

Costs and key points of managing a non-tillage orchard

Running a non-tillage orchard mainly has four types of costs: (1) **irrigation costs**, which include the cost of installing the hoses for the first time, the time to adjust them at the start of each growing period, and the time of the irrigation itself; (2) **costs of planting**, which include the price of the plant and the time to plant; (3) **costs of controlling adventitious plants**, including time to remove them on roads and between crops; and (4) **costs of applying forest products and compost**, including the time it takes to apply them.

■ Quantification of the running costs of a non-tillage orchard

The quantification of the functioning of a non-tillage orchard is based on calculating the various costs:

1. **Cost of irrigation.**
2. **Cost of plantation.**
3. **Cost of controlling adventitious plants.**
4. **Cost of applying forest products and vegetable fertilisers.**

Next, we will describe the different alternatives that we have analysed for each of these processes, indicating the costs they represent and their variability (Table 1). **The cost of livestock that can graze in the orchard is not included**, as it is part of a different element of Polyfarming.

1. **Cost of irrigation.** This cost includes four components:
 - The first cost is the irrigation material. The most common system is based on having a **central pipe** (63 mm in Planeses) from which the smallest 40 mm **perforated hoses** come out for each line. In the Planeses orchard this system includes about 80 m of main hose pipe (price around €1.5/m) plus the variable distance to where the water source is, and 75 m of smaller pipe per line (€0.5/m).
 - To this is added the cost of **making the trenches to introduce the hoses of the lines**. It can be done with a motor trencher (rented, €250/day), the worker walks at a normal walking speed (5-6 km/h, 1 km every 10 min), i.e. it takes 1-2 min to travel the 75 m. **If done manually, it takes longer, approximately 30 min to dig the 75 m.**
 - At the start of each growing period it is necessary to **prepare the hose system**: dig them up, clean the holes, start watering, test that water comes out of all the holes and uncover those that are closed. In total, the time needed to prepare 100 m of hose can be estimated at half an hour.
 - Finally, **the irrigation time itself is also considered**. In the first few days we should water every other day and after this time we should water depending on the weather. At Planeses, with the required flow rates, up to 4 lines can be watered at the same time for 20-30 minutes. **The time to change lines is very short**, but it forces a worker to be vigilant throughout the irrigation, although he/she may be doing other work.

2. **Cost of plantation.** The first cost to consider is **the price of the plants, which can vary considerably depending on what is planted**. The price of the plants depends on the species of plant that is planted, ranging between €0.1 and €0.2. Then there is **the time to plant them**. Normally, it is done manually, and it takes one garden worker 40 min for every 100 plants planted.

3. **Cost of controlling adventitious plants.** The costs of removing adventitious plants depend on where they grow in the garden:

- **Adventitious plants that come out on the main roads or on the paths of the lines are cut with a brush cutter**. In this case, it takes workers 2 minutes for each 75 m line, since they are walking slowly (about 3 km/h) and cutting the vegetation as they go.
- **Plants growing in the line or between crops have to be removed manually with scissors** so as not to disturb the crops. In this case, the yield is much lower: 1-1.5 h per 75 m line.

4. **Cost of applying forest products and plant fertilisers.** In all cases, the products are obtained directly from the orchard (manures) or from other uses of the farm such as the forest or animals (BRF, compost, biofertilisers), so **their cost can be considered 0**. There may be a cost for their application.

- The **manures** that are added to the orchard are the result of cutting dry crops or adventitious plants. Therefore, **no extra time dedicated to its application should be counted**.
- **BRF or compost is placed in the orchard trenches** early in the production period. The BRF takes approximately 0.75 hours to apply to the trench of a 75 m line.
- **Biofertilisers** should be applied every 2 days for the first 10 days, and each time it takes 4 min per 75 m line, including the time to recharge the backpack.

Once the orchard is working, **maintaining it involves other costs such as training some crops** (such as beans or tomatoes) **or harvesting the products obtained**. We have not included these costs, because they depend on the crops planted and the procedure followed at each farm.

From these considerations, we can establish a series of simple calculations to estimate the overall costs of running a non-tillage garden. The overall cost is the sum of four costs:

$$C_{\text{total}} = C_{\text{irrigation}} + C_{\text{planting}} + C_{\text{adventitious plant control}} + C_{\text{application}}$$

Irrigation, the sum of four costs:

$C_{\text{material}} = 80 \text{ m} \times \text{€ } 1.5/\text{m}$ (main hose, cost to be distributed among the different lines) + $75 \text{ m} \times \text{€ } 0.5/\text{m}$ (smallest hose) (per 75 m bed)

$C_{\text{installation (motor trencher)}} = 0.03 \text{ h} \times \text{Salary}/\text{h} + 0.03 \text{ h} \times \text{€ } 250/24\text{h}$ (per 75 m line)

$C_{\text{installation (manual)}} = 0.5 \text{ h}/75 \text{ m line} \times \text{Salary}/\text{h}$ (per 75 m line)

$C_{\text{adequacy}} = 0.5 \text{ h}/100 \text{ m} \times \text{Salary}/\text{h}$ (every 100 m of hose)

$C_{\text{irrigation}} = 0$ (if compatible with other jobs)

Planting, the sum of two costs:

$C_{\text{plants}} = \text{€ } 15/100 \text{ plants}$

$C_{\text{plantation}} = 0.66 \text{ h}/100 \text{ plants} \times \text{Salary}/\text{hour}$
(manual planting of 100 plants)

Control of adventitious plants, it depends on where they are:

$C_{\text{paths}} = 2 \text{ min}/\text{line of } 75 \text{ m}$ (on paths)

$C_{\text{trenches}} = 60 \text{ min}/75 \text{ m line}$ (in the trench or between plants)

Products application (per 75 m bed), it depends on the product we apply:

$C_{\text{BRF}} = 0.75 \text{ h}/75 \text{ m line} \times \text{Salary}/\text{h}$

$C_{\text{biofertilisers}} = 0.06 \text{ h}/75 \text{ m line} \times \text{Salary}/\text{h}$
(per application)

$C_{\text{fertilisers}} = 0$

■ Considerations on the optimal strategy for operating a non-tillage orchard

We must consider the following **key points** in the functioning of a non-tillage orchard:

- The **installation and adaptation of irrigation** is key in an intensive cultivation such as an orchard, so irrigation is essential for its operation.

- The **cost of the plants** is totally variable, it will depend on the species and the quantity that is planted, as well as the time it takes to plant them.

- **Controlling adventitious plants** is one of the most important costs in a non-tillage orchard. And it is especially important to do it just before they can affect the crops, although in general it is a task that is performed almost continuously throughout the entire period of the orchard's operation.

- **The application of products**, such as **BRF** at the beginning, **vegetable manures** when they are produced, or **biofertilisers** at different times of crop growth, allow a healthy soil to be maintained with a high level of fertilisation.

Parameter	Unit	Value used	Variability and causes
Irrigation material – central hole	€/m	1.5	The total amount needed varies according to the layout of the orchard and the distance from the water source
Irrigation material – line hole	€/m	0.5	The cost per line depends on the length of the bed, in the case of Planeses they are 75 m long
Rental of the motor-trencher to make furrows in the orchard	€/day	250	The price may depend on the specific offer in the area
Time to make the 75 m trench with a motor trencher	min	2	It is the time it takes to slowly walk 100 m
Time to make the 75 m trench manually	min	30	We have to stop often and remove the soil that falls into the trench
Preparation time of the hoses at the start of the orchard season	h/100 m	0.5	It includes digging up the hose, cleaning the hole and testing that water comes out of all the holes
Cost of plants for planting	€/100 plants	15	It varies considerably depending on the species planted, and can vary between €10 and €20 per 100 plants
Cost of plants for planting	h/100 plants	0.66	This is the time it takes to do it manually, several tools may reduce it
Time to eliminate adventitious plants on the paths of the lines with a brush cutter	min/75-m line	2	We must progress slowly and cut the vegetation continuously
Time to remove the adventitious plants between the plants on the lines manually	min/75-m line	60	It can be more, up to 90 min, if there are lots of adventitious plants and they are in close contact with the crops
BRF application time	min/75-m line	45	Only applied once at the start of the production period
Biofertilisers application time	min/75-m line	4	They are applied every two days after planting, and then every 5-7 days as needed
Plant manures application time	min/75-m line	0	The manures are the result of cutting dry crops or adventitious plants, so there is no extra time for their application

Table 1. Parameters used in the calculation of the operating costs of a no-till orchard, indicating the values used in Polyfarming and the possible variability that can occur in these values.