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Title:

Planning program for the use of machines based on climate regions

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Summary:

To facilitate the planning of cooperative use of machines in consideration of weather conditions, a program, APLAN, was commissioned by the Ministery of Agriculture in Bavaria. Climate data of the Bavarian Agri-metereological Measurement Network and data of filed record systems were used. The climatic areas according to KTBL could be verified with climatic data. In the next step, defined production methods for the respective climatic areas have been developed. This data base is used in the algorithms of the extension support program APLAN to speed up calculation of working time.

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1. Introduction, Issues and Goal

Apart from extra-operationally organized harvesting procedures, which are already the rule, there are other work processes in agriculture which have increasingly been organized on an extra-operational level. Efficient employment of jointly owned machinery presupposes the detailed planning of its use and the taking into account of regional factors. The use of operation-owned, and particularly of jointly owned, machinery, requires weekly planning schedules. The actual site and duration of use of specific machine combinations are not only dependent on weather and soil conditions, but also on the choice of production process. The duration of use is determined primarily by the degree of mechanization. An increased weather risk, however, usually involves the use of more powerful machinery, if possible, or the choice of a less risky production process. There is hardly any other economic sector that is so dependent on weather as agriculture: Not only growth and yield are subject to its inclemencies, but also the tillage of the soil, cultivation and various plant protection measures, which are feasible only if the soil is trafficable due to favorable weather conditions.

In order to facilitate the planning of operational and extra-operational use of machinery depending on respective weather conditions, the development of extension support software was commissioned by the Bavarian Ministry of Food, Agriculture and Forestry, resulting in the development of an easy-to-use planning program. The program takes into account weekly schedules, is simple to run and adaptable to the needs of individual operations. The goal was to supply a quick overview over working time and a detailed weekly planning system for agricultural operations. The program APLAN (Agricultural Working Time Planning) is based on the use of a personal computer with MS Excel 7.0.

2. Climatic Conditions and Soil

Being linked to acreage, agricultural production is heavily dependent on natural site conditions. The deciding factor in operational planning is the available time. Unlike with inside-oriented agricultural tasks, where the time available - depending on manpower supply - remains relatively constant throughout the year, the time available in outdoor tasks is far from constant.

2.1. Climatic Areas According to KTBL

In 1990, KTBL produced a classification of climatic areas and the respective time available (AUGTER 1990). The model is based on a simulation of soil moisture by means of using weather data (DYER and BAIER 1979). It assumes that the soil moisture of the respective production zone determines the actual execution of field work. According to KTBL, there are three decisive levels of soil moisture and a differentiation into three types of soil.

The division into climatic areas determines the time available for field work, and, in a next step, is designed to set the date for the execution of work for the respective production proce-

KTBL would have it. It must be considered, however, that the verification is based on time series of eight years.

2.3 Fluctuations between Climatic Areas

According to AUGTER, the upper limit for soil moisture for decisive level 2 with medium soil is 20 mm (AUGTER 1990). Accordingly KTBL, days with a soil moisture below 20 mm were identified, resulting in an average count of 59 available working days too many (table 2).

Table 2: Sum of available field working days from March to November to AUGTER and to the model of DYER using data of the Bavarian Agri-metereological Measuring Network

Climate Region	Sum of days by KTBL [days]	Sum of days with soil moisture < 20 mm [days]
2	40	98
4	71	128
5	83	149
6	104	173
7	125	192
8	155	201
Mean	**96**	**157**

Presumably, the soil moisture levels based on the weather data of the Bavarian Agri-metereological Measuring Network are slightly below the soil moisture levels calculated by AUGTER. If data from the weather stations Freising (station no. 42 (until 1994), 8 (from 1995) and weather data from the German Weather Service (30 year mean) are compared, it is obvious that lower levels of precipitation and higher air temperatures were measured, possibly due to sensor differences and yearly fluctuations. Higher air temperatures increase the capacity of the air to absorb water and its rate of evaporation. Lower levels of precipitation and higher air temperatures lead to low soil moisture levels.

Climatic areas with uniformly available days for field work could be verified. However, in the years from 1989-1996, the difference between climatic areas 7 and 8 did not seem quite as great and between areas 4 and 5 somewhat more substantial than according to the long-standing mean calculated by KTBL.

Looking more closely at available times for field work in individual climatic areas, it becomes clear that area 8 is the area with the greatest time period available. Climatic area 8 extends along the Main valley, being at the same time the warmest area and the one with least precipitation. The climatic areas 7 to 1 have less days for field work due to higher levels of precipitation and lower temperatures. If the extra-operational use of machinery extends to different climatic areas, the differences between the areas must be taken into account.

For the analysis of the possibilities of machinery use with respect to outdoor tasks, the seasons fall and spring are especially important. While harvesting procedures such as the combine harvesting of cereals or the sileage corn or sugar beet harvest are already primarily done with jointly owned machinery, the trend towards an extra-operational use of machinery is becoming more popular also for other tasks such as soil tillage, for example.

Table 4: Analysis of data from Bavarian field records for sowing winter wheat.

	Relative number climatic areas in %								
Week in the year	2	3	4	5	6	7	8	Absolute Number	Relative Number
39	1	0	1	1	3	1	0	303	2
40	8	8	6	6	7	6	8	1208	7
41	19	22	19	18	19	19	9	3321	19
42	26	23	30	31	28	27	19	5111	29
43	20	19	21	20	18	19	24	3509	20
44	12	12	10	12	11	13	25	2016	11
45	7	5	7	6	7	8	5	1184	7
46	4	5	4	4	4	4	3	707	4
47	2	3	1	1	1	1	5	222	1
48	1	1	1	1	1	1	1	155	1
Sum	100	100	100	100	100	100	100	17850	100

Also the analysis of sowing dates of winter barley and oil seed rape show no correlation between sowing time and climate region. The same can be seen for spring seeds and planting of potaoes, sugar beets and corn.

3. Extension Support Software APLAN

For the calculation of working time, an easy-to-use program was developed and extensively tested in seminar work. The program is structured as follows:

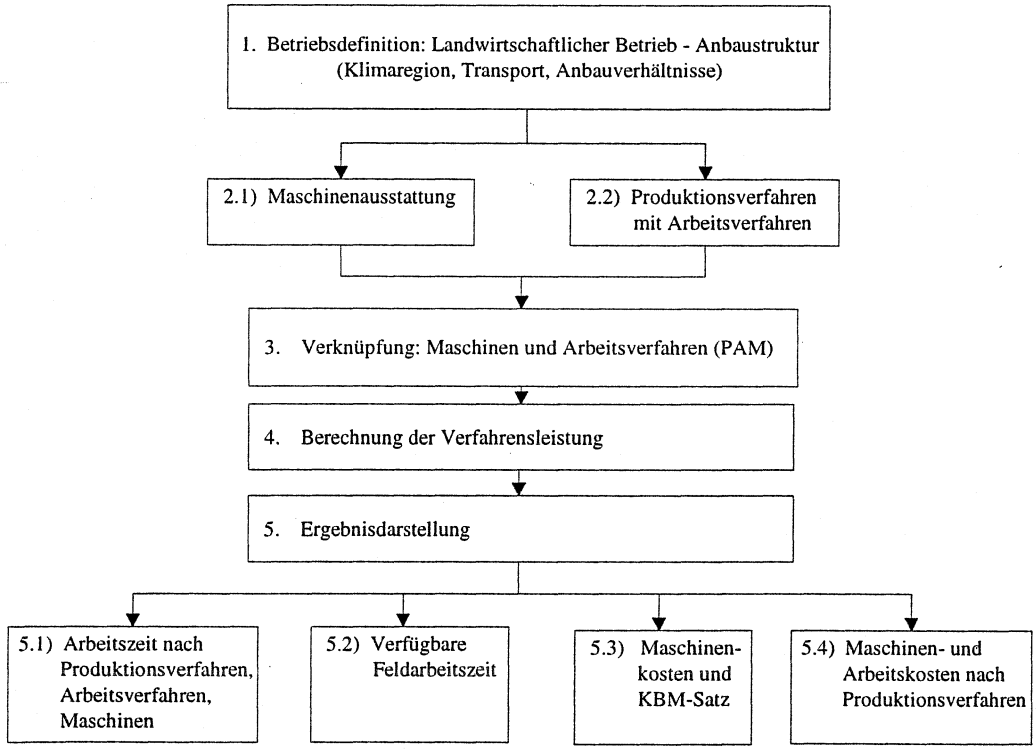

Figure 1: Structure of the extension program APLAN

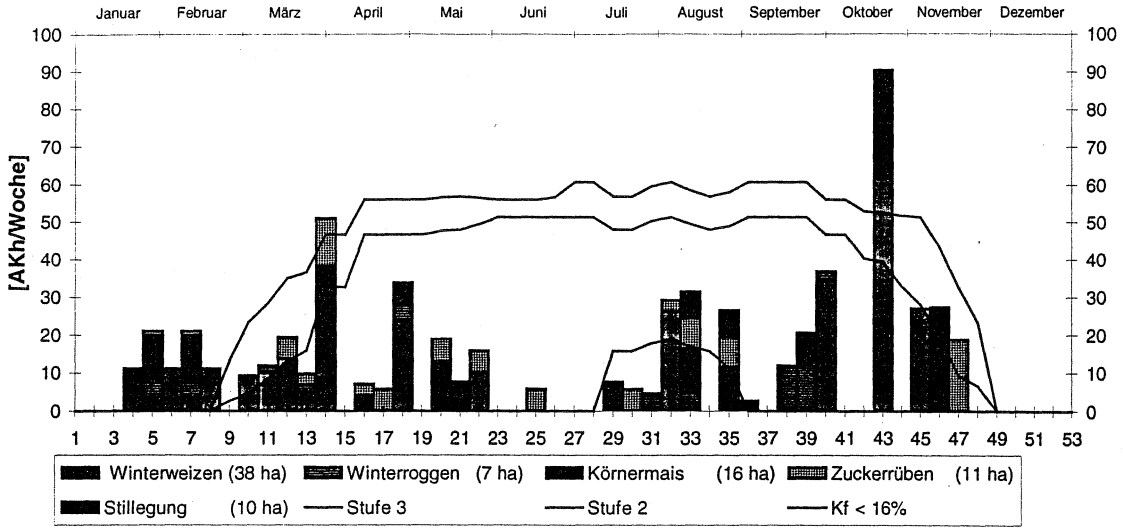

Figure 3: Working time required by different prodcution processes and available field working time of a farm near Munich calculated with APLAN.

Other result displays are possible. Also the machinery costs can be calculated and compared to the prices of machinery rings or contractors. The extension support software project was brought to a close by middle of 1998.

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