MODELLING OF LAND SLOPE RATE IMPACT ON CULTIVATION TECHNOLOGIES COSTS

MODELOVÁNÍ VLIVU SVAŽITOSTI POZEMKŮ NA NÁKLADOVOST PĚSTEBNÍCH TECHNOLOGIÍ

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Abstrakt

Vysoká svažitost pozemků má vliv na nákladovost pěstebních technologií, neboť lze předpokládat, že zejména náklady na provoz strojních souprav porostou. Cílem příspěvku je modelovat vliv svažitosti pozemků na nákladovost pěstebních technologií v oblastech s vysokým výskytem svažitých pozemků. Výpočty jsou proto zaměřeny na údržbu trvalých travních porostů pěstovaných na loukách a pastvinách

Klíčová slova: svažitost pozemkù, náklady, pìstební technologie, modelování

Introduction

The agricultural policy of the European Union gradually reduce the accent on own intensive agricultural activity and transfer the interest to complex approaches to the countryside and within this to the methods of management that are more considerate to the land. The aim of the interest is preservation of cultural country as a national treasure for future generations and preservation of life in this area. Special attention is given to management in difficult (disadvantaged) conditions as are mainly the conditions in mountain and sub mountain areas. The policy plans are summarised in a document called Plan of rural areas development in the Czech Republic in 2007 – 2013, in part II – Improvement of the environment and country.

The focus is on support of management environment-friendly methods that keep and develop biological variety of vegetal species and genotypes in nature. On the other side it means also a boost of employment rate and preservation of population in these areas. The management in these localities has some substantial aspects as:

- Extensive methods of management
- High production costs
- Disadvantaged management conditions given by worse climate and soil conditions
- Field demands expressed by mainly high land slope rate above 15 %

The disadvantaged management conditions in relation to economics make demands on selection of right production technologies and on selection of right machines and production lines. A huge attention to production technologies related to production conditions is given for instance in Germany (KRÖGER, M. 2006). Also a research project Nr 59 Innovativ Bergauf oder Traditionell Bergab (GROIER, M., HOVORKA, G. 2007) is dedicated to the disadvantaged conditions in LFA in Austria.

Mainly high land slope rate has an impact on the cultivation technology costs and a right choice of machines because it can be assumed that the costs of machines operation will increase. In relation to land slope rate there change mainly the demands for technical parameters of machines, mainly tractors (HUNTER, A. G. M. 1992).

The aim of the study is to model the impact of land slope rate on cultivation technologies costs in areas of high occurrence of slopes. The calculations therefore concentrate on the maintenance of permanent vegetation on meadows and pastures.

Methodology

The fundament for modelling impact of slope land rate on cultivation technology costs is a methodical procedure of calculation of permanent grass vegetation growth costs, e.g. standard and extensive cultivation technologies on meadows and pastures (KAVKA, M. et al. 2006). Comparing the cultivation technology costs at the lope rate of up to 9° » 15-16 % (according to GREČENKO, A., 1984 the agricultural machines and cars at the slope rate up to 15% do not change significantly the operational parameters) with costs at slope rate over 15 % (15,1-20,0; 20,1-25,0; 25,1-30,0 % and over 30 %) it is possible to calculate change indexes by whose it can be compared the impact of slope rate.

The changes of parameters for slope land and their impact on the costs and methodical procedure bounds is shown in the table no 1.

During the costs calculation is a first step to determine the cultivation technology on a level of working procedures. Then it is necessary to choose proper means of mechanisation for specific working operation of cultivation technology in relation to slope rate which has an impact on change of purchasing prices that are reflected in annual fixed $rNf_s(s)$ or $rNf_{ep}(s)$ costs at a slope rate function (s) in line with relation 1 (ABRHAM, Z. et al. 2007 and SYROVÝ, O., 2005) and that is separately for machine and separately for power unit (relation 1 is for power units – mainly tractors with index $_{ep}$ and it is possible to calculate it the same way for farm machines with index $_s$).

$$rNf_{ep}(s) = C_{ep}(s).\frac{a}{100} + \frac{C_{ep}(s) + Czb_{ep}(s)}{2}.\frac{zu}{100} + $$
$$+ C_{ep}(s).\frac{p}{100} + rNú_{ep} + rNpr_{ep} + rNg_{ep} + rNsd_{ep} \quad [1]$$

a - annual depreciation rate [%]

$C_{ep}(s)$ - purchasing price of power unit in a function of slope rate [CZK]

$Czb_{ep}(s)$ - residual price of power unit in function of slope rate e.g. at simplified calculations $Czb_{ep}(s) = 0{,}2\ C_{ep}(s)$ CZK]

zu - interest of own capital [%]

p - car insurance [%]

$rNú_{ep}$ - annual costs of credit interest or financial leasing [CZK/year]

$rNpr_{ep}$ - annual costs of damage liability [CZK/year]

rNg_{ep} - annual costs of garage [CZK/year]

$rNsd_{ep}$ - annual costs of road tax [CZK/year]

$rNf_{ep}(s)$ - annual costs of fixed power unit in a function of slope rate [CZK/year]

Next step is a calculation of total unitary costs jNc(s) of realisation of each working operation within cultivation technology at slope rate function in (s), namely of engineering sets. The costs can be calculated in line with relation 2.

$$jNc(s) = \frac{rNf_{ep}(s)}{rT_{ep}.hW_s(s)} + \frac{rNf_s(s)}{rW_s(s)} + jQph_{ep}(s).Ckn$$
$$+ \frac{hNobs.d}{hW_s(s).100} + jNo_{ep}(s) + jNo_s + jNzpm \quad [2]$$

rT_{ep} - annual usage of power unit [h/year]

$hW_s(s)$ - hourly output of machine in a set [ha/h]

$rW_s(s)$ - annual output of machine in a set at slope rate function [ha/year]

$jQph_{ep}(s)$- unit consumption of fuel (diesel) of power unit in a function of slope rate [l/ha]

hNobs - gross hourly wage of operation [CZK/h]

d - height of health and social insurance payment (in year 2009 - 34 % = 1,34) [%]

jNo_s - unitary machine repair costs [CZK/ha]

$jNo_{ep}(s)$ - unitary repair costs of power unit in a function of slope rate [CZK/ha]

Ckn - complex fuel price e.g. fuel price increased by lubricants price (= 1,1 . Fuel price without VAT) [CZK/l]

jNzpm - unitary costs of elemental and additional material (do not have to be taken into account during comparing as they are not dependent on slope rate) [CZK/ha]

From the table no1 and relations 1 and 2 it follows that the biggest impact of slope rate is on:

1. Change of purchasing price of machines and power units
2. Change of hourly and annual output of machine sets
3. Change of fuel consumption by the power units
4. Change of unitary repair costs of mainly power unit (GREČENKO, A. 1994and ABRHAM, Z. et al. 2007).

It is very difficult to model the impacts of other parameters presented in the table no 1 and therefore they are not included into modelling, also with regards to their lower significance.

Last step is the calculation of single unitary cultivation technology costs in a function of land slope rate according to relation no 3. It is a sum of unitary total costs for realisation of working <1; i∈ n> operations multiplied by repeating coefficient.

$$jNcpt(s) = \sum_{i=1}^{n} jNc(s)_i.Kop_i \quad [3]$$

jNcpt(s) - total unitary costs for cultivation technology realisation in a function of land slope rate [CZK/ha]

$jNc(s)_i$ - total unitary costs for realisation of i working operation in a function of land slope rate [CZK/ha]

Kop_i - repeating coefficient [1] – space less quantity determining:

- How many times is working operation in cultivation technology repeated (e.g. post harvest stubble ploughing 2x - Kop=2) or;
- On which percentage of land it is done (e.g. 1x per 4 years it is limed - Kop = 0,25) or;
- Technology representation (e.g. straw graining 40 % - Kop=0,4, press straw cleaning 20 % - Kop=0,2, straw picked up by a car 40 % - Kop=0,4) or
- Share of manipulated mass or distance towards standard calculated version.

Comparing normative cost for working operation at different land slope rate of green land it is possible to determine coefficients required with respect to impact of land slope rate Kpb(s) to cultivation technology costs (see relation no 4).

$$Kpb(s > 15\%) = \frac{jNcpt(s > 15\%)}{jNcpt(15\%)} \quad [4]$$

With regards to minimise the impact of variety of typical machines and tractors and from it following operational indicators it was used comparison similar as in relation no 4 to determine impact of purchasing prices change, annual and hourly capacity, fuel consumption and repair costs which allowed evaluation only on the level of agricultural machines and tractors. Basis with a coefficient 1,00 is a land slope rate up to 15 % which corresponds with standard slope availability of most agricultural machines and tractors.

Results

Hypothetical changing trends (increasing or decreasing) of presented operational indicators further in the results are only expert estimations. For need of modelling are such obtained values sufficient, factually by following research confirmed values the results could be calculated. The final machine operational costs in a function of land slope rate finally grow due to higher investment into purchasing adequate technical equipment as well as due to lower hourly and yearly capacity, higher fuel consumption and higher repair and maintenance costs. Thereby grow also the working operation costs and cultivation technology costs.

Impact of land slope rate to selection of machines and tractors

The slope accessibility of standard produced tractors is up to 20 %. The slope accessibility of agricultural machines and tools is rather miscellaneous. Either it is identical with slope accessibility of tractors or it is independent parameter of the machine (up to 15-20 %). This technical parameter must be taken into account with respect to selecting the agricultural machines and power units. For the slopes over 20% up to 30% it is necessary to choose mountain modification of agricultural machines and tractors and for the slopes over 30% special mountain mechanisation.

The land slope rate, rough terrain and bad access roads limit usage of standard manufactured machines and power units for flat land or their usage requires amendments for the work on the slope or a development of special mechanisation machines for slopes (HANDLER, F., WIPPL, J. 2004). At such mechanisation machines can be solved the safety and operation problems but at a cost of higher purchasing prices and operational costs.

As other power units for the areas are different modifications of tractors constructively oriented on lowered centre of gravity also at a cost of lower luminosity higher wheel gauge, extra added security frame or cabin and overall operation ergonomics. Stability of tractor and border line of slope availability significantly changes dependent on its aggregation with a machine that can be carried on, or trailed.

It is assumed that vast majority is secured by a ride on the contour requesting linear stable drive. However, it is quite often that driving on the contour makes the land slide which the operation must equalize and therefore the driving is curvilinear.

The tract ional qualities of the power units, its manageability especially at turning, driving directness, security and land disturbance affects the slip of the running wheels mainly during the works on the slope. Especially at higher tract ional power the drive of all four wheels shows positively during the slip reduction. Also during the selection of the power unit it is necessary to respect the requirement for bigger engine capacity which means comparing to a work on flat land to choose an engine of a level higher output (10 – 20 kW). But it causes in average a lower usage of the engine capacity and higher specific fuel consumption.

Overhung equipment that is grounded on one or more wheels can after the amendment turn the wheels against the slope and thereby catch part of side strength. Towed machines must be equipped by brakes.

If we carry out a recapitulation then the agricultural machines and tractors for steep slopes must comply with the requirements introduced in the table no 1. Complying with the requirement will show at the purchasing price both machines and tractors? In the table 2 are showed results of analysis of increased purchasing prices indexes of agricultural machines and tractors depending on slope availability for working procedures used on meadows and pastures.

Impact of land slope rate to the hourly and yearly performance of agricultural machines

Performance of agricultural machines affects depending on the land slope rate:

- In average lower size of lands which has a consequence in high percentage of turning and headland crossings during working procedures,
- Adjustment of driving speed to the land slope rate,
- Adequate way of driving on the land (usually from one side),
- Worse driving skills,
- Different average transport distance and slope rate of transport lines.

With regards to the above mentioned reasons and the analysis it can be assumed a decreasing trend of hourly performance and from it following annual performance with respect to the slope rate (see table 3).

Impact of land slope rate to the fuel consumption

Fuel consumption with respect to slope rate affects in general higher specific and hourly consumption as a consequence of usage of more powerful power unit with lower utilisation of the engine output in general and therefore a work of the engine in a regime of higher specific fuel consumption. Higher fuel consumption is also caused by higher need of the performance on the slope, lower hourly performance and higher slip of the wheels.

With regards to above mentioned reasons it can be assumed a growing trend of fuel consumption depending on the slope rate (see table 4).

Impact of land slope rate to repair costs

During the works on the slopes it is larger wear and tear of clutch and transmission and the whole running gear including the tyres. Therefore it can be assumed a growing trend of unitary repair and maintenance costs of power units – the tractors depending on the slope rate (see table 5).

Table 1 Changes of parameters for steep land and their impact on the costs

Machines and tractors parameters	
Power units (tractors)	Lower centre of gravity, wider wheel gauge, all wheel drive, higher engine capacity reserve, lower utilisation of engine capacity – Higher specific fuel consumption, safety frame or cabin, higher slip of the wheels.
Machines and equipments	Lower centre of gravity, smaller angle, controlled turning of wheels against the lope, braking system.
Impact on costs	Higher purchasing price, higher fuel consumption, higher wear and tear = higher fixed costs and costs for fuel and repairs.
Machine sets parameters	
Performance	Shorter agricultural deadlines, smaller lands, occurrence of stones and groves, less regular shapes of land and higher slope rate means lower hourly and annual performance and bigger use of human labour.
Fuel consumption	Higher specific consumption, higher slip of the wheels, increased demand of performance for overcoming the slope and lower hourly performance means higher fuel consumption.
Repair costs	Higher wear-out and repair costs.
Impact on costs	Higher unitary fixed and variable costs.

Working methods parameters											
rW	Consumption			Variable costs					jNf	jNc	Kop
	jP	jZPM	jPH	jNpr	jNzpm	jNphm	jNsoup	jNv			
Cultivation technologies											
Working methods i = 1											
rW	Consumption			Variable costs					jNf	jNc	Kop
	jP	jZPM	jPH	jNpr	jNzpm	jNphm	jNsoup	jNv			
Working methods i = 2											
.											
.											
Working methods i = n											

Costs for cultivation for permanent grass vegetation at different slope rate of land								
Consumption		Variable costs					jNf	jNc
jP	jPH	jNpr	jNzpm	jNphm	jNsoup	jNv		
jNc for (s):		do 15 %	15,1 – 20,0 %	20,1 – 25,0 %	25,1 – 30,0 %		over 30 %	

Comparative coefficients of slope rate impact on the costs of relevant cultivation technologies				
Up to 15,0 %	15,1 – 20,0 %	20,1 – 25,0 %	25,1 – 30,0 %	over 30 %
1,00	Bigger than 1.00			

Legend:

rW – annual machine performance in a set [ha/year]
jP - work consumption [h/ha]
jZPM - basic and additional material consumption [kg/ha]
jPH - fuel consumption [l/ha] or unitary fuel costs [CZK/ha]
jNpr - unitary costs for labour [CZK/ha]
jNzpm - unitary costs for basic and additional material [CZK/ha]
jNphm - unitary costs for fuel and lubricants [CZK/ha]
jNsoup - unitary costs for machine sets (without fuel and lubricants) [CZK/ha]
jNv - unitary variable costs in total [CZK/ha]
jNf - unitary fixed costs [CZK/ha]
jNc - unitary total costs (VN + FN) [CZK/ha]
Kop - repeating coefficient of working method within cultivation technology

Table 2 Overview of suitable categories of machines in sets and tractors for working methods used at cultivation technologies on the meadows and pastures and indexes of changed purchasing prices depending on the slope availability

order	Machine or tractor category	HTP	Orientation index of price increase [1]				
			Up to 15%	15,1-20,0%	20,1 – 25,0%	25,1 – 30,0%	over 30,0%
1	Wheel tractors (TR) 4x4	50-59 kW	1,00	1,00	1,40	1,40	1,90
2		60-69 kW					
3		80-99 kW					
4		100-119 kW					
5	Rotary reaper + TR 50-89 kW	1,65, 2,20-3,00 m	1,00	1,00	1,00	1,00	1,90
6	Rake + TR 60-69 kW	7,50 m	1,00	1,00	1,00	1,00	1,90
7	Hay turner + TR 50-59 kW	2,50	1,00	1,00	1,00	1,00	1,90
8	Rolling press + TR 80-89 kW	0,8 to 1,6 x 1,2 m	1,00	1,20	1,20	1,20	(-)
9	Self-riding field chopper with adapters	do 200 kW	1,00	1,20	1,20	1,20	(-)
10	Pick-up trailer with cutting mechanism + TR 70-79 kW	do 30 m^3	1,00	1,00	1,00	1,00	1,90
11	Mulch-laying machine + TR 80-89 kW	3,5 m	1,00	1,00	1,00	1,00	1,00
12	Smooth rolls + TR 50-59 kW	4,5	1,00	1,00	1,00	1,00	1,00
13	Meadow-pasture drag + TR 60-69 kW	3 m	1,00	1,00	1,00	1,00	1,00
14	Manure spreader + TR 50-59 kW	5 m	1,10	1,25	1,25	1,25	1,50
15	Gulley sucker + TR 80-89 kW	8 m^3	1,10	1,25	1,25	1,25	1,50
16	Mineral fertiliser spreader + TR 80-89 kW	do 3 t	1,00	1,00	1,00	1,00	1,00
17	Front loader + TR 80-89		1,00	1,00	1,00	1,00	1,60
18	Manipulator		1,00	1,00	1,00	1,00	1,60
19	Packets wrapping + TR 50-59 kW		1,00	1,00	1,00	1,00	(-)
20	Bulk cargo semi-trailer + TR 60-89 kW	8 -15 t	1,00	1,00	1,15	1,15	(-)
21	Flat semi-trailer + TR 60-69	10-15 t	1,00	1,00	1,00	1,00	(-)

Legend:
HTP – main technical parameter used for a category of machine or tractor.
TR – category of tractor.
All wheel tractors are in modification of 4x4 (all four wheels drive). Should the index of increased price be equal to 1, than there are used machines for slope availability up to 15% for the bigger slopes. Should be showed (-), than the machine is not used for steep slopes.

Tab. 3 Hypothetical changes of hourly and yearly capacity of machines depending on land slope rate

Land slope rate [%]	Index of decreasing hourly and yearly capacity against land slope rate up to 15 % [1]
up to 15,0	1,00
15,1 – 20,0	1,15
20,1 – 25,0	1,30
25,1 – 30,0	1,50
over 30	1,75

Tab. 4 Hypothetical changes of hourly fuel consumption based on slope rate

Land slope rate [%]	Index of growing unitary fuel consumption against land slope rate up to 15 % [1]
up to 15,0	1,00
15,1 – 20,0	1,15
20,1 – 25,0	1,30
25,1 – 30,0	1,50
over 30	1,75

Tab. 5 Hypothetical changes of measuring cost for maintenance and repair of tractors based on land slope rate

Land slope rate [%]	Index of growing unitary maintenance and repair costs against land slope rate up to 15 % [1]
up to 15,0	1,00
15,1 – 20,0	1,10
20,1 – 25,0	1,20
25,1 – 30,0	1,30
over 30	1,40

Impact of land slope rate to cultivation technologies costs Impact of land slope rate to machine costs – working methods

By the substitution of increased prices indexes from table 3 to relation 1, index of decreased hourly and annual performance, index of fuel consumption and repair costs and results of relation 1 to relation 2 there were obtained costs for suitable machines operation (category of power units and tractors). By comparison of such calculated costs there were obtained indexed of increased unitary costs for working methods (see table 6) secured by power units depending on the land slope rate.

Directions of agricultural production technologies are elaborated for 3 intensities of production: standard, intensive and extensive. In areas with high occurrence of steep slopes (e.g. LFA – Less Favoured Areas) grow permanent grass vegetation on the meadows and pastures using more or less standard or extensive cultivation technology.

For these two intensities were form the literature [3] and [2] adopted production technologies with normative costs for working methods that became a basis for slope rate up to 15%. These costs were against the directions reduced by the costs for basic and additional material (the slope rate doesn't have an impact of values for the costs) and by the costs with no impact of the slope rate (wage costs on maintenance of pasture fencing) and multiplied by the repeating coefficient. For the slope rate over 30 % were the coefficients changed so that they reflect factually used versions of cultivation technologies (operation of only collecting power units instead of press and self-riding field chopper). By multiplying cost for the slope rate of 15% by relevant indexes of increased unitary costs for working procedures secured by power unit form table 6 were calculated the costs for further level of slope rate. By a rate of costs to the slope rate of 15% were calculated the coefficients of increased costs rate due to slope rate – see table 7.

Calculation of coefficients of increased costs rate due to slope rate of meadows and pastures for standard and extensive cultivation technology

Complete example of calculations of costs for standard cultivation technology for the meadows in a function of slope rate is showed in table 7. Using a similar method were analysed other cultivation technologies, i.e. extensive for the meadows and standard and extensive for the pastures. The resulting coefficients of increased costs rate of relevant cultivation technologies due to land slope rate are showed in table 8.

Conclusions

Determination of costs of cultivation technologies come from methodical calculations of unitary costs for operation of power units depending on the land slope rate that influence: higher purchasing price of mechanism power units, lower performance of power units, higher fuel consumption and higher repair costs of the power units.

Combining the indexes of increased or decreased relevant operational parameters of power units using the method of comparison were set the coefficients of increased costs for cultivation technologies on the meadows and pastures in a function of land slope rate- These coefficients can be used for differentiation of allowances in LFA areas as a consequence of high slope rate.

And finally it is necessary to emphasise that the values of power units operational parameters indexes in a function of slope rate showed in this model are only hypothetical and therefore it is required to research exact values under

Tab. 6 Indexes of growing unitary operational costs provided by machines in a function of land slope rate

Order	Machine/ *working operation*	Indexes of growing unitary direct costs for working operation provided by machines [1]				
		Up to 15%	15,1-20,0%	20,1 – 25,0%	25,1 – 30,0%	over 30,0%
1	Rotary reaper + TR 50-89 *Fodder cutting with spreading*	1,00	1,14	1,36	1,47	2,10
2	Rake + TR 60-69 *Raking*	1,00	1,13	1,30	1,46	2,04
3	Hay turner + TR 50-59 *Turning*	1,00	1,13	1,28	1,41	1,95
4	Rolling press + TR 80-89 *Hay pressing*	1,00	1,17	1,38	1,47	-
5	Self-riding field chopper with adapters *Collection of faded fodder to haylage*	1,00	1,22	1,35	1,45	-
6	Pick-up semi-trailer with cutting mechanism + TR 70-79 / *Collection of hay or faded fodder to haylage and transport*	1,00	1,14	1,30	1,40	2,07
7	Mulch laying machine + TR 80-89 *Mulching*	1,00	1,14	1,36	1,47	2,12
8	Smooth rollers + TR 50-59 *Rolling*	1,00	1,13	1,29	1,38	2,01
9	Meadow-pasture drag + TR 60-69 / *Dragging*	1,00	1,13	1,40	1,54	2,12
10	Manure spreader + TR 50-59 / Manure fertilisation	1,00	1,14	1,40	1,52	2,07
11	Gulley sucker + TR 80-89 *Fluid fertilisers usage*	1,00	1,13	1,40	1,53	2,08
12	Mineral fertiliser spreader *Mineral fertilisers usage (PK)*	1,00	1,13	1,40	1,52	2,05
13	Front loader + TR 80-89 *Loading, hay storage*	1,00	1,00	1,00	1,00	1,00
14	Manipulator / *Manipulation, loading, hay packets storage*	1,00	1,13	1,16	1,28	-
15	Packets wrapping + TR 50-59 *Hay packets wrapping*	1,00	1,00	1,00	1,00	-
16	Bulk cargo semi-trailer + TR 60-89 *Transport of faded fodder to haylage*	1,00	1,13	1,26	1,38	-
17	Flat semi-trailer + TR 60-69 / *Hay packets transport*	1,00	1,13	1,26	1,38	-

Tab. 7 Costs for standard cultivation technology for meadows and pastures in a function of land slope rate

Order	Title of working operation	Repeating coefficient	Normative costs multiplied by repeating coefficient [CZK.ha^{-1}]				
			Up to 15%	15,1-20,0%	20,1 – 25,0%	25,1 – 30,0%	over 30,0%
1	Lime share	0,20	260	296	341	372	512
2	Growth setting up	0,07	319	363	417	455	627
3	Spring rolling	1,00	275	311	355	380	553
4	Manure fertilisation	0,30	495	564	693	752	1025
5	1st cutting +fodder spread	1,00	495	564	673	728	1044
6	Turning	2,00	750	848	960	1058	1463
7	Raking	1,00	400	452	520	584	816
8	Hay collection and storage	0,50	204	233	265	286	845
9	Storage + finishing drying	0,50	350	384	384	384	804
10	Hay pressing	0,50	317	370	437	465	0
11	Transport and packets storage	0,50	249	281	313	343	0
12	Control of packets storage						
13	Fluid fertilisers usage	0,30	248	280	347	379	515
14	Fertilisation PK	0,30	70	80	99	107	145
15	2. cutting + spread	1,00	495	564	673	723	965
16	Turning	2,00	750	848	960	1058	1463
17	Fodder raking	1,00	400	452	520	588	816
18	Faded fodder pressing	0,50	318	371	438	467	0
19	Hay packets wrapping	0,50	865	952	952	952	0
20	Transport and packets storage	0,50	104	118	131	144	0
21	Collection of faded fodder by self-riding field chopper	0,30	378	461	510	548	0
22	Faded fodder transport	0,30	117	133	148	162	0
23	Collection of faded fodder by pick-up semi-trailer with cutting mechanism	0,20	108	123	140	151	1118
24	Storage faded fodder into cattle-bin	0,50	525	594	662	725	2028
25	Mulching	1,00	670	764	911	985	1420
Total normative cultivation technology costs without basic and additional material multiplied by repeating coefficient			**9162**	**10406**	**11849**	**12796**	**16159**
Coefficient for increased costs due to land slope rate of meadows for standard cultivation technology			**1,00**	**1,14**	**1,29**	**1,40**	**1,76**

Tab. 8 Coefficient of increased costs due to land slope rate of meadows and pastures for standard and extensive cultivation technology

Cultivation technology		Coefficient of increased cultivation technology costs due to land slope rate [1]				
		Up to 15%	15,1- 20,0%	20,1 – 25,0%	25,1 – 30,0%	over 30,0%
Meadows	*Standard*	*1,00*	*1,14*	*1,29*	*1,40*	*1,76*
	Extensive	*1,00*	*1,14*	*1,28*	*1,38*	*1,81*
Pastures	*Standard*	*1,00*	*1,13*	*1,30*	*1,43*	*1,81*
	Extensive	*1,00*	*1,12*	*1,29*	*1,40*	*1,94*

the conditions of the Czech Republic. The authors also work on an application that would calculate the dynamically demanded coefficients.

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Literatura:

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Abstract:

High land slope rate has an impact on the cultivation technology costs because it can be assumed that especially costs of machines will grow. The aim of this work is to model an impact of land slope rate on cultivation technologies costs in areas with high occurrence of slope land. The calculations are therefore focused on maintenance of permanent grass vegetation grown on the meadows and pastures.

Keywords: land slope rate, cultivation technology, modelling

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