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LANDTECHNIK WEIHENSTEPHAN

Work Load Assessment Following the Energy Consumption Model in LISL

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Introduction

Work requires both, time consumption and a more or less straining work load. For scheduling working time requirements, several of methods are well known. Unlike that, work load assessment is still under-represented in agricultural work science research. Reasons for that are the complex interactions of influencing factors on the one hand and the varying possible reactions of the workers on the other.

Methods

From a physiologic point of view, every labour results in a muscular demand and consequently in energy consumption or conversion. This can be differently defined for various body positions and types of work. HETTINGER and SPITZER (1979) have acquired substantial schedules for averages and deviations of energy consumption values (tab. 1).

Accordingly, the *"Information System for Agricultural Processing - LISL"*, developed in the 1980ies (AUERNHAMMER, 1983), was extended by an energy consumption model. The existing model structure (fig. 1) was used to integrate energy consumption in the time standard documents. During the calculation of working time requirements, the expected energy consumption is calculated and the overall result is displayed accordingly to the permanent work load limits of male and female workers.

Working posture	kJ/min
Sitting	1.0
Kneeing	3.0
Crouching	5.0
Standing	2.5
Ducked standing	4.0
Walking	7.0
Moving up/down	3,0 per meter
Type of Work	**kJ/min**
Simple handwork	1.0 - 2.5
Medium handwork	2.5 - 4.0
Heavy handwork	4.0 - 5.5
Simple one arm work	2.5 - 5.0
Medium one arm work	5.0 - 7.5
Heavy one arm work	7.5 - 10.0
Simple two arm work	6.0 - 8.5
Medium two arm work	8.5 - 11.0
Heavy two arm work	11.0 - 13.5
Simple body work	11.0 - 17.0
Medium body work	17.0 - 25.0
Heavy body work	25.0 - 35.0
Very heavy body work	35.0 - 50.0

Tab. 1. Energy consumption schedule (HETTINGER AND SPITZER, 1982)

Working posture analysis for milking processes

Analyses of important milking systems result in large differences regarding the working posture and the type of work.

Working in *"tied-up housing systems with bucket milking system"* means a large time share for *"standing"*, but also for *"ducked standing"* and *"crouching"*. Both are very exhausting and have to be reduced in a well-organised work regime. The types of work are smoothly distributed from easy to medium work, whereas *"two arm work"* shares are significantly higher than *"one arm works"* (fig. 2).

In *"loose housing systems with a herringbone milking parlour"* the situation of working posture changes drastically. There is a lot more *"standing"* quota, but at the same time the share for *"walking"* increases. There are also considerable changes in type of work, because it shifts to *"arm work in standing position"* (fig. 2).

Finally, in *"loose housing systems with rotary milking parlour"* the time share for "walking" reduces again. The work now can be denoted as exclusive *"standing work"*. Therefore, at average working periods of 140 minutes, it is mandatory to introduce adjusted recreation periods for the workers. Additionally, there is a load, caused by the predominant share *"medium two arm work"*.

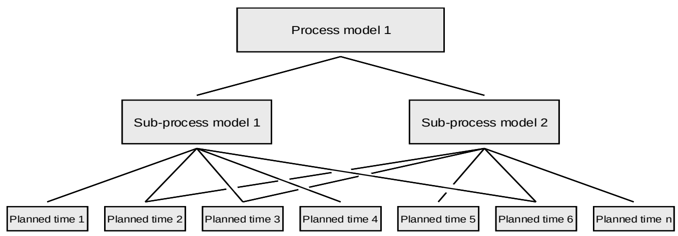

Fig. 1. Basic model structure in LISL

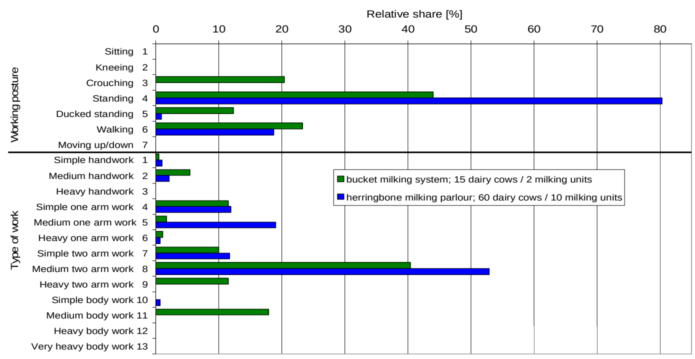

Fig. 2. Relative shares of working posture and type of work while milking

Energy consumption profiles for milking processes

Regarding the time-related investigation of energy consumption with the same assumptions as mentioned above, clear differences between the systems can be observed as well. In *"tied-up housing systems with bucket milking system"* appears a very high increase in the second third of the 60 minutes of the working process. Due to the carriage of heavy buckets, not only the average value of energy consumption is exceeded, but there is also an overall overload of male and female workers (fig. 3). From a ergonomic point of view, female workers should not carry out the milking work.

In Principle, the progression of energy consumption in *"loose housing systems with a herringbone milking parlour"* is favourable. In spite of a better milking efficiency the average value decreases to about 12.5 kJ/min (fig. 3). But with an increasing number of cows, the time shares of equal load increase as well. Furthermore, there is relatively high load of preparatory work at the beginning of the process. Following this results, female workers would exceed there permanent load limit while milking larger herds.

Investigations on *"loose housing systems with rotary milking parlour"* tend to result in a similar energy consumption profile like the herringbone milking parlour, but with longer time periods of equal energy consumption.

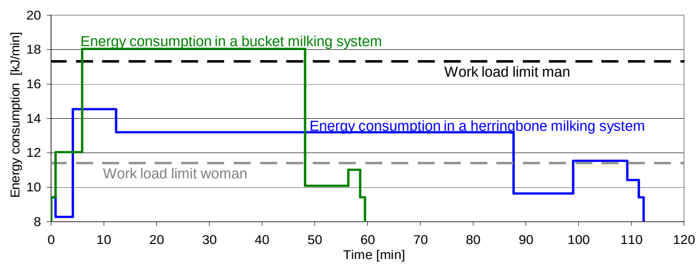

Fig. 3. Energy consumption while milking

Discussion and outlook

The presented analyses persuade by their clear results in both, the working posture in work types and energy consumption profiles over work time. Additional information can be taken by identifying uncomfortable positions and types of work as well as from noticing exceedings of the permanent load limits of male and female workers (tab. 2). With respect to the kind of work to do, those results show a clear difference in suitability of different workers at all.

Furthermore they give hints for necessary ergonomic improvements as well as for a better work organisation and for recreation phases. But one has to notice that especially the energy conversion over time requires a realistic progressing of the simulation and that working postures differing from the model cannot be calculated.

Tab 2. Time shares of unfavourable posture and exceeding of permanent work load limit in different milking systems

	Bucket	Pipeline	Herringbone	Rotary
Dairy cows	15	20	60	100
Milking units	2	3	2x5	12
Unfavourable working posture [%]	32,8	34,9	27,0	36,0
Unfavourable type of work [%]	12,6	4,4	0,7	0,9
Over female work load limit [%]	77,0	75,3	76,7	87,7
Over male work load limit [%]	29,5	3,1	0,0	0,0

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