction prices in the Netherlands and, for the past five years, also in Flanders, are a good source.
- To judge what can or cannot be sold as quality wood/niche, you can look at the roundwood auction and at the [European Forest Tree Atlas](#), each of which also includes a paragraph on use.

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