On the drawing up of planning documents for agricultural production process

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Accurate data on working time, energy requirements and capital requirement for machines and buildings are needed for the planning and objective comparison of agricultural production processes. These should then be linked in practical models to permit calculation of the costs per unit and thus comparison and classification.

Determination of data

In the field of cattle management the work time requirements have been determined in the form of work observations for 10 years. More than 120 000 individual time measurements now form the basis for about 350 schedule times in the fields of bullock fattening, dairy cattle, calf and heifer management. All these schedule times are available in fully documented form on computer data storage media and are being used regularly by 10 institutions. Due to the accurate definition of the parameters included and the data filing system even joint evaluations of times measured in different places were possible.

In the same way about 60 000 individual time measurements have been carried out on agricultural building sites over the past 7 years. These data have also been evaluated and documented and stored in the above-mentioned form.

Since 1978 greater efforts have been made to determine electricity consumption. Comprehensive practical measurements on storage equipment for pre-wilted silage. hay and silage maize revealed a wide basis for the still universal planning data on a functional basis.

Model formation

Taking the work time data for cattle management as a basis, a start was made in 1975 on compilation of a universal calculation system for bullock fattening in the form of a pilot study. The following requirements had to be met:

- simulation on the basis of deterministic models
- complete documentation of all models
- model structuring in accordance with the practice in the herarchical sections
  schedule time
  process
  total work
- consideration of all relevant parameters with practical pre-adjustments
- separation of calculation program and model data
- computer assistance with machine-independent programming
- production of result reports with different information contents from complete recording of results to output of only the final result.

Introduction of remote data processing via visual display units resulted in the following additional requirements:

- interactive operation
- retrieval in the dialogue

Until 1980 all these requirements were met by the 3 computer programs UPDATE. KALDOK and DOKSYS. They now permit compilation of a complete circulation system as shown in Fig. 1.

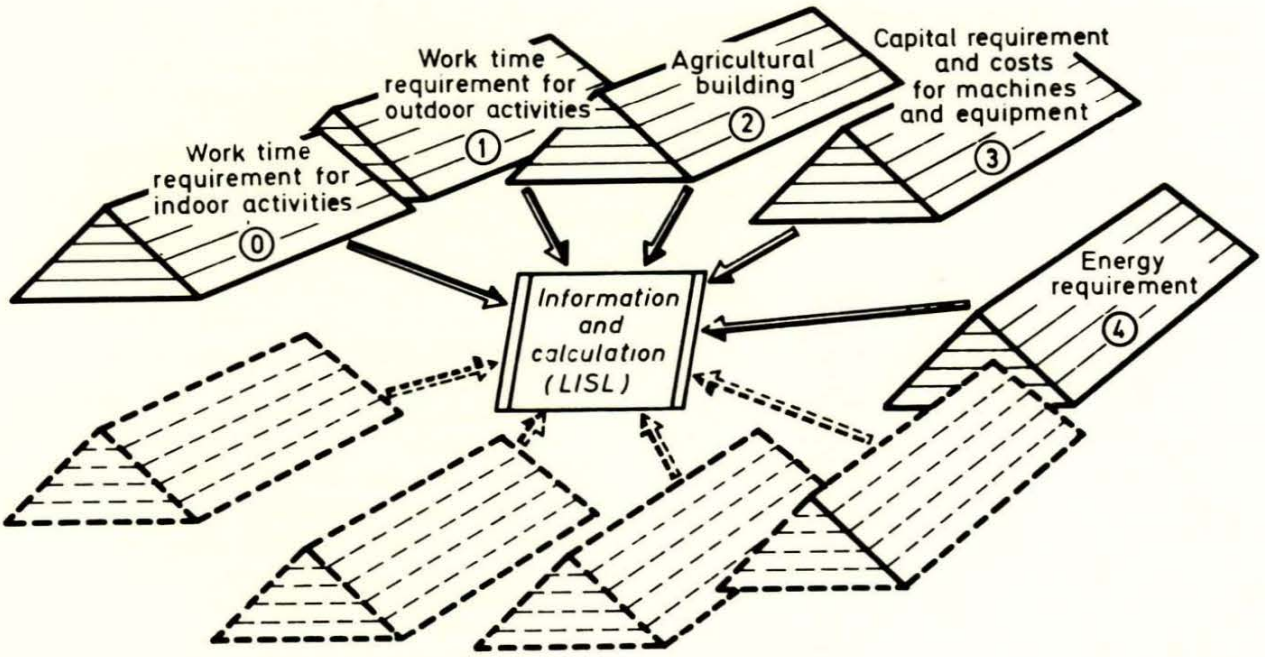

Fig. 1: Data and model areas in the "Landtechnik Agricultural information system (LISL)"

The separation into individual data and model areas opens up the possibility of system construction in different places, as is done here in collaboration with the Research Centre for Farm Management and Agricultural Engineering in Tänikon (Switzerland)*.

The model documents specified in Table 1 are now available for working time calculation in cattle management. They are supplemented by about 120 model programs for agricultural building and initial model formation for determination of the electricity requirements.

Table 1: Models for calculation of working time requirement in cattle management

Type of model	Number of models				Total
	bullock fattening	dairy cattle	calves	heifers	
Total work models	2	4	-	1	7
Process models	14	21	4	19	58
Partial process models	32	76	14	60	182
Element models	31	305	60	-	396
Plan times	352				352

Situation on April 1, 1982

*) Auernhammer, H. und E. Nacke (editors): Work time calculation in agriculture with computer programs suitable for use on large and small computers. Schriftenreihe der Landtechnik Weihenstephan, No. 8, 1981

Production of result by model analysis

The machine-independent programming in FORTRAN IV programming language permitted virtually trouble-free use of the system on the most diverse computers. the available core memory of which must contain at least 128 k bytes. As shown in Fig. 2, the work time calculation has meanwhile been used on 6 different computer types and it is thus possible to bring the complete system or parts of it to the attention of a wide range of potential buyers.

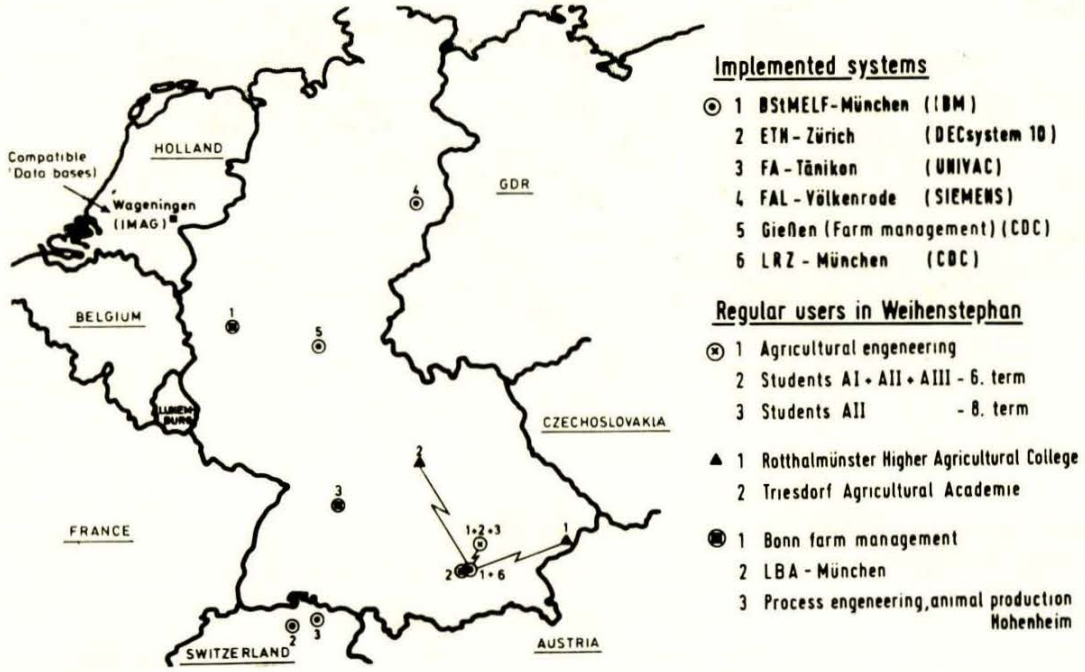

Fig. 2: Electronic data processing systems in service and users for working time analysis

In addition to regular use for scientific calculation, it was thus possible to use the system for advisory service and teaching on a scientific basis and on a practical training basis for young farmers. The last-mentioned users in particular were surprised by the

- rapid acceptance of the system
- the independent use and
- the positive feed-back in the case of shortcomings in the data or models.

Meanwhile these users have put forward increasing demands for comprehensive cover of all areas of agricultural production, although these demands cannot be met in the foreseeable future because of the restricted availability of personnel. In addition, it is largely impossible to adopt other systems for training, because they are either linked to a specific computer or the dialogue capacity essential for training does not exist.

The most important forms of result will be described below. Fig. 3 shows a realistic form of presentation with an indication of the parameters and values. realistic designation of the sections, representation of the result and the final analysis with regard to the individual animal or the herd.

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LISL          LANDTECHNIK WEIHENSTEPHAN, 14.10.1982          K A L D O K  (V3C)
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  MODEL CALCULATION AT PROCESS LEVEL WITH PRE-ADJUSTMENTS AND COMPLETE RECORD
  --------------------------------------------------------------------------

       THE CALCULATION IS MADE WITH PROPORTIONATE ELEMENT ALLOWANCE

                    PARAMETERS (MODEL NO. 201)
                    --------------------------

  1. FREQUENCY ..................................      1.000  PROCESS
  2. HERD SIZE ..................................     20.000  COWS
  3. FEEDS PER DAY ..............................      2.000  FEEDS
  4. NUMBER OF ROWS OF THROUGHS .................      2.000  ROWS
  5. EATING PLACE WIDTHS PER ANIMAL .............      1.200  M
  6. NUMBER OF BUCKETS CARRIED AT THE SAME TIME.       2.000  BUCKETS
  7. QUANTITY OF CONCENTRATE PER BUCKET .........      8.000  KG
  8. QUANTITY OF CONCENTRATE PER ANIMAL PER DAY.       6.000  KG
  9. NUMBER OF DOORS, LEAVING CONCENTRATE STORE.       1.000  DOORS
 10. DIST.: STARTING POINT TO CONCENTRATE STORE.      20.000  M
 11. DIST.: START OF THROUGH TO CONCENTR. STORE.      10.000  M

 OPERATING SEQUENCE STRUCTURE          (GA=TOTAL WORK, VG=PROCESS, TV=PARTIAL PROCESS, EL+PL = ELEMENTS)
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    MODEL -                                                                  TIME REQUIRED IN MAN MIN FOR
 CODE  NUMBER          MODEL DESIGNATION WITH FREQUENCY                      PL/EL      TV     VG     GA     HV
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   VG    201  LOADING CONCENTRATE INTO A BUCKET AND DISTRIBUTION             1.00

    TV   2010  SCOOPING CONCENTRATE FROM STORAGE CONTAINER, DISTRIB          1.00
     EL  20100  WALKING TO CONCENTRATE STORAGE AREA                         1.00    .3
     EL  20001  OPENING DOORS                                              1.00    .1
     PL 100034  SCOOPING AND DISTRIBUTION OF CONC., RETURN TO STORE         4.00   4.7
     EL  20002  CLOSING DOORS                                              1.00    .1
     EL  20308  RETURN TO STARTING POINT                                   1.00     3      5.5    5.5
                                                                                  -----  ------ ------
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            TIME REQUIRED PER ANIMAL PER DAY       .55 MAN MIN=      .01 MAN H
            TOTAL TIME REQUIRED PER DAY          11.03 MAN MIN=      .18 MAN H
            WORKING TIME                         11.03 MAN MIN=      .18 MAN H

            FOR A MANAGEMENT TIME OF                          365    DAYS
            TIME REQUIRED PER ANIMAL                         3.35 MAN H
            TIME REQUIRED FOR THE HERD                      67.08 MAN H
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Fig. 3: Realistic representation of result of a work-time calculation

Table 2 shows the iterative form of presentation of the result with variation of one parameter with the most important characteristic values and Fig. 4 the analysis of the work time requirement and electricity requirement for storage of pre-wilted silage with pneumatic conveyors in a form of presentation similar to that in Fig. 3.

Checking the model by a comparison of required and actual values

Whereas compilation of data by measurements and surveys under practical conditions leads to statistically confirmed planning data, the deterministically constructed models require analysis by a comparison of required and actual values to prove the result. This analysis was carried out by SAUER* on 11 farms with dairy cattle and produced the results shown in Fig. 5.

*) Sauer, H.: Productivity investigations and checking of method by model calculation in dairy cattle management. Thesis at Munich-Weihenstephan Techn. University: Institute for Agricultural Engineering, 1981

Table 2: Iterative presentation of a result of a work-time calculation

INITIAL SITUATION : 10 ANIMALS, 365 DAYS MANAGEMENT TIME, 2 FEEDS/DAY
NO. CHANGED : 3. HERD SIZE .....
FROM 10.00 TO 80.00 COWS , INCREMENT = 10.00

VARIABLE NO. 3 (COWS)	WORK TIME / DAY MAN MIN	WORK TIME REQUIREMENT FOR THE DAY PER ANIMAL MAN MIN	PER HERD MAN MIN	PER HERD MAN H	MANAGEMENT TIME PER ANIMAL (MAN H)	PER HERD (MAN H)	PER ANIMAL PER YEAR (MAN H)
10.000	5.4	.54	5.4	.1	3.30	33.0	3.30
20.000	11.0	.55	11.0	.2	3.35	67.1	3.35
30.000	18.4	.61	18.4	.3	3.73	111.8	3.73
40.000	27.5	.69	27.5	.5	4.18	167.0	4.18
50.000	38.3	.77	38.3	.6	4.66	232.8	4.66
60.000	50.8	.85	50.8	.8	5.15	309.3	5.15
70.000	65.1	.93	65.1	1.1	5.66	396.3	5.66
80.000	76.4	.96	76.4	1.3	5.81	465.0	5.81

RECORD OF RESULT OF AN ELECTRICITY REQUIREMENT CALCULATION
FOR THE STORAGE OF PRE-WILTED SILAGE WITH PNEUMATIC CONVEYORS
(WORKTIME AND ELECTRICITY REQUIREMENT, BASED ON MANUAL METERING)

CALCULATION RESULT WITH THE FOLLOWING INITIAL SITUATION
DRY MATTER = 30.0 %
DRIVE POWER = 12.0 KW
QUANTITY OF LOADED MATERIAL = 3000.0 KG

SECTION	TIME REQUIREMENT (MAN MIN)	(%)	ELECTRICITY REQUIREMENT (KWH)	(%)
PRELIMINARY WORK	0.481	2.08		
SETTING	0.818	3.54	0.122	2.86
UNLOADING	20.478	88.62	3.999	93.99
SETTING	0.902	3.90	0.134	3.15
SUBSEQUENT WORK	0.429	1.86		
TOTAL	23.108		4.255	
MAN H/TONNE =	0.128	KWH/TONNE =	1.418	
TONNE /H =	7.790	TONNE /KWH=	0.705	

Fig. 4: Record of result of an electricity requirement calculation for the storage of pre-wilted silage with pneumatic conveyors (manual metering)

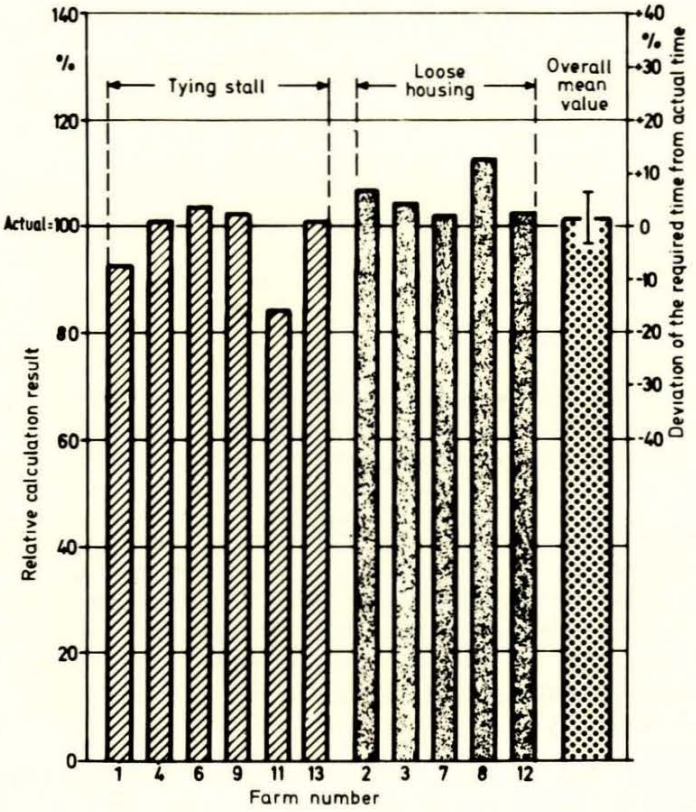

Fig. 5: Comparison of required and actual values for the work-time requirement on 11 dairy farms

According to the results the models constructed for the dairy cattle overestimate the work-time measured in practice by an average of 2%. With one exception the range of the deviations was between -7 and +12%. Trouble-free application of the planning data to practical results is thus ensured.