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Revision of the Working Time Classification to Optimize Work Processes in Modern Agriculture

Stefanie Reith[*a], Jürgen Frisch[a], Brigitte Winkler[b]

[a]Association for Technology and Structures in Agriculture (KTBL), Bartningstrasse 49, D-64289 Darmstadt
[b]Saxon State Agency for Environment, Agriculture and Geology (LfULG), August-Böckstiegel-Strasse 1, D-01326 Dresden
s.reith@ktbl.de

Precise knowledge of work processes is necessary to estimate the working time requirements in agriculture. Working time data are key criteria for structuring, organization and economic calculation of work processes. The focus is on times for working persons as well as for equipment and work objects.
To derive specific data, transparent and variable models reflecting the reality are needed. The analysis of agricultural processes is based on systematic work classification, whereby the individual sections represent the total work and total working time, respectively. Review of existing time classifications revealed weak points resulting in the need for a revision of the time classification. The requirements include a wide applicability to agricultural work processes, understandable structuring and simultaneous consideration of man power and working equipment. The new time classification also takes actual production methods including automated recording of time data into account. If necessary, the element times can further broken down.
In conclusion, recording and analysis of working time data provide the basis for a comprehensive assessment of the status quo. Optimization of work processes reduces required time and have positive effects on the economics of work systems in agriculture.

1. Introduction

Data on working time requirement recorded by different methods (Auernhammer, 1976; Schrade et al., 2005) are indispensable for strategic planning of work processes in agriculture (Jäger, 1991). According to Hesse (1925), these data can be used to represent an individual work element, a specific complex of work elements or work performance within a certain unit of time. Effective time management provides the basis for fulfilling precise objectives and requirements. The evaluation of the time is based on the working time classification subdividing the total working time into its element times. An exact definition of the element times is essential for measurement of the working time requirement of specific work elements.
Equally important is the identification of influencing variables affecting the individual work elements. These have to be recorded and described in detail, as well (Gindele, 1972).
The calculation of standard times for an operation is allocated appropriate attention in various studies (Auernhammer, 1976; Hammer, 1976; Schick, 2006). In general, multistage model calculation methods are used to provide key figures regarding labor organisation for agricultural procedures as well as for combined procedures. By means of logical connection between work elements and their influencing factors, working time requirement can be calculated in model form at the working procedure stage and put togehther to form any desired production process. Apart from helping to plan work, the classification of work processes admits representative statements about the efficiency of working and production procedures. The influence of particular time types can also be seen and understood. With regard to the determination of element times, the number of subdivisions depends on the demanded accuracy. Possibilities of classifying work processes are shown in Table 1. The whole process of conducting working time studies is described by Schick (2006). For individual process steps, an automated data recording is possible (Herzog and Schick, 2014).

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Table 1: Possibilities of work classification

Classification	Element
Abstract	Operation time
	Preparation time
	Closing time
	Inherent delay time
	Functional and technical fault time
Local	Working in the field/on the headland
	Drive on the road/cart track
Economic	Times with a positive/negative financial balance
	Cost-neutral times
	Cost-generating times
Functional	Times of maximum machine efficiency
	Times of low machine efficiency due to organization
	Times of low machine efficiency due to operating conditions
	Machine downtime due to a defect

2. Existing working time classifications in agriculture

The origins of the time classification for agricultural work processes are attributed to time studies conducted by Seedorf (1919). With the aim of improving time studies, v. Bismarck and Buchholz (1931) focussed on a permanent optimization of structuring and organization of work processes. They differentiated between preparation time, operation time, non-productive time and fault time. Since the mid 1950s, this time classification has been further developed and applied by integrating additional element times. According to Daelemans (1977), a method (known as CIOSTA-method) used to determine the working time requirement was already reported during the sixth CIOSTA-congress held in Helsinki in 1955. The relevant element times were divided into five main groups: operation time, non-productive time, delay time, preparation time and transit time. This scheme was widely – although differently accentuated – used by various researchers and work groups pursuing different objectives (Figure 1).

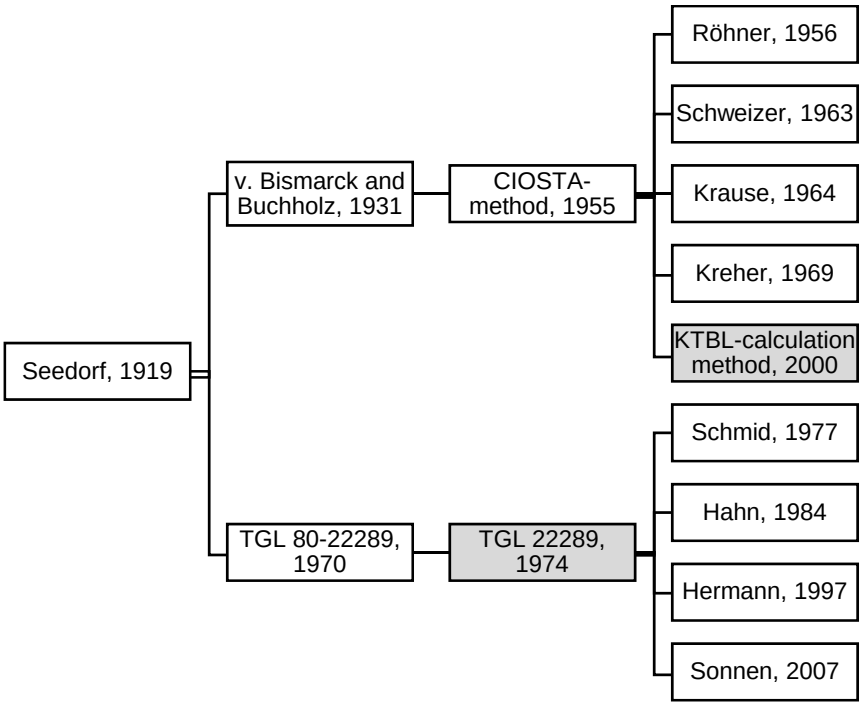

Figure 1: History of the development of the working time classification in Germany (incomplete)

Auernhammer (1976) made a further contribution to the improvement of agricultural working time analysis by developing an integrated method to break down work processes and to describe their influencing factors.
Due to the division of Germany after the Second World War, two different working time classifications developed, among which the TGL 22289 and the calculation method of the KTBL were the most frequently used in the former GDR and in western Germany, respectively. In comparison to the KTBL-calculation method with six element times, the TGL 22289 is characterised by eight element times resulting in a wider range of applications (Winkler and Frisch, 2014). Nevertheless, there is insufficient clarity and inadequate comparability making it difficult to understand the findings obtained from the analysis of agricultural work processes.

3. Requirements for a time classification

Already Herrmann (1999) postulated a standardized and optimally structured time classification. The more detailed the subdivision of the total working time, the more precisely the element times will be defined. Thus, relevant information necessary for planning work processes will be sufficiently available to provide an accurate representation of reality.
According to Fechner (2014), the expectations as well as the special requirements differ from user to user of the time classification (Table 2). A farmer is interested in obtaining significant information needed for evaluation of work and machine efficiency. Current knowledge of the technically suitable, economical and manageable methods is essential for optimazing production processes and farm management. The accountant benefits from the time classification by evaluating agricultural work performance of employees and cooperatives.
Overall, the aim is to achieve a logical and transparent structure for the respective user promoting a high level of acceptance among users. Additionally, experience has shown that the existing working time classifications are no appropriate to consider the methods used in modern agriculture. Mechanized working methods are increasingly important. Technological progress and future trends in automated time recording (e.g. ISOBUS) also demand a revised time classification.
Hereof, the following requirements are to be taken into account:

- uncomplicated
- sufficiently detailed
- expandable
- suitable for all kinds of work
- applicable for automated time recording

Table 2: Users of working time classification (Fechner, 2014; modified)

User	Information
Farm management	Effectiveness of the production methods
	Machine efficiency
	Weak point analysis
Accounting	Planning of alternative solutions
	Work performance control (time requirement) of employees
	Scope of a service (work of agricultural contractors or cooperatives)
Research	Details on work processes
	Causes for fault times
	Performance evaluation of new machines and working methods (simulation)

4. The new time classification for agricultural work processes

The time classification is relevant to the recording of time of working persons as well as of machine running. Automated working time measurement is allowed by different machines statuses indicating activity or machine downtime. A precise definition is possible to specifically assign the statuses to element times. The new definition introduces three main categories (operation time, process time, total time) which can be subdivided into further levels (Figure 2). The notation to describe the different element times uses t with corresponding numeric identifiers. The sum of operation time, fault time and non-productive time (level 1) represents the total working time. Overall, the following definitions apply to the revised time classification:

- t_H operation time = t1
- t_P process time = t1 + t2
- t_G total time = t1 + t2 + t3

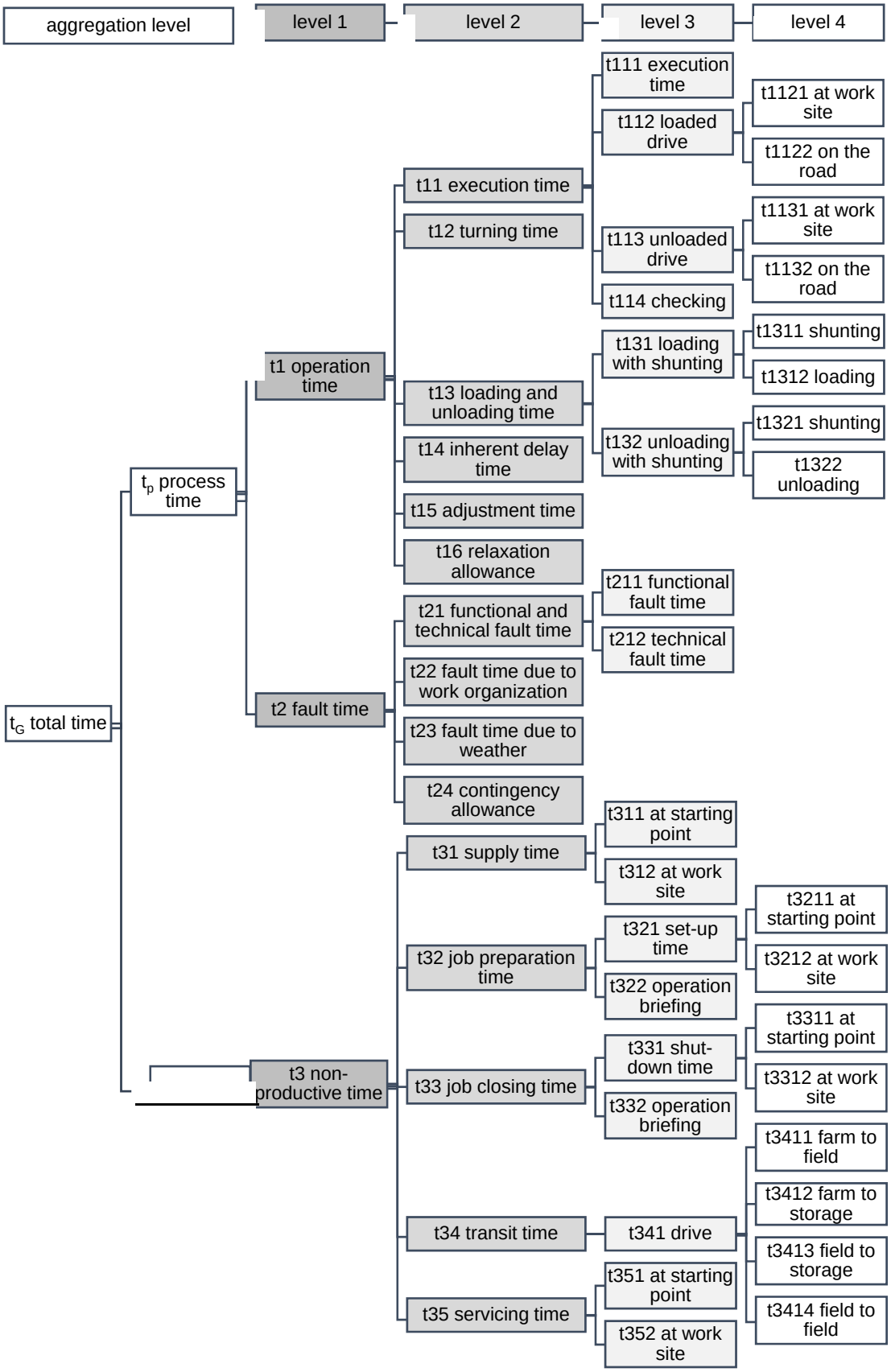

Figure 2: Working time classification for agricultural works

4.1 Operation time (t1)

The operation time comprises execution time which consists of – divided into two additional levels – execution time in a narrower sense including travelling time for transports (loaded or unloaded drive) and checking the resut of the operation. Returning to the second level, the time for loading and uploading means of production (e.g. fertilizer, seeds), the adjustment of the working equipment as well as further adjustment of working processes and the turning time belong to the operation time. The turning time describes the required time for changing the working direction of working equipment (e.g. at the headlands). Additionally, a distinction is made between the inherent delay time and the relaxation allowance due to work load. Interruptions due to personal reasons are not included.

4.2 Fault time (t2)

The fault time describes unplanned faults. These times refer to functional and technical faults. Technical faults represent the need to repair agricultural machinery faults or to replace defective elements, devices or machines. In contrast, functional faults are defined as times for putting work equipment into operation again without modifying elements of the equipment and without material consumption. Besides, fault times are caused by work organization, contingency allowance or the weather.

4.3 Non-productive time (t3)

The non-productive time is defined as planned activities which are essential to maintain sustainability of the work system and to restore the initial system. The supply time includes filling or unloading means of production and further additives. There is a precise differentiation between starting point and work site. This also applies – within the job preparation time and the job closing time – to the machine set-up time (needed e.g. for setting the machinery for the required working width, working height or working depth) as well as to the corresponding shut-down time. Set-up times involve set-up times at the farm and set-up times in the field. In this context, the operation briefing contributes to the success of the various work processes. Additionally, the transmit time and the serving time for preventive maintenance of working equipment are part of the non-productive time.

5. Conclusions

The recording of working time data is the fundamental prerequisite for the calculation of standard times needed for the modelling of work processes. It is very important to detail the influencing factors affecting the individual work elements. The resulting simulation of working time requirement is useful to combine single work processes as well as to analyze complex systems. Among other aspects, an enhanced acceptance of the revised time classification is ensured by taking the automated time recording into consideration. The presence of modern communication interfaces at agricultural machinery allows a comfortable data collection with comprehensive parameter information of the machine status and production process.
The presented time classification has been proven effective in practice and is suitable for providing data for farm planning and process optimization.

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