Markus Löbbert, Siegburg

Landscape care

Evaluating technical systems with special consideration of invertebrates

Different cutting systems were compared for their technical/ecological effect on invertebrate survival with alternative systems ranked based on the results (rank 1 = highest positive effects). Results 1 – 4: reciprocating knife, disc mower, Y-flail mower, tooth-flail mower.

Dr. Markus Löbbert worked since his doctorate in 1998 until December 2000 as editor of the specialist magazines „Lohnunternehmen“ and „Kommunaltechnik“ at Verlag Beckmann in Lehrte. Dr. Löbbert has been free-lance since January 2000. Between June 1992 and July 1997 he was a member of the scientific staff at the Chair of Agricultural Engineering in Bonn (director: Prof. Dr.-Ing. K.-H. Kromer).

Keywords

Grassland, biotope proctection, invertebrate fauna benefit analysis

Extensive grassland is exceptionally important for species and biotope protection. Grassland features two-thirds of biotopes regarded as valuable for nature protection. Simply placing a site under protection is often not enough. Precise maintenance of such sites must be applied, especially for so-called semi-natural eco-systems created by human action and comprising a rich variety of flora and fauna [8].

Important measures applied for maintaining and/or securing species variety through supporting open landscape characteristics are mechanical (machinery linked) and biological (animal linked).

Minimising direct damage to fauna

Mechanical measures have the greatest effect in an area context. Compared with grazing control, there's no great disadvantage when the areas are not adjacent and operations can be easily integrated into existing farming structures. But it must be considered that, as well as the desired positive plant community maintenance and development effects there are also undesirable ones. Mechanical control can especially affect the invertebrates such as grasshoppers, ground beetles, spiders and butterflies on the treated sites. Invertebrates represent 86% of all animal types [1].

So far, knowledge of damage extent to these fauna through the different mowing systems is insufficient. Also, a complete decision system has to consider non-financial aims such as species protection.

The mowing or mulching system has special importance for the effect of fauna [6]. For value-analysis of machinery application in landscape care, damage rates (DR) must be applied for cutting systems and a model developed involving all components (*fig. 1*) and allows selection of the appropriate system.

Cutting system damage rates

Because of the problems for investigations with real fauna on a site (cumulative distribution, differentiating before/after hardly possible, unidentifiable insect remains), a research programme using model bodies (MB) was selected through which was determined a damage rate (DR) as follows:

S_R= (end population of damaged MB (individuals))/initial population of undamaged MB (individuals)•100% (1)

The models were based for biophysical characteristics (weight, hovering speed, size) on the ground beetle (model I) and the spider (model II). Both species are regarded as critical in assessing animal life in grassland biotopes in a nature protection context [2]. The trials features cutting systems usually applied in landscape care [3, 7]: flail mulchers (SMU), disc mower (SBW) and reciprocating knife mower (DMW). SMU implements features a wide range of flail shapes and in the trial was used Y-flail (in-

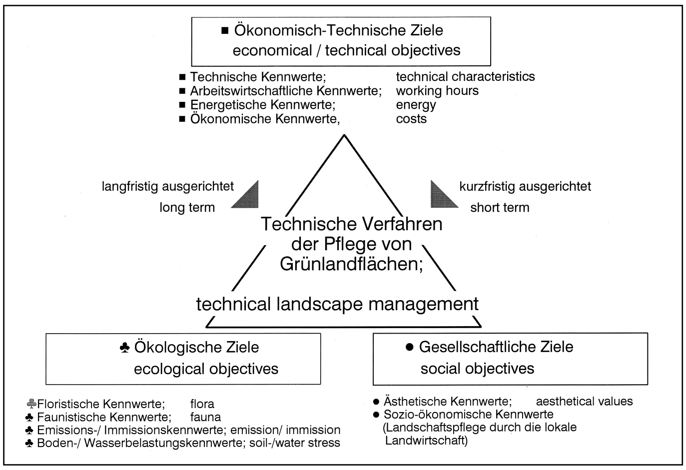

Fig. 1: Aims of technical care systems in grassland

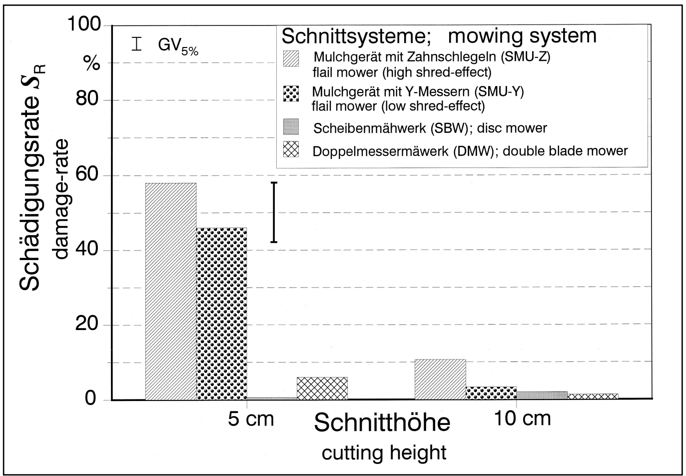

Fig. 2: Damage rates of model bodies I on the ground in association with cutting system and cutting height

creased line efficiency) and tooth flail (increased eveness of work) models. Selected were cutting heights of 5 cm (conventional) and 10 cm (to test whether more invertebrate protection could be thus achieved). Before cutting, the model bodies (50 units) were:

a) laid out on the ground (underneath cutting level)
b) fixed at 5 cm/10 cm (cutting level), and
c) fixed at 20 cm height (above cutting level).

Mowing took place at 5 km/h. Trials were carried out on sites with high (tall oatgrass pastures yielding 160 dt fm/ha) and relatively low (golden oatgrass yielding 100 dt/ha) growths with four replications.

Reciprocal blade advantageous

Tendentiously the results from the two pastures were similar and almost the same for model I and model II. Checking the model bodies on the ground indicated whether the cutting system had a suction or blowing effect on the models used. For this, mowed or mulched material was collected immediately after cutting/ cutting+chopping on a plastic sheet behind the implement. The results for MB I are shown in *figure 2*. At 5 cm cutting height there was a clear influence of the cutting system with chopping effect on the MB (SR of 42 to 58%). Here, Y-flails caused a lower SR than tooth flails. With both components working at 10 cm cutting height there was a clear reduction in SR (model I: 3 and 11%; model II: 5 and 14%). At both cutting heights SBW and DMW had in each case a limited effect on the MBs (up to a maximum of 10%). Checking the SR at 20 cm cutting height after inspection of models gave the following results:

SMU-Z > SMU-Y >> SBW > DMW

whereby for both SMUs > 50%, sometimes up to > 90% (SMU-Z) was determined and both other implements never lay over 30% (partly < 10%) [6].

To be considered when choosing a system for landscape care is that a detailed actual situation analysis must always precede a decision and the potential of possible care alternatives has to be evaluated in the light of care requirements. With openland care several aims have to be considered (*fig. 2*) and including animal-ecological protection requires extension of conventional evaluation methods (cost-benefit analyses).

Technique evaluation

The technique evaluation is defined by VDI Guideline 3780 [9] as planned, systematic, organised methods, that:

- evaluate direct and indirect technical, economical, ecological and other results of a technique, and possible alternatives
- utilise defined aims to evaluate these results
- deduce from these method and design possibilities

to enable decisions that are reasoned, determined, justifiable and practical.

The first step is to ask whether the technique offers the level of care required. The aims can be classified as ecological, economical/technical and social (fig. 2). Evaluation of machinery and implements and the results of their application take place primarily and practically according to performance figures [10, 11]. The four investigated cutting systems are evaluated below with regard to selected target criteria according to the scale in *table 1*. The table is based on use-benefit analysis (NWA) [4, 5, 12]. The NWA is a method for evaluating central requirements using methodical justifiability while considering a variety of parameters and subjective preferences [9]. At the same time it is helpful and practical when in each case the best, best possible and worse alternatives are taken as base points of the scale. Proved useful for an NWA is a value spectrum of from 0 to 4 [12, 4]. The figures used for evaluation are based on a range of field trials results or on the evaluation of literature data [6].

The target parameters or performance figures of the individual alternatives are ranked according to the illustrated scale, thus target yields are transformed into use-benefits. The resultant selected target profiles can then be graphically presented for the individual alternatives (*fig. 3*). Representation of target yields in a polar coordinates system has the benefit that it can show directly whether the solution variants are well balanced or to what extent they have weak spots

Table 1: Definition of selected target classes for evaluation of cutting systems

Evaluation criteria	4	3	2	1	0
Cutting quality	Will cutting quality affect regrowth?				
	no	not significantly	medium	definitely	very definitely
Chopping effect	Is there a danger that regrowth will be delayed and the vegetation composition altered by leaving the cut on the ground?				
	no	not significantly	medium	definitely	very definitely
Cutting precision	How precisely does the cut follow a cutting height of 5 cm?				
	very precisely	precisely	medium	imprecisely	very imprecisely
Cut-retrieval	Is easy retrieval of the cut material possible?				
	possible without limitations	possible with limitations	possible with addi tional input	possible with substantial additional input	impossible
Power requirement	Power level for mowing?				
	very low	low	medium	high	very high
Soil protection	Implement weight?				
	very low	low	medium	high	very high
Emissions	How high are the expected climate-relevant machinery emissions?				
	very low	low	medium	high	very high
Fauna damage	How high is expected damage to invertebrates at 5 cm cutting height?				
	very low	low	medium	high	very high

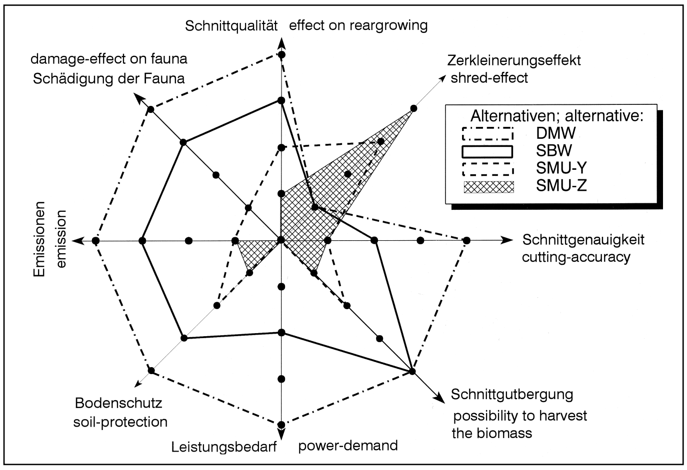

Fig. 3: Target value profile of cutting system in polar coordinate presentation

[4]. A measurable comparison can be done over area; the larger the area, the better can the variant be evaluated.

A comparison of areas emphasised the relative advantages of the reciprocal knife system. This showed a value of 90.6% (area: 36.8 cm^2). The disc mower took second place with 65.6% (area: 19.1 cm^2). The flail mulcher performance was much poorer with the worst result being 28.1% (area: 3.5 cm^2) for the tooth flail. The Y-flail recorded 37.5% (area: 5.7 cm^2). The area represents a measurement for the fulfilment degree of the selected alternatives. It clearly indicated that DMW with the exception of the criteria „chopping effect" showed a very balanced value profile. In comparison the SBW had, in the majority of the evaluation criteria, a grading one step below regarding value although profile was of a similar level. In the same way the graphic documented the lower evaluation for the flail implements whereby the Y-flail implement was ecologically-technically better.

The evaluation was not tied to generalisations but always according to definite, sometimes exact, requirements. Under other conditions the relative superiority can turn around. This is possible, e.g., when for so-called initial care operations plant communities have to be regenerated after some years of fallow and a greater extent of bushing in such areas has to be reckoned with.

It is necessary to consider the direct short-term and long-term effects of care methods when making a comprehensive evaluation. The former are evident soon after care operations and can be associated in a concrete way with the technique applied [10, 11]. Indirect results become apparent often only after several years. These can only be indirectly and partly associated with specific implement techniques and are also influenced by other factors such as nutrient supply or weather. Such consideration of long-term effects is the task of biologists, botanists, ecologists and landscape planners.

Literature

Books are identified by •

[1] *Wasner, U.*: Artenvielfalt und Naturschutz. LÖLF-Mitteilungen 8 H. 2, 1983, S. 7-12

[2] *Finck, P., D. Hammer, M. Klein, A. Kohl, U. Riecken, E. Schröder, A. Ssymanik und W. Völk*: Empfehlungen für faunistisch-ökologische Datenerhebungen und ihre naturschutzfachliche Bewertung im Rahmen von Pflege- und Entwicklungsplänen für Naturschutzgroßprojekte des Bundes. Natur und Landschaft 67 (1992), H. 7/8, S. 329-339

[3] *Kromer, K.-H.*: Untersuchungen der mechanischen Pflegeverfahren von Grasflächen an Straßenrändern. Forschungsbericht des Instituts für Landtechnik der Universität Bonn, 1986

[4] • *Zangemeister, Ch.*: Nutzwertanalyse in der Systemtechnik. Wittmannsche Buchhandlung, München, 1970

[5] *Bechmann, A.*: Nutzwertanalyse, Bewertungstheorie und Planung. Beiträge zur Wirtschaftspolitik 29, Bern, Stuttgart,1978

[6] *Löbbert, M.*: Vergleichende Bewertung technischer Pflegeverfahren für artenreiches Grünland unter besonderer Berücksichtigung des Schutzes der Wirbellosen-Fauna. Forschungsbericht Agrartechnik VDI-MEG, Nr. 322, 1998

[7] *Kromer, K.-H. und H. Mitterleiter*: Mechanisierungsverfahren in der Landschaftspflege, besonders für Grünflächen. Forschungsbericht des Instituts für Landtechnik der Technischen Universität München-Weihenstephan, 1977

[8] *Schumacher, W.*: Magerrasen. In: Biotoppflege, Biotopentwicklung; Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau e.V. (Hrsg.), Teil 1: Maßnahmen zur Stützung und Initiierung von Lebensräumen für Tiere und Pflanzen. Bonn, 1990, S. 67 – 77

[9] VDI-Richtlinie 3780: Technikbewertung. VDI-Verlag, Düsseldorf 1991

[10] *Kraut, D. und H. Freitag*: Bewertung landtechnischer Verfahren. Landtechnik 48, (1993), H. 12, S. 640 – 643

[11] *Baganz, K. und D. Kraut*: Erfahrungen bei der Bewertung von Technik in der Landschaftspflege. In: Technik und Verfahren zur Landschaftspflege und für die Verwertung der anfallenden Materialien, VDI/MEG Kolloquium Agrartechnik, Heft 17, Potsdam-Bornim, 1994, S. 32 – 44

[12] • *Pahl, G. und W. Beitz*: Konstruktionslehre, Handbuch für Studium und Praxis. Springer-Verlag, Berlin, Heidelberg, 1977