Workload Assessment in Agriculture – Integration in a Work Budget System

Matthias Schick [1], Katja Heitkämper [1], Marion Riegel [1], Ruedi Stark [1]

[1] Agroscope Reckenholz-Tänikon Research Station ART, Research Group "Buildings, Animals and Work", 8356 Ettenhausen, Switzerland, matthias.schick@art.admin.ch

ABSTRACT

The use of a contemporary model-based work budget allows the comparison of work and production processes up to total-farm level under otherwise equal conditions. The inclusion of physical load is ensured via expanded OWAS codes with a mass-related load index as well as with the average physically strenuous working-time requirement. Consequently, sectoral statements on manpower potential and workload in farming are also possible. The continuous traceability of the data is ensured, so that expansions and corrections of errors are easily carried out. Data may be exported from the program via interfaces. The software, which is modular in design, is available in four languages. The computer-based work budget therefore represents an internationally applicable tool both for the improvement of work organisation and time planning, as well as for the measurement of workload.

Keywords: Working-time measurements, modelling, work budget, work record chart, workload, Switzerland

1. INTRODUCTION

The use of model calculation systems allows calculating the working-time requirement of work processes, to production processes, up to total-farm level. At the same time, the element-oriented approach with its clear-cut beginning and end points for each work element also facilitates the inclusion of body postures, masses moved, and work-load groups.

Within the "Farm" work system, concrete time planning must be carried out in addition to the accurate calculation of the expected working times. The purpose of time planning is to determine what tasks the workforce deals with at what times, and how these tasks are prioritised. The computer-based work budget can serve as a tool here, both for work organisation and time planning.

Matthias Schick et al. "Workload Assessment in Agriculture – Integration in a Work Budget System". International Commission of Agricultural and Biological Engineers, Section V. Conference "Technology and Management to Increase the Efficiency in Sustainable Agricultural Systems", Rosario, Argentina, 1-4 September 2009. The authors are solely responsible for the content of this technical presentation. The technical presentation does not necessarily reflect the official position of the Internation Commission of Agricultural and Biosystems Engineering (CIGR), and its printing and distribution does not constitute an endorsement of views which may be expressed. Technical presentations are not subject to the formal peer review process by CIGR editorial committees; therefore, they are not to be presented as refereed publications.

2. MATERIAL AND METHODS

In Agroscope Reckenholz-Tänikon ART's "Work Economics Planning Bases" project, work-economics key figures and the workload components affecting them (e.g. masses and posture) are recorded, edited and statistically analysed on the element level, and made available as both planning times and influencing variables to a model calculation system for further calculations, for the purpose of compiling work budgets. On each participating farm, a detailed questionnaire for recording the farm labour organisation (e.g. number of workers, state of labour force) and important influencing variables (e.g. number of dairy cows, milk yields, milking methods, distances travelled, etc.) is compiled. In this connection, an initial work observation is also performed to prepare the participating workforce and timekeepers for the time measurements.

The time measurements are carried out with electronic time-recording systems (hand-held PC and built-in recording software). They are performed exclusively as a direct work observation with individual time measurements on the element level. The essential influencing variables "masses moved", "body postures", "distances travelled", "milk yields", "feed quantities" and "driving speeds" are determined and recorded electronically during the time measurements. All other influencing variables (e.g. milking-parlour width, milking-parlour length, cowshed length, feeding-table length) are to be recorded before and after the time measurements.

With cyclical workflow steps such as "premilking", "udder stimulation" and "milking-unit attachment", determination of data quality takes place during measurement via the so-called Epsilon test. For this test method, the absolute value of the half confidence interval is applied to the mean, with an Epsilon of < 10% judged to be good. Using the determination of data quality as a starting point, the expected sample size n' can also be determined after the recording of just a few measuring points. This makes it possible to plan the effort for the data recording.

3. ANALYSIS, ELEMENT DATABASE AND MODEL CALCULATION SYSTEM

For further processing, the recorded data is first prepared in tabular form, and then examined with non-problem-oriented test procedures (normal distribution, outlier, coincidence). In the absence of normal distribution, a one-sided logarithmic transformation is carried out as a basis for the following problem-oriented test procedures and regression calculations.

Next, the analysed data are transferred in the form of planning-time values and functions to a planning-times database table, with each element being assigned a unique alphanumeric code, a name with beginning- and end points, and the appropriate statistical parameters, including contents description, author, and creation date.

The continuing calculation of working-time requirement values on the level of work processes is performed with the built-in model calculation system. This involves the logical linking of work elements with the quantitative and qualitative influencing variables affecting them. All influencing factors are entered in the model calculation system as variables, and can be altered at any time within the upper and lower bounds. A warning message is automatically displayed in the event of entries falling outside these limits.

The calculation system is modular in construction, and in addition to the planning-times database consists of the modules “list of influencing variables”, “interconnection area”, and “output area”. For each work process of interest, a separate extract is created from the planning-times database. All data are available for further processing in freely selectable formats.

In order to assess workload, the load index L (according to Lundquist, 1990), the mass-related load index (according to Riegel and Schick, 2005) and the physically strenuous working time (BMPh) are enlisted (see Fig. 1).

$$B_{MPh} = W_P * \sum WT_P + W_{PM} * \sum WT_{PM}$$

WT = Working-time requirement per work process
WTP = Working-time requirement per work process with MCL 2, MCL 3 and MCL 4
WTPM= Working-time requirement per work process with MCL 2, MCL 3 and MCL 4 and masses >= 2 kg
WPM = Weighting of body posture with masses
WP = Weighting of body posture without masses

Fig. 1: Calculation of the physically strenuous working time B_{MPh}

The advantage of the workload indices lies in their ease of handling, as well as in the accurate qualitative comparison of individual working processes. On the other hand, the use of the physically strenuous working time makes available a facility for quantitative comparison. In addition to allowing consideration from an ergonomic viewpoint, this approach also permits an objective monetisation of the effort and benefit of measures designed to make work easier.

4. MODEL CALCULATION SYSTEM AND WORK BUDGET

Using the model calculation system as a point of departure, work and production processes can be compiled. In this context, a work process is a self-contained sequence of operations spanning all necessary work sub processes or work elements and influencing variables for achieving the work objective (e.g. ploughing or milking). By contrast, a production process consists of a possible and logical combination of different work processes for producing a product (e.g. grain cultivation) or rearing a production unit (e.g. dairy-cattle husbandry). The overall farm working-time requirement is calculated through the combination of different production processes, bearing in mind circumstances of the individual farm, as well as the available fieldwork days for the individual activities.

On the one hand, overall working-time requirement values for production, special tasks and management activities may be represented on this level. On the other hand – using this level as a starting point – detailed analyses up to the “work process” level can be compiled.

An initial overall work budget is available as a result, which shows the working-time requirement for the whole farm as a function of the selected work and production processes as well as of the chosen influencing variables. In addition, this also allows us to determine how many labour units are required for the farm.

5. ASSESSMENT OF WORK VIA “WORK-RELATED PHYSICAL STRAIN” GROUPS

On the “work budget” level, the objective degree of physical strain experienced by the workforce owing to the individual work and production processes is illustrated. Also possible at this level, however, is a subjective appraisal on the basis of “work-related physical strain” groups. These are groups of tasks with comparable work sequences (e.g. driving a tractor without significant manual labour, light manual labour, heavy manual labour). Using these “work-related physical strain” groups as a starting point, the performance per group is allocated for each labour unit. Ultimately, this allows us to calculate the performance per farm branch, or for the entire farm.

6. INITIAL RESULTS AND DISCUSSION

The significant physically strenuous work processes in all production systems with dairy farming are milking and feeding. The proportion of overall daily work for these is well over 50%.

Physical strain varies substantially depending on the milking process used. In tied housing, the milker spends the overwhelming part of the time spent milking in an unfavourable posture. With the pipeline milking plant, automatic cluster removal and track transport may contribute to the simplification of work.

The workload indices of the milking parlours also vary, since task completion in terms of body postures varies to a fair extent in the standard processes without technical aids. However, where full use is made of technical aids (udder stimulation, automatic switch-off, automatic cluster removal, milking arm), these differences occur to a limited extent only.

As herd size increases, the working-time requirement for all daily tasks (without management and forage-crop production) increases from 6 MPh for 40 cows to over 50 MPh for 1000 cows per herd and day. At the same time, where milking and feeding are hardly mechanised, the proportion of activities involving significant physical exertion rises from 28% to 33% (see Fig. 2). With a high level of mechanisation, the proportion of physically strenuous tasks rises from 16% to 30%. This means that the decrease in herd size and the process-engineering equipment used (diet feeder, milking parlour with milking arm) are not sufficient to offset the majority of the physically strenuous hours.

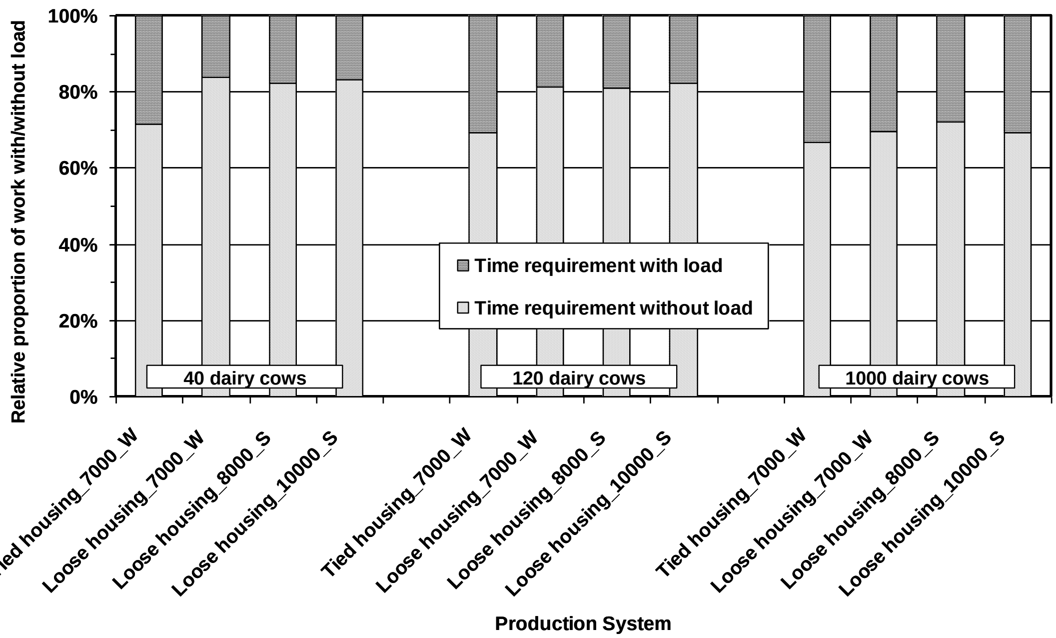

Fig. 2. Average relative workload per kg milk and day for different production systems (M = meadow grazing in summer; S = year-round feeding of silage))

Comparison of the different production systems in the dairy-farming sector shows that despite its very good technical configuration (short-standing with open-steel flooring, suction unit, automatic cluster-removal unit), tied housing is the system with the highest physical workload. Likewise, the highly intensive loose-housing system can be viewed as relatively unfavourable in terms of physical workload when coupled with very large herds, year-round silage and very high milk yields. Medium-sized herds with facilities that are optimal in process-engineering terms (cubicle housing system, elevated cubicles, herringbone milking parlour with service arm, diet feeders and mechanised feed-refill) are more favourable in terms of workload.

7. CONCLUSIONS

In combination with the need to move masses by hand, unfavourable body postures have a negative influence on work quality. Up till now, simple tools for the ergonomic analysis and assessment of work processes and whole farms have been lacking. In association with the calculation of working-time requirement values, a work-estimate system that includes workload indices and physically strenuous working times may constitute a useful tool for qualitatively and quantitatively assessing workload.

8. REFERENCES

Lundqvist, P. (1990): Wopalas - A method for ergonomical analysis and practical improvements - examples from Swedish industry and agriculture. Advances in Industrial Ergonomics and Safety II, pp. 827 – 832

Pinzke, S. (1999): Towards the good work. Dissertation, Swedish University of Agricultural Sciences. Agraria 155

Schick M. and M. Riegel (2003): Arbeitsqualität in der Milchviehhaltung. Agrarforschung Nr. 10 (4) pp. 155 – 157

Schick, M. (2005): Arbeitszeit und Management auf dem Landwirtschaftsbetrieb. 51. Kongress der Gesellschaft für Arbeitswissenschaft GFA, Personalmanagement und Gestaltung, Heidelberg, pp. 341 – 344