

Analytical and Modelling Deduction of Requirements on Tractor Concepts for Cultivation and Application Purposes

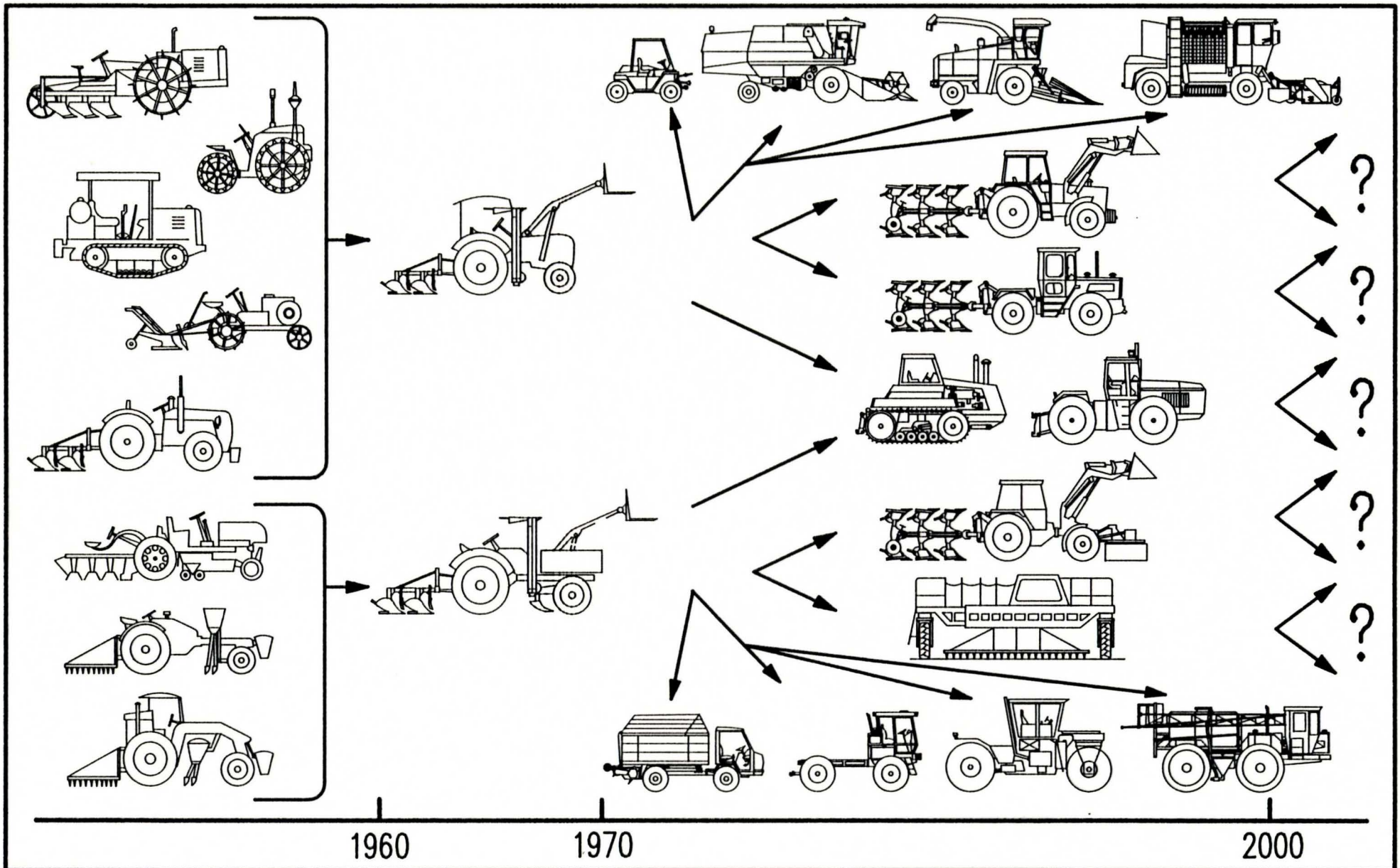
by

**Demmel M., Auernhammer H.,
Institut für Landtechnik, Technische Universität München
85350 Freising-Weihenstephan, Germany**

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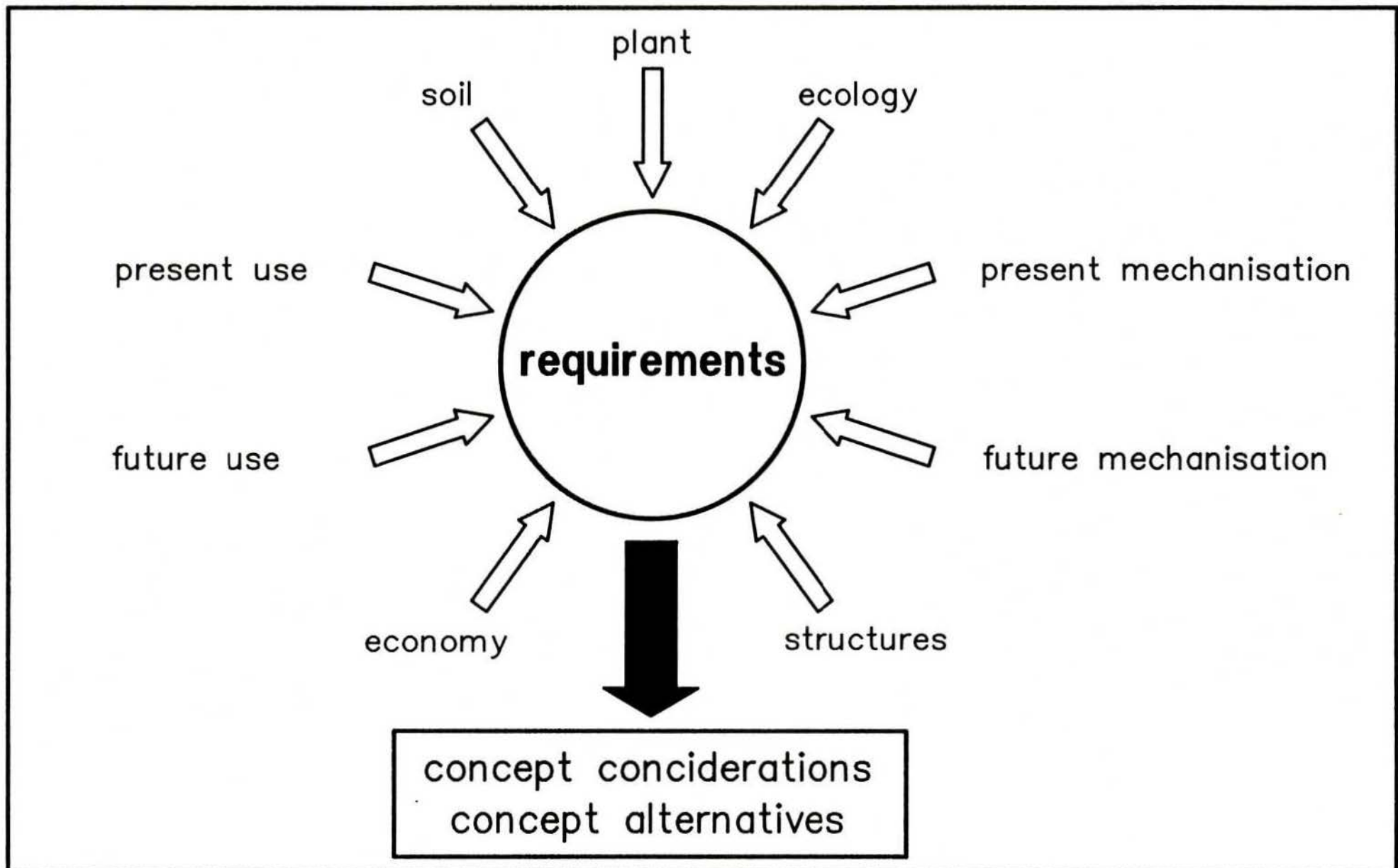
Tractor conceptions in the
course of the years




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	statistics			projection (by NEANDER 1986)	
	1971	1983	1990	1990	2000
basic data: agricultural acreage number of farms acreage per farm acreage per full-job farm	12.7 Mio ha 1 160 000 11.0 ha 17.4 ha	12.0 Mio ha 768 000 15.3 ha 24.7 ha	11.8 Mio ha 667 000 17.7 ha 28.1 ha	11.7 Mio ha 683 000 17 ha 28 ha	11.3 Mio ha 558 000 20 ha 34 ha
share of: priority farm (50% and more of the margin of the enterprise out of one production segment)	78.5 %	92.0 %	94.9 %	95 %	97 %
share of: special farms (75% and more of the margin of the enterprise out of one production segment)	29.1 %	51.2 %	63.5 %	60 %	67 %
Demmel Auernhammer	<u>Development and concentration of farms in the agriculture of the Federal Republic of Germany</u> (Germany in borders of 1989, statistical yearbooks, added by projections of NEANDER 1986)			 98 2AD 019	

data type of the survey	"large tractor-survey" Weihenstephan	"tractor-survey" FAL-OLFE	"cultivation tractor-survey" Weihenstephan
year of survey	1980	1980	1989
number of participating farms	478	1978	577
avg. agricultural acreage	100 ha	54 ha	91 ha
total number of tractors in survey	971	5097	1922
avg. number of tractors / farm	2.0	2.6	3.3
avg. engine power / tractor	72 kW	44 kW	60 kW
avg. engine power / 100 ha acreage	148 kW	216 kW	222 kW
avg. tractor hours / year	523 h	350 h	432 h

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Surveys on tractor use in Germany



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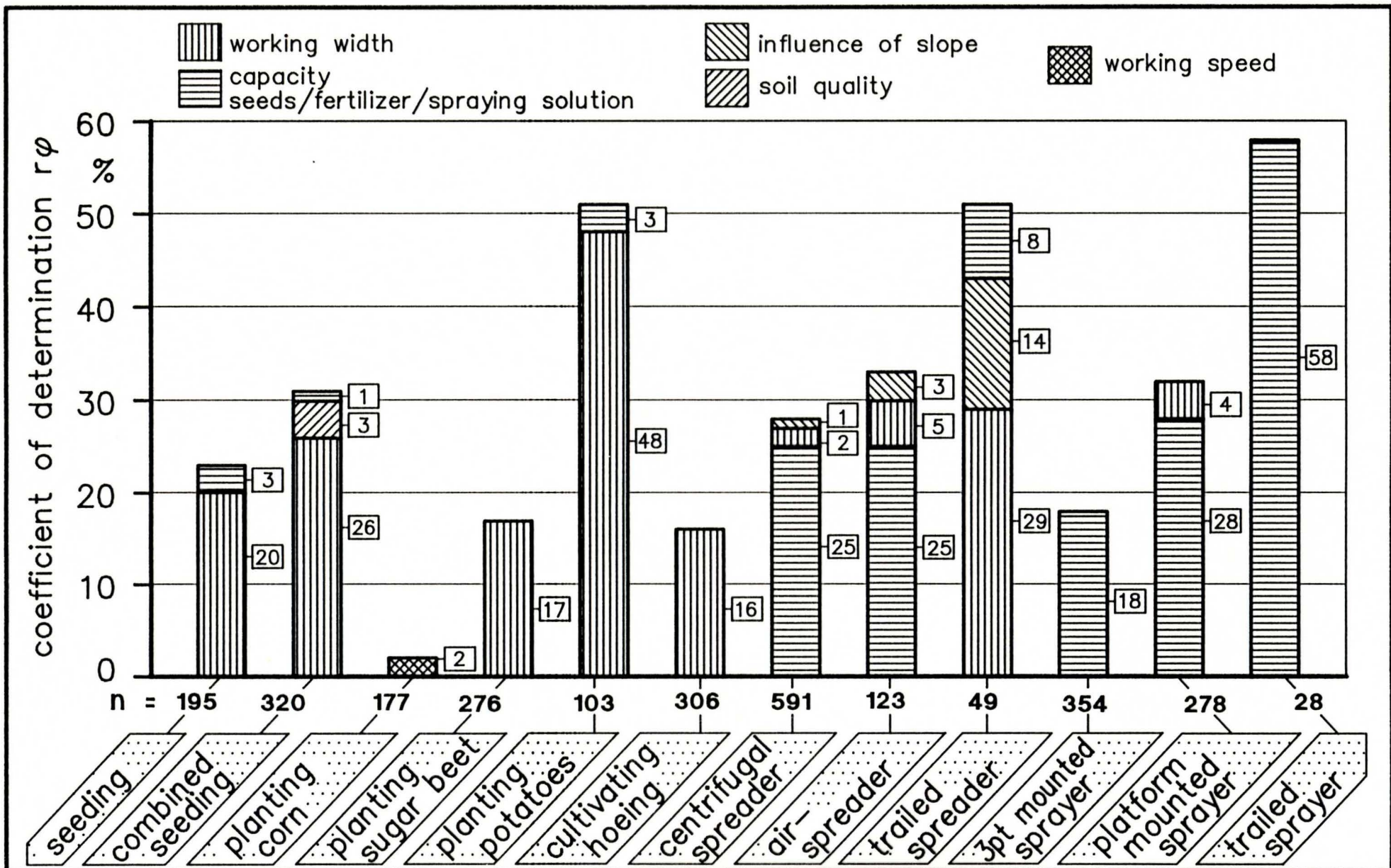
implement	number	working width average, (stddev.) m	working speed average, (stddev.) km/h	container/tank volume average, (stddev) kg
drill, air-seeder	179	3.3 (1.1)	8.9 (19)	370 (210)
planter sugar beet	282	3.7 (0.4)	5.7 (1.0)	---
planter corn	180	3.1 (0.5)	6.6 (1.2)	250 (120)
planter potatoes	109	2.1 (0.8)	5.4 (1.9)	530 (420)
centrifugal spreader	514	12.9 (2.7)	9.5 (2.0)	830 (320)
drawn spreader	75	12.0 (4.5)	9.4 (1.8)	4610 (1280)
air spreader	92	13.2 (3.9)	9.0 (1.8)	1460 (380)
3pt mounted sprayer	334	11.8 (2.5)	7.2 (1.5)	695 (280)
platform sprayer	279	14.2 (3.4)	7.0 (1.2)	1650 (410)
drawn sprayer	29	16.5 (4.3)	6.5 (1.4)	2390 (610)
cultivator / hoe	317	3.4 (1.1)	5.9 (1.7)	290 (60)

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**Working width, working speed and container/tank
volume of implements for cultivation and
application tasks**
(cultivation tractor inquiry 1989, 577 Betriebe)



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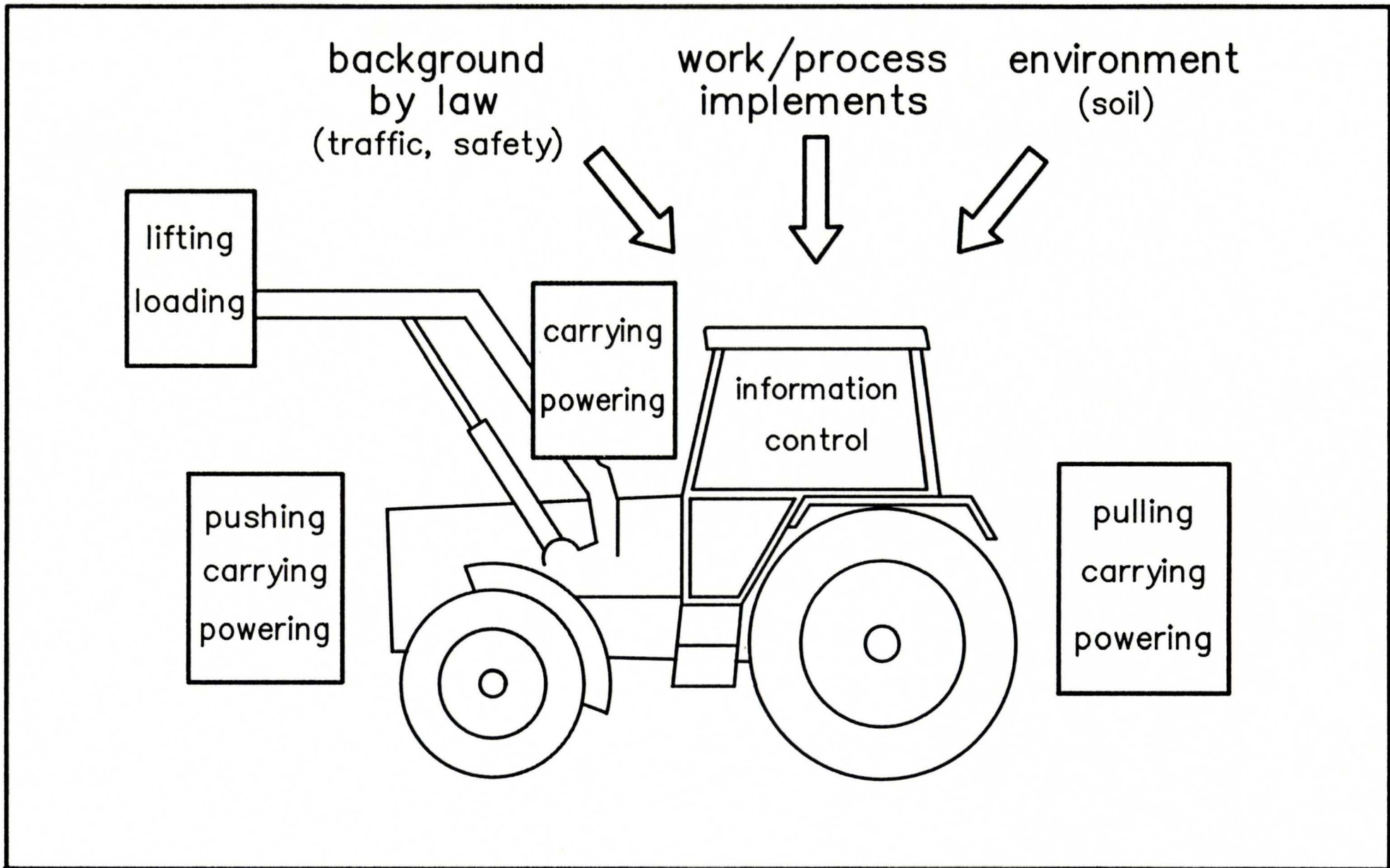
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Influence of different parameters on the tractor engine power with implements for planting and cultivation
("Cultivation tractor inquiry 1989")

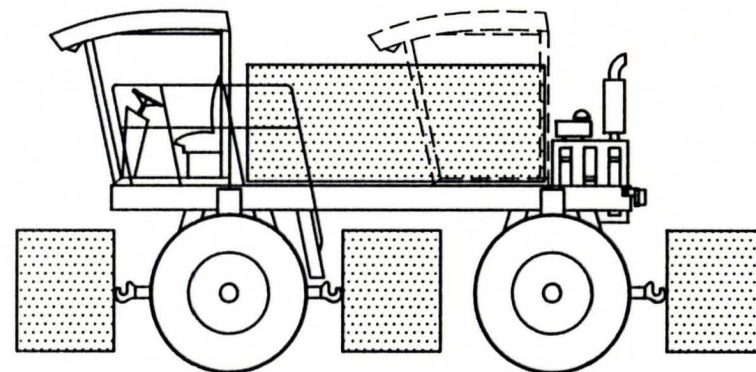
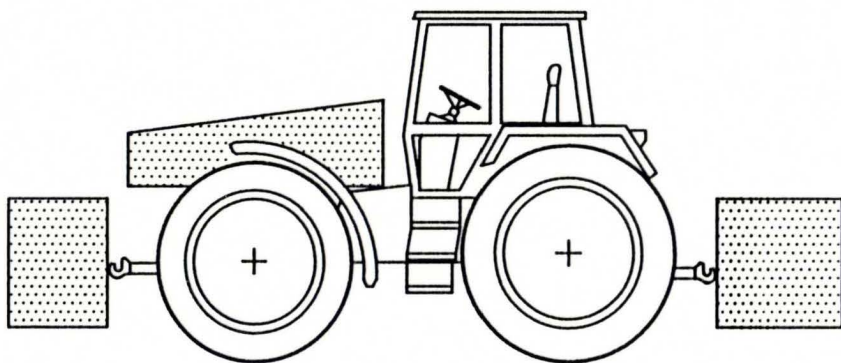
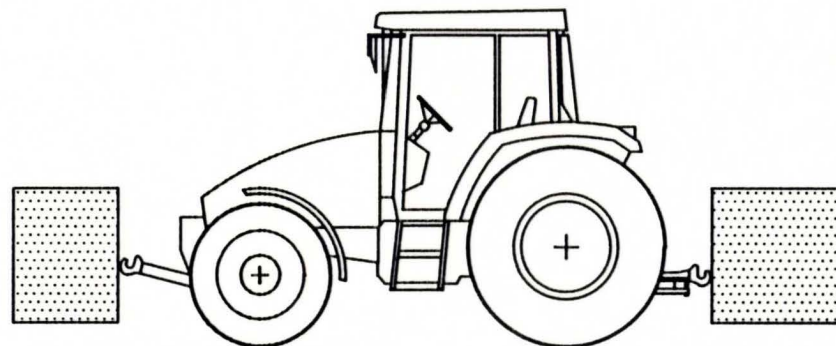
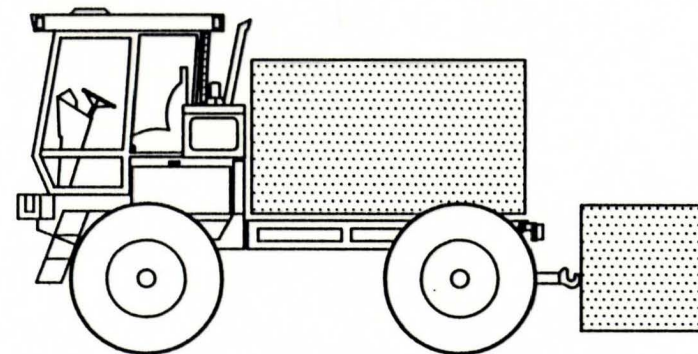
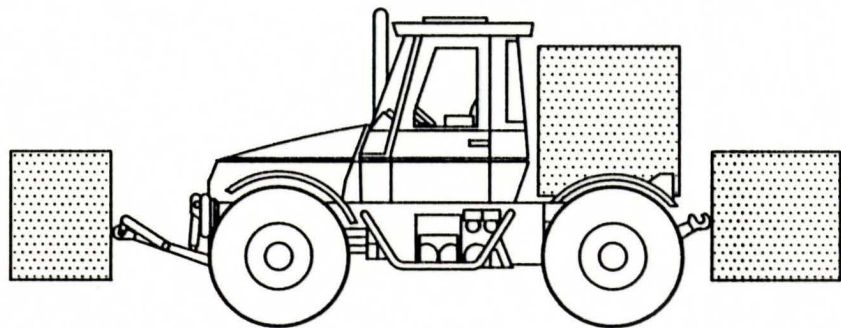


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functions	requirements	
pulling	driving in the field, heavy pulling not necessary	
pushing	light pushing	
carrying	carrying is main task	
powering	small to medium power demand	
lifting / loading	loading (front end loader) not necessary	
information / control	man-machine interface tractor-implement interface	
<u>Demmel</u> <u>Auernhammer</u>	<u>Requirements on the functions of a tractor</u> <u>conception for cultivation and application tasks</u>	 98 2AD 018



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**Tractor models for cultivation
and application purposes**



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features/ property	standard- tractor	tool- carrier	trac- tractor	load- carrier I	load- carrier II
construction	frame	block	frame	frame	frame
engine rating	90 kW	90 kW	90 kW	90 kW	90 kW
driving	mfwd	mfwd	4wd	4wd	4wd
transmission	cvt mechanical	cvt mechanical	cvt mechanical	cvt hydrostatic	cvt hydrostatic
steering	2w (front	2w (front)	2w / 4w	2w / 4w	2w / 4w
power take off	front/rear	front/rear	front/rear	front/ platform	front/raer/ between axles-/ platform
pto rating	full engine 540/750/1000	full engine cvt mech.	full engine cvt mech.	20 kW cvt hydr.	20 kW cvt hydr.
empty weight	5000 kg	5200 kg	6200 kg	3500 kg	4000 kg
load	3600 kg	2300/3800 kg	2800 kg	4000 kg	4000/6000 kg
tread settings	150/180/200 cm	150/180/200 cm	180/200 cm	180/200/225 cm	225-300 cm
clearence	40 cm	70 cm	40 cm	80 cm	120 cm
speed	40 km/h	40 km/h	40/60/80 km/h	20/40 km/h	20/40 km/h

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**Features and technical data of the tractor models for
cultivation and application tasks**



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functions	weight of factors	evaluation of tractor models *				
		standard-tractor	tool-carrier	trac-tractor	load-carrier I	load-carrier II
pulling	10 %	5	5	5	3	3
pushing	5 %	4	4	4	1	3
carrying	50 %	2	3	3	5	5
power take off	15 %	3	4	4	3	3
lifting / loading	0 %	4	4	4	1	1
information	10 %	3	4	3	2	4
control	10 %	1	3	3	4	4
final evaluation	100 %	2.6	3.5	3.4	3.9	4.2

* 5 = very well, 4 = well, 3 = sufficient, 2 = deficient, 1 = not fulfilled

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Evaluation of the fulfillment of the requirements on functions of tractor conceptions for cultivation and application with multi attribute utility technique



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functions	weight of factors	evaluation of tractor models *				
		standard-tractor	tool-carrier	trac-tractor	load-carrier I	load-carrier II
engine	5 %	5	5	5	5	5
drive/transmission	12 %	5	5	5	5	5
undercarriage	16 %	2	3	4	4	5
pto	10 %	2	3	4	4	4
hydraulics	5 %	4	4	4	4	4
implement carrying	20 %	2	4	3	3	5
electrics /electronics	8 %	3	4	4	4	4
cabin	6 %	4	4	4	4	5
measure /weight	18 %	2	2	5	5	4
final evaluation	100 %	2.8	3.6	3.6	4.2	4.6

* 5 = very well, 4 = well, 3 = sufficient, 2 = deficient, 1 = not fulfilled.

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Evaluation of the fulfillment of requirements on components of tractor conceptions for cultivation and application with multi attribute utility technique



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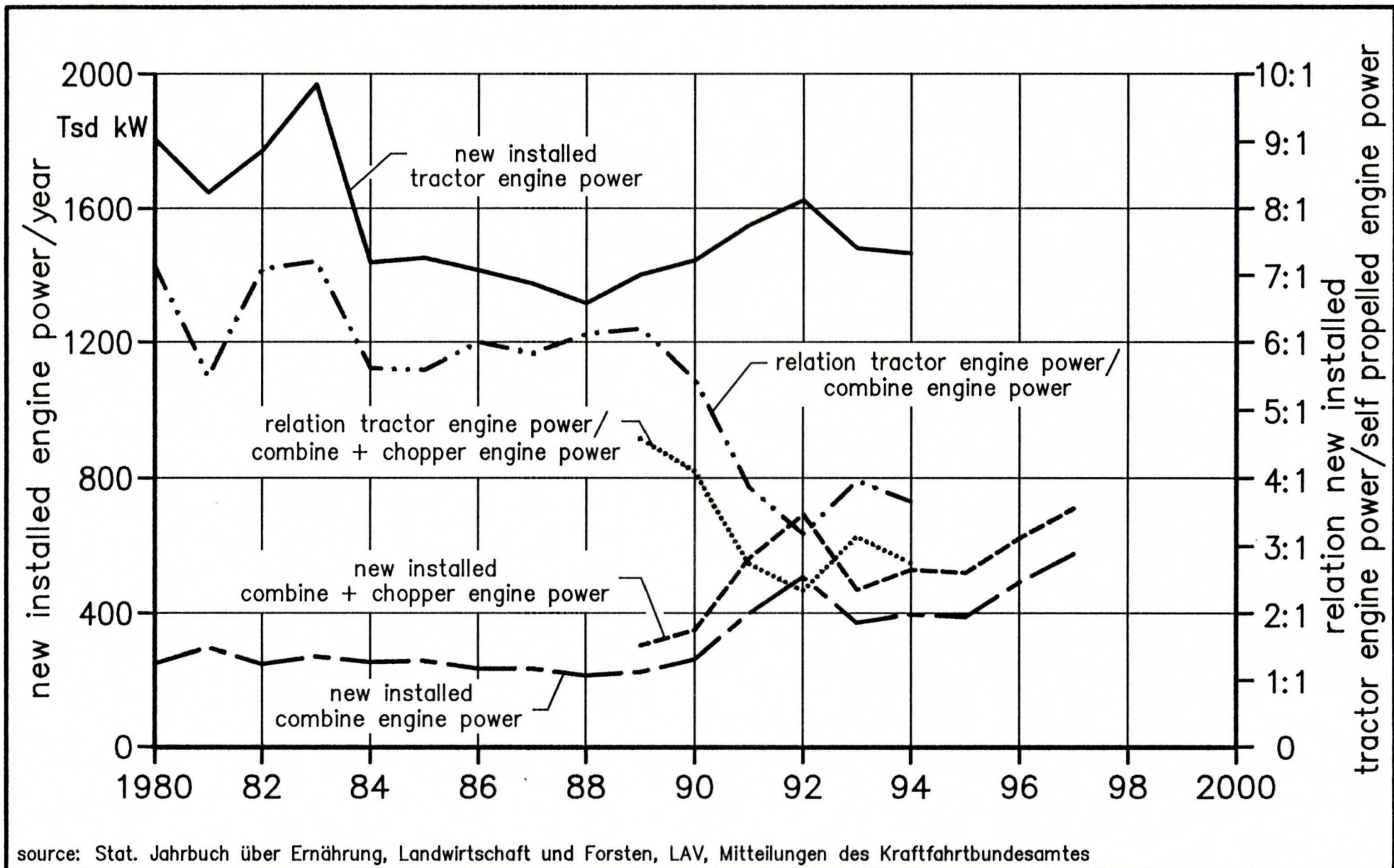
cases of use	necessary acreage for annual use of		
	500 h/a ha	750 h/a ha	1000 h/a ha
application mineral fertilizer (2x) + pesticides (3x) + seeding (75 % AF)	460 / 830	690 / 1 240	920 / 1 640
application mineral fertilizer (2x) + pesticides (3x) + seeding (75 % AF) + planting (25 % AF)	410 / 670	620 / 1 000	820 / 1 330
application mineral fertilizer (2x) + pesticides (3x) + seeding (75 % AF) + planting (25 % AF) + cultivating / hoeing (2x 25 % AF)	340 / 600	510 / 900	680 / 1 200
application mineral fertilizer (2x) + pesticides (3x) + seeding (75 % AF) + slurry to grain (50 % AF)	390 / 670	590 / 1 010	790 / 1 350
application mineral fertilizer (2x) + pesticides (3x) + seeding (75 % AF) + planting (25 % AF) + slurry grain (50 % AF) + corn (25 % AF)	310 / 510	470 / 770	620 / 1 030
application mineral fertilizer (2x) + pesticides (3x) + seeding (75 % AF) + planting (25 % AF) + slurry grain (50 % AF) + corn (25 % AF) + cultivating / hoeing (25 % AF)	290 / 470	430 / 710	580 / 950

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**Necessary acreage for the use of a load carrier
tractor conception for cultivation and application
tasks**



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source: Stat. Jahrbuch über Ernährung, Landwirtschaft und Forsten, LAV, Mitteilungen des Kraftfahrtbundesamtes

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Development of new installed engine power of tractors and self propelled machines in Germany

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Conclusions:

- fast changing structures in agriculture make high efficiency and productivity necessary
- present and future equipment for cultivation and application works puts high demands on the used tractors
- universal use of standard and "system" tractors for cultivation and application tasks
specialized tractor for heavy pull type work and large load carriers for some application work
increasing use of self propelled machines especially for harvesting
- usable load of standard tractors too small for efficient application purposes
- light load carriers with high usable load, low empty weight, continuous variable transmission, high clearance and hydraulic variable tread settings fulfill these requirements best
- price advantages of standard tractors (versus specialized machines) are reduced by decreasing production numbers and increasing numbers of types
- the question, if in future self propelled "multi purpose" light load carriers or highly specialized single purpose sprayers or spreaders will succeed is still open

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Analytical and Modelling Deduction of
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98 2AD 026