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Harvesting Aids for White Asparagus

Manually harvesting white asparagus is time-consuming and labour intensive. In recent years harvest aids to reduce the work load have increasingly been developed. Different types of partly mechanised harvesting systems from one to five rows can be found in practice. At the Institute of Agricultural Engineering in Bornim (ATB), in collaboration with the State Experimental Institute Oppenheim, non-mechanised and mechanised harvesting aids have been examined. The results are presented in the following paper.

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Keywords

White asparagus, cutting method, partly mechanised harvesting

Literature

[1] *Hoffmann* zitiert (1999) von Landesforschungsanstalt für Landwirtschaft und Fischerei Mecklenburg- Vorpommern, Institut für Acker- und Pflanzenbau unter http://www.landwirtschaft-mv.de/spargel.mv.

Conventional harvesting of white asparagus is done by using a basket only. This non-mechanised harvesting is very labour-intensive contributing to up to 37% of the total work load in white asparagus production [1]. During the last few years, the use of "black-white" plastic film to cover the ridges got commonly accepted by the farmers. This measure has additionally augmented the amount of work. .

With the aim to reduce labour and costs, several harvesting aids for one- to five-row systems are available on the market. Although the underlying procedures differ in the degree of mechanisation, all aids are constructed to handle the plastic film and to provide transport facilitation for the harvested spears. In this research, the focal question was whether actually ergonomic benefits are generated through the use of mechanised harvesting aids with the consequence that working time is significantly reduced.

Methods of data collection for the comparison of harvesting methods

From 2001 to 2003, a comparative analysis of different work routines in cutting white asparagus based on mechanised and non-mechanised harvesting methods has been carried out. The study comprised field experiments in several asparagus production enterprises in Germany and the Netherlands using "black-white" plastic film.

The work routine of the non-mechanised harvesting method is divided in the following sub-routines: cutting process, walking and plastic film handling. The sub-routines of the partially mechanised method are: cutting process, walking and waiting (in case that in multi-row production systems labour is not continuously provided).

The sub-routine "cutting process" is defined in relation to different cutting methods by the following single routines: digging, cutting, putting the asparagus spear into the basket and closing the ridge.

Single work routines of the harvesting process and sub-routines of the cutting process have been quantitatively analysed by time interval measurements using the Chronarith board (ZT 973, Otto-Otto, Germany). Multi-moment studies were made in order to determine the percentage of waiting time caused by the harvesting aids. Measurements were accompanied by video recordings and visual evaluation of the work routine.

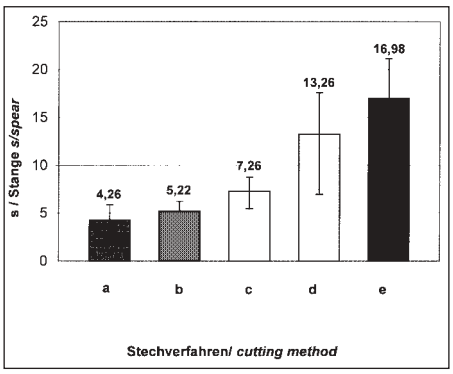

Fig. 1: Labour requirement in sec./ asparagus spear of different cutting methods (not cleared of performance level) a) blind b) partial blind c) digging with training d) digging without training e) digging on heavy soil

Effects of cutting methods on the economic use of harvesting aids

In general, the decision to use or refuse harvesting aids should be made corresponding to cutting methods. In principle, three different cutting methods are used:

1. "cutting blind" (cutting without digging and putting the spear into the basket)
2. "cutting partially blind" (partially digging, cutting and putting the spear into the basket, partially closing the ridge)
3. "digging" (digging for the spear, cutting, putting the spear in the basket, closing the ridge)

Figure 1 shows the specific demand of time for each cutting method in practice. In comparison of all methods "cutting blind" has a time advantage of 3 seconds (70 % relative) compared to the method "digging with training" and of 9 seconds compared to "digging without training" (210 % relative). Thus, "cutting blind" considerably reduces the working time per ha and is able to minimise the work load of the cutting process. Therefore, the use of each harvesting aid is economically advantageous only if "cutting blind" is chosen as the cutting method.

Comparing harvesting methods

When comparing work routines of non-mechanised with partially mechanised harvesting methods, advantages of partially mechanised harvesting methods become evident because the latter does not include the sub-routine "plastic film handling". The me-

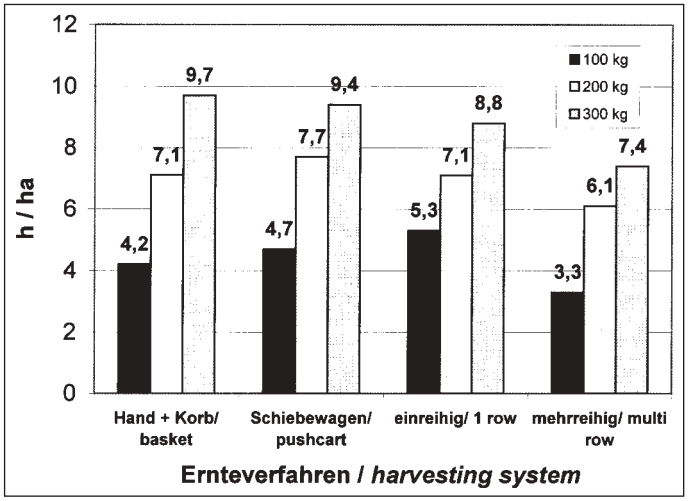

Fig. 2: Working time/ha (cutting „blind", without turning and recovery)

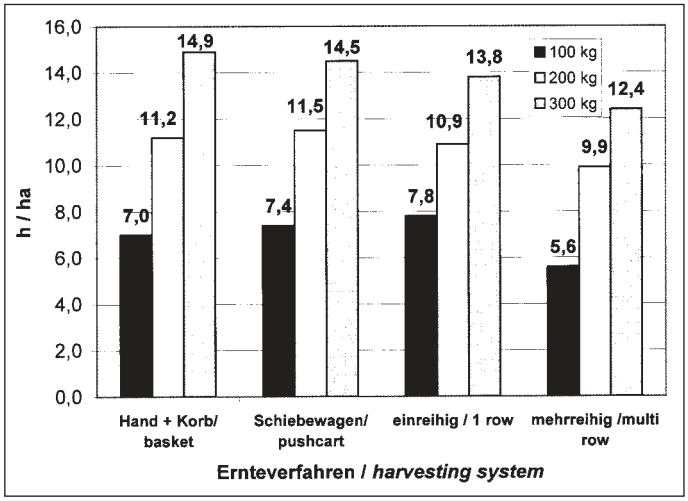

Fig. 3: Working time/ha (cutting" partially blind", with turning and recovery)

thods show similar effects regarding the work load for "walking". Not affected by the use of harvesting aids is the sub-routine cutting.

The contribution of the sub-routine "waiting" can be neglected if harvesting aids are used. This sub-routine just occurs in connection with low yields and a small width of the working area (under the plastic film levered by the harvesting aid). It decreases with higher yields per day.

Comparing the work load per ha between non-mechanised and partially mechanised harvesting methods ("cutting blind"), results indicate advantages of harvesting aids for multi-row systems. The time advantage may comprise up to 14 % at daily yields of 200 kg/ha compared to non-mechanised methods (*Fig. 2*).

When regarding harvesting aids for the one-row system, the advantages compared to non-mechanised methods are less pronounced. At low yields of 100 kg/ha the use of aids even results in an increase in work load. However, at high yields of 300 kg/ha the aids for single-row systems can reduce the total work load by 9 % (*Fig. 2*).

The work load of non-mechanised harvesting derives from the repeated handling of the plastic film and the basket, and from transporting the filled baskets repeatedly out of the rows. As an example, based on an average walking speed of 3 km / h, transporting filled baskets out of the field will create an extra work load of 2 h/ha due to the need to walk the paths up to three times per row and depending on the length of the rows.

In comparison with standard manual harvesting methods ("partially blind") harvesting aids generate advantages in reducing the work load by up to 11 % at yields of 200 kg/ha and by up to 16 % at yields of 300 kg /ha (*Fig. 3*). The use of harvest aids for a single-row system reduces the advantage to 7 % at yields of 300 kg/ha.

The lowest stage of mechanisation, the pushcart, even increases work load at most yield levels (*Fig. 2 and 3*). In this case, the workers have to fulfil an extra sub-routine by laying the spears into the pushcart.

At low yields, partially mechanised harvesting aids for multi-row systems could diminish the work load because the time for waiting increases. Due to the width of the working area of these aids and to lower yields the work supply is reduced and a minimum of one worker can be saved. Therefore, waiting time could ascend up to one hour and more per ha, using harvesting aids for two-row systems. A share of 8 to 50 % of the total work load for waiting was measured at low yields. The spread is caused by different harvesting aids and the differences in width of their working areas.

Table 1: Partly mechanised asparagus harvesters

Kind of harvesting (Type of machine)	Characteristics
Handernte m. Korb	1-reihig, manuelle Erntemit Folienhandhabung und Korbtransport - häufiger Abtransport des Erntegutes
Schiebewagen	1-reihig, manuelle Ernte, manuelle Folienhandhabung, Kiste auf Wagen - seltener Abtransport des Erntegutes
Spargelfloh	1-reihig, gezogen oder geschobene Verfahrensvariante, automatisierte Folien führung, Kistentransport
Winner	1-reihig, mit Batterieantrieb, automatisierte Folienführung, Kistentransport
Spargelspinne	1-/ 2-reihig, mit Batterieantrieb, automatisierte Folienführung, Kistentransport
Spargelmaus	1-/ 2-reihig, mit Motorantrieb, Sitzplatz, automatisierte Folienführung, Kistentrans port
Spargelfuchs	1-/ 3-reihig, mit Motorantrieb, 2 Sitzplätze, automatisierte Folienführung, Kisten transport
Kügel R 1/3, PK 5/7	1- reihig (mit Sitzplatz), 3-/ 5-reihig, mit Motorantrieb, automatisierte Folienführung, Kistentransport
Hester (Niermann)	5-reihig, mit Motorantrieb, automatisierte Folienführung, Kistentransport, Witte rungsschutz

Conclusions

The use of harvest aids for partial mechanisation of harvest processes in white asparagus cultures could reduce total work load because single sub-routines are cancelled or optimised.

Harvesting aids automate the sub-routine "plastic film handling" with lifting and covering of the plastic film and the transport of spears out of the field. This automation helps to standardise the work routine for harvest in total. In comparison to non-mechanised harvest methods the use of harvest aids creates a more fluent work process which is a prerequisite of an optimised work load and harvest process. In addition, these standardised work routines reduce the work load in harvesting white asparagus and particularly the physical stress of workers.

Comparing mechanised and partially mechanised methods in relation to yield, low yields contribute to augment the share of the sub-routine "waiting" on the total work load when using harvesting aids for multi-row systems. In contrast, with higher yields non-mechanised harvesting methods generate increasing disadvantages due to extra work load for "walking" and transportation of asparagus out of the field.

In the beginning of the season, yields are low and harvesting aids should not be put into action, instead "digging" should be applied as harvest method, otherwise the share for waiting increases in relation to the total work load. Here after harvesting should be done by usage of harvest aids and "cutting blind" as harvest method to reduce work load and time efforts. In times with low demand for white asparagus (and low prices), as well as in periods with high temperature and high growth rate, white asparagus should be cut "blind" under usage of harvest aids. If yields per day are low, harvest activities should be at a standstill.