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Mechanization of hazelnut production in Germany

Growing of hazelnut in Germany is new and there is little experience in all areas of nut production. Therefore an interdisciplinary research project was initiated. The Institute for Agricultural Engineering and Animal Husbandry in Freising-Weihenstephan took over the task to analyse, realize and evaluate solutions for the mechanization. During the last three years machines or systems could be found or developed for orchard maintenance, harvesting and post-harvest conditioning. Most of the equipment is produced in foreign countries and some of the systems had to be adapted to local conditions first.

Keywords
Hazelnut production, mechanization, orchard management

Abstract
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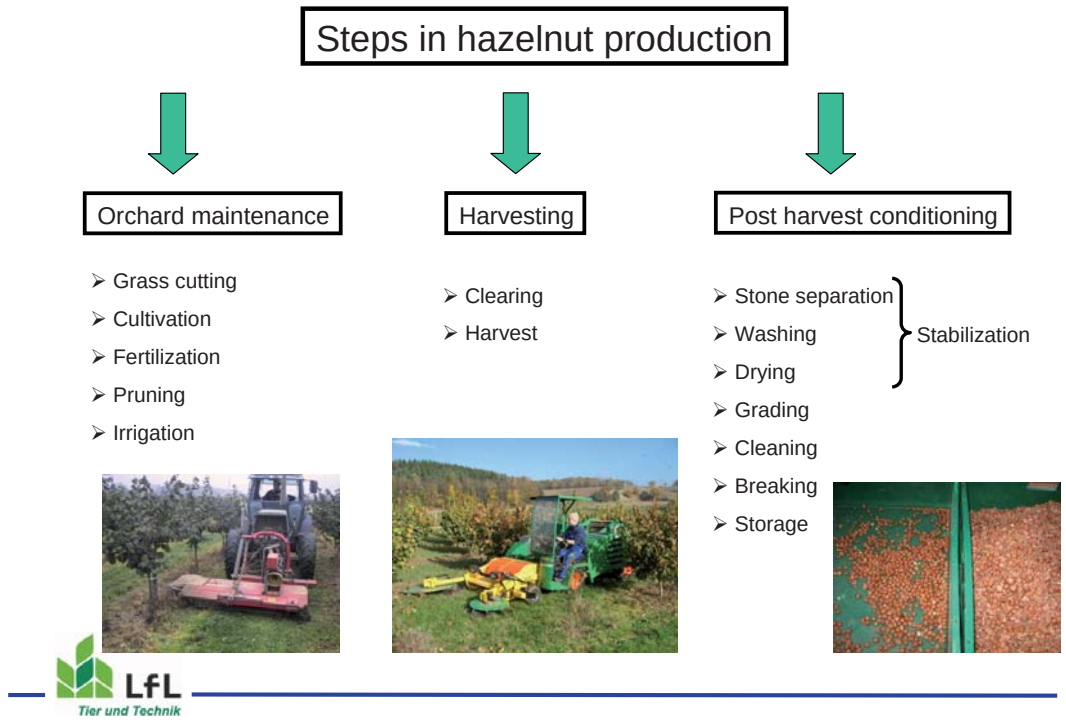
Hazelnuts are cultivated only on a small area in Germany. Currently, this crop is grown on approximately 1,000 ha, of which about 230 ha are situated in Bavaria [1]. Nevertheless, some farms have a cultivated area of more than 10 ha, and the mechanization of the cultivation of this work-intensive crop is indispensable. In Germany, knowledge about the mechanization of hazelnut cultivation is currently small, and virtually no adapted special machines are available. In Turkey, which is the most important hazelnut-growing country worldwide, manual labor is predominant [2]. Farmers in the USA, Italy, and France produce far fewer nuts. However, their mechanization degree is high. Due to the climatic differences, mechanization strategies and machine technology can only conditionally be applied under the conditions in Germany. In the years 2006 until 2008, studies on the mechanization of cultivation and the post-harvest conditioning of hazelnuts were carried out as part of a pilot project for the promotion of hazelnut cultivation in Bavaria. A complete mechanization chain for hazelnuts was designed and tested on a pilot farm in Franconia.

Mechanization chain

Figure 1 shows an overview of the most important work steps in hazelnut cultivation. There are three large main areas.
Care: As of the time of planting, the orchard must be cared for. In addition to pure manual labor, such as tree pruning, different solutions for the mechanization of soil cultivation are available. Like in wine and fruit cultivation, flail choppers with additional mowing tools on arms have proven themselves for the cutting of plants growing in the row area and between the rows. These machines can even work in the row closely to the trunks. In addition to purely mechanically actuated systems, more and more electrohydraulically controlled arms are offered which are advantageous for the care of young, sensitive trees due to their smaller mechanical impact. Once the trees reach a certain height, plant protection can be carried out using fan sprayers for viticulture and fruit cultivation.
Harvest preparation and harvest: Before the harvest, the soil surface in the orchard must be prepared intensively and carefully. Dirt impedes harvesting and post-harvest work and makes it more difficult because the hazelnuts are picked up from the ground by means of sweeping or sucking. Direct harvesting through shaking and catching with screens like in the cherry harvest is difficult because the nuts do not ripen at the same time, but rather in intervals over a longer period. Dirt (stones, loose plants, branches, etc.) must be removed before the harvest. Flail choppers with attached collection containers or special implements for horse paddock or golf course care are suitable for this purpose. The area near the trunks is a problem: The branches hanging down there impede work with the implements, which are often more than one meter tall. Therefore, it can be appropriate to apply a cleaning method from viticulture where the area between the rows is cleaned using row cleaners and the material is transported to the center of the tramline. At the same time, uneven spots, such as molehills, mouse holes, and vehicle tracks can be leveled, which would otherwise also impede the harvest.

During the harvest (**figure 2**), there are different mechanization degrees: from the simple, hand-held aspirator (similar to a leaf aspirator) and tractor-mounted implements to self-propelled sweeping machines or aspirators in different power classes. The purchasing costs range from approximately € 1,000 (simple hand-held implement) to almost € 100,000 for a fully equipped self-propelled machine (engine power > 100 kW, hop-

Fig. 1



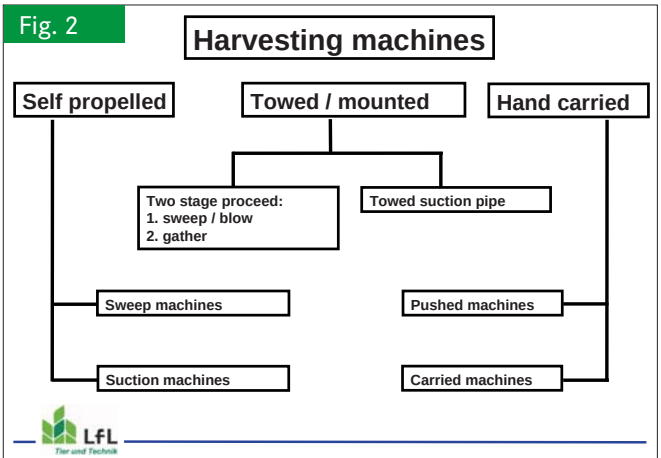
Working steps in hazelnut growing

per content > 2,000 l). Depending on the equipment, the nuts are pre-cleaned in the machines with the aid of chain webs and winnowing steps in combination with suction and pressure fans.

Post-harvest conditioning: The hazelnuts must be cleaned and dried immediately after collection in order to prepare them for storage and to secure quality (**figure 3**).

Under wet, dirty harvesting conditions, the hazelnuts are first cleaned in a drum washer. Afterwards, stones are separated in a sedimentation basin. Under dry harvesting conditions, wet cleaning may not be necessary. In this case, foreign bodies are separated in several steps with the aid of special wind cleaners. Drying is required in any case in order to prepare the nuts for storage. For this purpose, a tobacco drier has been converted into a box drier in the pilot project. The boxes also serve as storage and transport containers. For later processing or sale, the nuts must be calibrated. Drum sifting devices are suitable for this process because their sifters cannot get clogged in contrast to those of vibrating or shock sorters. For sale as cracked merchandise, the nuts must be broken. This work step is very demanding and difficult because the cores often cannot be completely separated from the shells. Highly precise post-cleaning is therefore necessary.

Fig. 2



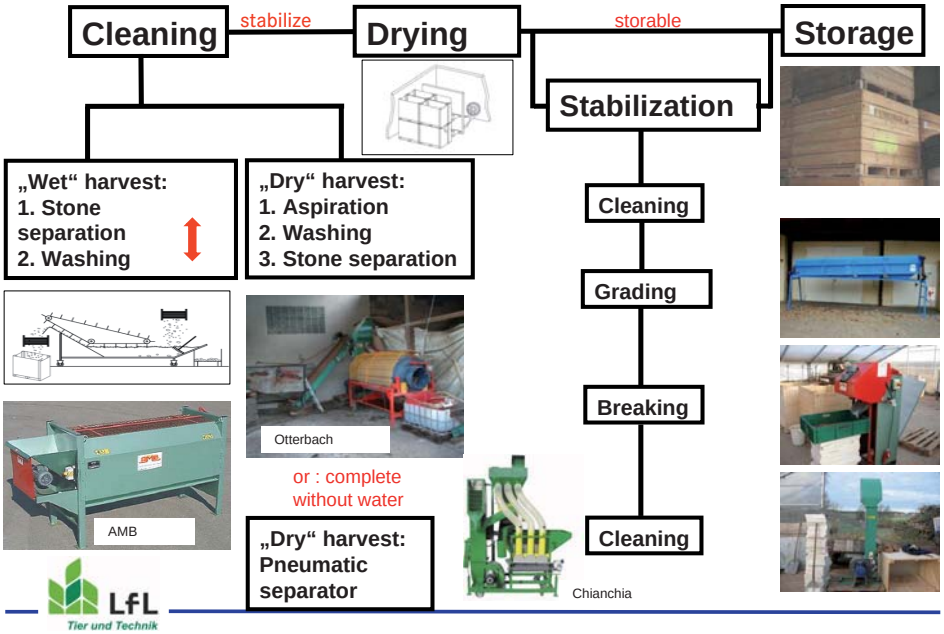
Systematics of harvesters for hazelnuts

Conclusions

Like in the case of many other special and permanent crops, the mechanization of hazelnut cultivation is complex, demanding, and strongly dependent on the conditions at the individual location. In a pilot project, exemplary technical solutions for orchard care, harvesting, and post-harvest conditioning were developed and tested. In most cases, the equipment had to be adapted to the conditions in Germany. Under the prevailing conditions here (number of farmers, average orchard size per farmer), complete mechanization is only realistic if the machines are used cooperatively.

The demand for nuts from German production is considered great. If, however, the processing industry (regional and specialized bakeries) accepts German products in the long run can only be determined when a sufficient supply is available.

Fig. 3



Steps of post-harvest conditioning

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