

# **HAZELNUT COLLECTION, CALIBRATION AND SHELLING**

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## **Abstract**

Manual harvesting is the most limitative operational handicap for the expansion of hazelnut cropping in Portugal, yet the importing equipments is not a realistic alternative option because it is very expensive and are not adapted to Portuguese hazelnut orchards.

In an attempt to overcome this shortcoming, a small-size and low-cost equipment is being developed for mechanical harvesting and two others were prepared for calibration and shelling, all within the scope of an AGRO 162 project called “Yield increase on hazelnut crops in Portugal”.

The hazelnut harvesting equipment is composed of a hopper, a four-stroke engine, a ventilator, two flexible tubes for conveying the draw in material and a wheelbarrow required to drive the assemblage. The calibrator is built with three iron sieves mounted in a slope position to allow the hazelnuts rolling. The shelling equipment is made essentially by a metallic roll driven by an electrical engine, with two rulers, positioned in accordance with the generating roll, that compress the hazelnuts against a wooden ruler. The distance between the roll and the wooden ruler can be adjusted.

The trials on hazelnut harvesting allowed to obtain works rate from 23 to 40 h/ha, depending on the conditions of the test. The calibrator was designed to obtain lots four different lots sizes. The shelling equipment performances depend greatly on the size of the lot, being the best results obtained with the biggest hazelnuts.

As a summary can be stated that this harvesting equipment is a reasonable solution for short acreage orchards, where a low work rate is allowed, since it has a low price. The shelling equipment provides a good percentage of shelling hazelnuts in the upper lots, but in the lower ones it is necessary to do more than one shelling operation; this limitation can be reduced if the we have more sieves to get more lots of small hazelnuts.

## **INTRODUCTION**

Hazelnut orchards represents a important culture of North Portugal, but the low prices of foreign hazelnuts and the high labour costs, special due to the lack of mechanization of some cultural operations, namely harvest, has contributed to the diminishing area.

Analysing some foreign harvesters equipments, we did not find the right solution for most Portuguese hazelnut orchards as the small ones are hard to operate and has a low work rate, what makes the work labour increase to much, and the biggest ones are to expensive and will have problems to go through the trees.

So, with the purpose of lowering the production costs, turn less hard the harvest labour and facilitate the equipments usability in the orchards, we decided, in the scope of project AGRO 162 “Yield increase on hazelnut crop in Portugal”, to create some simple equipments for the harvest, calibration and shelling the fruits.

## MATERIAL AND METHODS

### The hazelnut harvester AGRO 162

The manual hazelnut harvester from de ground is an operation less and less used because has a low work rate, 6 - 8 kg/h (50 - 60 kg/day), which increase too much the production cost. The work rate can be improved assembling the trees productions in piles, strips or putting traps under the canopy but, with these solutions, only the countries with cheap work labour can support economically this operation.

For the mechanised collection there are several kinds of equipments whose utilisation depends of the orchard installation, especially the trees conduction, distances, ground characteristics, and so on.

Analysing the several options of collecting hazelnuts, either the manuals or the mechanised ones, and considering the Portuguese orchard characteristics we decided to develop a equipment with the present characteristics.



**Figure 1-** Hazelnut harvester AGRO 162

### 1- Constitution

The hazelnut harvester AGRO 162 is, as we can see in figure 1, a vacuum harvester basically built by a hopper, a four stroke engine, a ventilator, two flexible tube for conveying the aspirated material and a wheelbarrow to allow the operator to move the set.

The hopper is part (2/3) of a 200 L tank where we open, in the lower part, a door to remove the material deposit inside the tank and, in the upper part, two air admissions, where are connected, tangentially, the two flexible aspiration tubes.

The four stroke engine combustion has 6 hp @ 3000 rpm and was taken from a cutter bush.

The ventilator, in cast iron, with 42.5 cm diameter and 8 blades, positioned horizontally, is mounted in the engine shaft; the ventilator, that works inside a carter, is deviated from the centre, with a hole connected to the hopper and other one, tangential, to the exit of the low weighty aspirated material.

The aspiration tube, with 12 cm wide and 3.5 m long has, in the top, one aluminium tube with a handle, to be held for the operator.

The wheelbarrow let easily transport the equipment since its weight is mainly supported by the wheels. In the beginning the equipment was mounted in a tractor but this makes the set to noisy, more expensive and time consuming to move.

## **2- Working**

The engine, positioned at the arms operator level, is manually launched and work at the high regime. The aspirated material, because the tangentially tubes connection, allows the more weight material, due to the friction with the hopper walls, to deposit in hopper bottom being, the light one, transported to the outside.

It is important to leave a little air entrance in the bottom door used to remove the material, to create a rising air blows to help the transport of light material to the ventilator carter; this opening cann' t reduce significantly the suction power.

## **3- The collection (harvest)**

In the hazelnut collection the work rating is significantly improved when the ground is regular, dry and clean, why is advisable to do some previous works to get this conditions. The ground irregularities, makes the distance between the aspiration tube and fruits, to be different, changing the power suction. The wet soil makes more difficult the hazelnut suction and makes the aspirated soil to settle inside the tubes and hopper, decreasing the suction capacity. The contact of the aspirated material with the land deposited inside the hopper, increase the friction, making that material fall down in the hopper, increasing the debris deposited.

The grasses, especially the gloves, makes more difficult to see the fruits, and the end tube adhere to the vegetation, becoming the operation more stressful; this situation is mainly important in the presence of gramineous weeds.

Relatively to the methodology used in the hazelnut harvest, witch interfere in the work rate, were done several trial, in different conditions, being specially important to display the material in one, or two bands, between rows. The stripe, that can not be very compact, makes the work more easily, because it is not necessary to work close to the trees, which is particular hard in bunch plantations (multistem bush), which is the natural tendency of growth of this specie, and used in a great number of Portuguese orchards; the longest handle rake used to strip the material makes it use less difficult. The strings formation allows a separation among the different material witch lets the leaves stay at the string surface and the fruits close to the ground, witch makes easier a previous leaves remove, increasing the harvesting fruit working rate.

No striping the material involves the aspiration of all the ground surface, with decrease the working rate and increase the aspiration of land, little stones and vegetable debris; in this situation it is important to work from the middle of the space between rows to the trees, to avoid put ones' s foot on fruits.

## **Calibrator AGRO 162**

### **1- Constitution**

The calibrator is built with three iron sieves mounted in a slope positioned, to allow the hazelnuts rolling; the sieves, as we can se in figure 2, can be mounted in two positions, in function of hazelnut roundness. If the hazelnuts roll easily in the sieve we can mounted them one under the other but, if not, is better to mount one after the other, because is more easy to make them move with a rake.

If the sieves are mounted one after the other it is advisable to adapt a cloth structure, in funnel shape, to conduct the hazels to boxes, preventing them to fall down to the ground.

## 2- Working

The hazelnut is deposited in the upper sieve, witch leave to pass the fruits smaller than the distance between separators, falling or rolling the remaining ones, to the next sieves, until they arrive the boxes.



**Figure 2- Calibrator AGRO 162**

The lot formation is essential because, only in that way, it is possible to adjust the shelling machine to crack the shell without break the kernel; the hazelnut selling price is so much high as bigger are the fruits, why it is advisable to do this operation to sell the all fruits.

## The shell equipment AGRO 162

### 1- Constitution

The shell equipment is built, basically, by a metallic roll, with two round metallic bars positioned according the generating roll, drive by an electrical engine, witch shrink the hazelnuts against a wood ruler. The distance between the roll and the wood ruler is adjusted in function of the lot dimension; the round metallic bars, welded to the metallic roll, help the hazelnut transport to the region shrink.

The movement transmission from the electrical engine to the roll is reduced to  $\pm 50$  rpm, which was the regime that allowed to get an expressive rate of unbreak kernel and a high equipment debit; the possibility of changing the rate transmission will be very important why it allowed to adjust the regime to the different hazelnut sizes, but a gear box or a hydraulic transmission will raise the equipment price.

The hopper has in the bottom an adjusted opening to change the hazels amount carried out to the shrink zone and the laterals bottom parts are slopped to avoid the hazelnuts stay there.



**Figure 3-** Shell equipment AGRO 162 and shelled hazelnuts

## **2- Regulation**

The adjustment of this equipment has as main purpose to get the right distance between the roll and the wood ruler. To get this distance we begin to use the distance corresponding to respective sieve and, by trials, short gradually this distance, until we have a biggest percentage of shelled hazelnuts and the lower of break kernel. This approach is done turning a crank that allows the wood ruler approach the roll.

To the smaller lots the shell is improved when is done in two or three steps, so the hazelnuts not shelled in the first time are placed again in the hopper and the distance between the wood ruler and the metallic roll is shorten. This methodology is more hard work but improve the amount of shelling fruits, why its interest must be analysed for each situation, especially for the smaller lots, where the shell crack without damaging the kernel is more difficult, because it fills almost the inside fruit.

## **RESULTS**

The available results reports only to a trial year, why they must be faced with some care.

### **Hazelnut collector AGRO162**

Tests realized in good conditions, with the material spread in the ground (not stringed), allow to get times of 3 - 4 min / tree with  $\pm 2$  kg / tree production. The distances among the trees were 3 x 5 m which correspond to 33 - 34 h/ha, only to the collection and, for a average production of 1335 kg/ha (667 trees \* 2 kg / tree), to empty the hopper, when it has  $\pm 30$  kg, are necessary more 2 - 3 h/ha (1335/30\*3), because, in average, it takes  $\pm 3$  min, to empty it. Total equipment utilisation time, considering the factors mentioned and the time to fill the engine tank, is estimated in  $\pm 40$  h/ha.

In tests realized in hard conditions (material to wet), with strings of  $\pm 1.5$  m width, we had collecting times from 10 to 15 min, for 20 m string length. The production was not measured because it was done a manual collection before. For 3 x 5 m distance among trees, which correspond to a 2000 m string, for the most difficult situation are necessary (15 min / 20 m)  $\pm 25$  h/ha for collecting, which correspond to a total time

of  $\pm 30$  h/ha; for the best situation are necessary 17 h/ha (10 min / 20 m) for collecting which correspond to a total time of  $\pm 20$  h/ha.

**Table 1-** Average times, in hours, to collect hazelnuts

	Stripped material		No stripped material
	Good conditions	Bad conditions	Good conditions
Collection	17	25	34
Empty the hopper	3	3	3
Others (fill the tank)	3	5	3
Total	23	33	40

### **Calibrator AGRO 162**

**Table 2-** Calibrator dimensions, in mm.

	Lot 1 ( $< 14$ mm)	Lot 2 (14 - 16 mm)	Lot 3 (16 - 18 mm)	Lot 4 ( $> 18$ mm)
Minimum	10.92	14.28	16.19	17.89
Maximum	14.72	17.58	19.12	22.56
Average	13.75	15.91	17.23	19.65
Standard deviation	0.72	0.68	0.56	0.97

The incorporation of one more sieve, to get one more lot for the smaller hazelnut, could let to increase the percentage of shelled fruits with only a operation. In alternative we can do one more shelling operation, shorten the distance between the wood ruler and the metallic roller, to shell the smaller ones.

The distance precision between the metallic roller and the wood ruler is fundamental to get goods shelling results why the lot scope size must be so uniform as possible.

### **Shelling equipment AGRO 162**

The lots of the biggest hazelnuts are easier to shell because exist some space between the shell and the kernel.

**Table 3-** Average results, in %, got with the shelling equipment:

Lots sizes (mm)	Intact hazelnuts (%)	Shell hazelnut (%)	Broken kernel (%)
$> 18.0$	10	85	5
16.0 – 18.0	5	80	15
14.0 – 16.0	15	70	15
$< 14.0$	10	65	25

## **CONCLUSIONS**

As main conclusions we can point out:

- the hazelnut orchard conditions are essential to get the better performance of the harvest equipment;

- the vacuum hazelnut equipment is a cheap machinery that allow increase significantly the work collection rate, especially when the material is previously stripped;
- the performance of calibrator equipment, to get homogenous lots, is determinant to the shelling equipment;
- inside each lot, when the size standard deviation is high, is better to shell the hazelnuts in more than one stage, beginning with the high metallic roll - wood ruler distance, diminishing after the distance;
- as the hazelnuts are smaller more difficult is shelling them because the kernel is to close to the shell;
- the performance improvement of these equipments is fundamental to keep the hazelnuts Portuguese orchards in production.

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