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REGIONAL APPROACH TO SOME FARM MANAGEMENT CHARACTERISTICS IN RELATION TO LAND LAYOUT

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Introduction

The requirements the physical outfit of rural regions has to meet are changing quickly. In behalf of farm management, size, shape and accessibility of farm lots and parcels need adapting to the rising cost of labour and the increasing mechanization of fieldwork and transport. To that purpose measures as land improvement, re-allotment of holdings and re-siting of farm buildings are executed in the Netherlands on a large scale. Research into the layout - management relationsis necessary to meet these technical and economic demands in a proper way.

In this paper a regional approach to the effect of land layout on farm management results is treated with the intention to come to an economic evaluation of the existing situation in comparison with one or more alternative proposals. To that purpose the technical relations involved will be discussed briefly. They concern the labour requirements and machine cost of fieldwork and transport as well as the effect of holding layout on crop yield. A first compilation of this scope has been given by REINDS (1970).

Duration of fieldwork in relation to land layout

Factors of land layout influencing the duration of fieldwork are in case of rectangular plots in short: area and width of the parcels, their perimeter and their distance from the operation centre. To analyze this statement, work elements may be divided in five categories, defined respectively as:

- the main time (F. ta), i.e. the time needed for the real fieldwork, inclusive storing at the farmyard and the additional, non-relevant time losses*;
- the turning time of implements on field ends (B. tb);
- the border bound time (K. tr) for cleaning ditches, maintaining hedges or other boundaries inclusive delay in fieldwork on field borders;
- a parcel constant (tp) for putting the machines in and out of work on the field and the corner-bound delay;
- the time for transport, needed to cover the distance between field and farmbuildings or other relevant centres for transport and supply of goods (F. na(E. tv + tn)) as well as for moving of men and implements from field to farmbuildings and vice versa (factor S /(S - (E. tv + tn)), transforming working time exclusive of time for transport into total need of time). For each activity a transport element 0.5 (E. tv + tn) is added to account for half term transfers, not combined with beginning or end of a half day's period, the frequency factor 0.5 being an average between the extreme values 0 and 1.

*the main time though independent of parceling has to be included to include possible changes in area of cultivated land resulting from land improvement projects (e.g. as a consequence of digging or filling ditches, road construction or changes in land use).

In its most simple form this statement can be written as:

$$t = (F.ta + B.tb + K.tr + tp)\frac{S}{S-(E.tv+tn)} + (0.5 + F.na)(E.tv + tn) \qquad (1)$$

in which t = number of (man)hours needed for performing an activity
F = area of parcel in ha
B = width of parcel , 100 m
K = perimeter of parcel, 100 m
E = distance between field and farmbuilding, 100 m
S = half day's working period, hrs
ta = main time, (man)hrs per ha for the activity involved
tb = time for turning implements on field ends per 100 m of width, (man)hrs
tr = border bound time, (man)hrs per 100 m of border length
tp = a constant, (man)hrs per parcel
tv = time for driving to and fro , (man)hrs per 100 m distance
tn = preliminary time for such a drive, (man)hrs
na = number of loads per ha, each asking a drive to and fro

In case of irregular (non-rectangular) formed parcels, B has to be considered as being the maximum dimension of the plot transverse to the main tillage direction and tp can best be written as tp + H.th , H being the number of corners and th the additional time per corner.

A further refinement takes into consideration the possibility of a travelling frequency which will depend on the grouping of separate parcels within a larger (compound) lot. For that purpose the term 0.5(E.tv + tn) may be written as $0.5\sqrt{F/Fl}\,.\,E(tv + tn)$, in which Fl = area of the lot of which the parcel with area F forms part. This means a saving on the total travelling distance if the existing parcellation makes interfield-movements attractive ($F < Fl$).

Finally, in grassland regions fieldwork often will be confronted with the presence of field drains. To meet this situation an item G.tg is added in which

G = total length of field drains on the parcel in 100 m and
tg = additional time for fieldwork per 100 m of length

Formula (1) then changes into:

$$t = (F.ta + B.tb + K.tr + G.tg + H.th + tp)\,.\,S/(S - (E.tv + tn)) +$$
$$+ (0.5\sqrt{F/Fl} + F.na)(E.tv + tn) \qquad (1a)$$

Although computer availability allows incorporation of further details without too great a calculation problem, the intention of regional application of this formula will limit the usefulness of such a refinement. A regionally conducted inventory of data takes much time and seems, moreover, for some characteristics, e.g. the interfield distance, to be hardly practicable.

In case the time elements ta, tb, tr, tg, th and tp and the number of loads na are totalized for all activities occurring during a year for one crop or even a whole crop rotation, and representative values are chosen for tv and tn and if $0.5\sqrt{F/Fl}$ is written as $0.5\,nw\sqrt{F/Fl}$, nw being the number of activities for such a crop or rotation, (1a) will give the mean annual number of (man)hours needed at the given crop rotation. Additional adjustment to regional use can be realized by adding up before further calculation the separate values of F, B, K, G and H for all P parcels, reading E as the mean lot distance of the block and substituting the mean number of parcels per compound lot m for Fl / F. Dividing this total by the block area Fk (a constant for the district involved not equal to Σ F, the area of cultivated land) will give the mean number of (man) hours needed for fieldwork per unit of gross area in relation to land layout:

$$T = [(\Sigma F.ta + \Sigma B.tb + \Sigma K.tr + \Sigma G.tg + \Sigma H.th + P.tp).\ S/(S - (E.tv+tn)) + (0.5\ P.nw / \sqrt{m} + \Sigma F.na)(E.tv + tn)] \ /\ Fk \qquad (2)$$

Machine cost and crop yield relations

In a similar way an estimation of the number of traction and machine hours can be made. Totalizing the machine hours will be possible only after introducing the specific cost per hour for each machine. Substituting the symbols ma, mb, mr, mg, mh, mp, mv and mn, indicating the machine cost per unit of area, length, etc. for ta, tb, tr, tg, th, tp, tv and tn respectively will transform formula (2) into a formula to that purpose.

Crop yield too will be influenced by the holding layout. In general field borders and for grassland strips next to field drains also, have a lower production per unit of area than sites without border influences. In some cases field borders are not cultivated. Moreover, as already mentioned, land improvement measures often will change the area of cultivated land as a result of digging or filling up ditches, etc. The crop yield-layout relation can be formulated analogous to (2), leaving out preparatory and transport items. For a crop rotation, yield aspects have to be given in money values, the contribution of each crop weighted according to factor income, i.e. gross return minus variable non-factor costs.

Cattle husbandry

Although the above holds both for arable land and grassland, cattle farms face some special problems of holding layout. Intensive grazing systems on modern dairy farms need a frequent change from field to field and therefore a non-scattered land use pattern. For a family-farm in the Netherlands, generally comprising dairy cattle husbandry as well as roughage production, the optimum situation can be realized approximately when 60% or more of the total holding area is concentrated within one compound lot adjacent to the farmbuildings, in which milking is carried out. The remaining 40% then is available for dry cows and young stock. Cutting for silage and hay-making will occur on both parts of the holding, its pattern being determined by grass production and stocking density.

Scatter of grazing fields is a hindrance to farm according this system, up till now often circumvented by shifting the herd from one lot to another simultaneous with a mobile milking equipment. This sometimes still has the result of a too intensive grazing of the lots nearest to the farmbuildings. Evaluating the drawbacks of the regional existence of such a situation would ask for a hardly practicable survey of interfield distances and weighing against each other the pros and cons of different farming systems for present as well as future price ratios.

A more practicable approach seems to be sticking to grazing near the milking place at home, even when the available area is less than 60% of the total holding area and supply, at least in thought and as a basis for calculation, the additional need of fresh fodder from the field lots.

As a consequence holdings with less than 60% of their grassland area concentrated near the farmbuildings, will have their dairy cattle graze part of the grazing season ($fh/0.6$, fh being the concentrated fraction of the holding area) on the house lot at its mean half depth from the buildings and part ($1 - fh/0.6$) near or inside these buildings at a distance equal to zero. Other grazing is situated on the field lots. On holdings with 60% or more house lot area, dairy grazing occurs on the 60% area nearest to the farmbuildings, the mean grazing distance assumed to be $0.6/fh$ times the mean distance of the centre of this lot, the given reduction only being useful in case of strip-parcelling. Young stock and dry cattle are thought to graze on the remaining 40%. Frequency of transport (to bring the herd to and from the milking place twice a day and supervision of herd and young stock) makes that a well-based assumption about the site of grazing is very important, especially in a district with long distances. On the other hand the need of labour in cattle husbandry is hardly influenced by parcel dimensions. It can be formulated as:

$$t = tc + Ew.tw + Ej.tj + F.nm.(tm + E.tt) \qquad (3a)$$

or, if $fh < 0.6$:

$$t = tc + Ew.tw.fh/0.6 + Ej.tj + F.nm[tm + E.tt + (1 - fh/0.6)(tz + Ev.tij + E.tu)] \qquad (3b)$$

in which

t = number of manhours, needed for cattle husbandry per holding
tc = a herd constant, manhrs
$Ew.tw$ = a transport item for the milking herd, Ew being the mean grazing distance in 100 m and tw the time in hrs needed per 100 m of distance
$Ej.tj$ = a transport item for young stock, Ej being the mean grazing distance in 100 m and tj the time in hrs needed per 100 m
$F.nm$ = the number of cows, nm being the stocking density
tm = a constant per cow including young stock, hrs
$E.tt$ = a transport item per cow with young stock for manuring, E being the mean field distance in 100 m and tt the time for transport of manure per 100 m of distance, hrs
$fh/0.6$ = period of dairy grazing as part of grazing season, fh being part of the holding area concentrated near the farmbuildings (vide text)
tz = extra time per cow in case of non-grazing during summer, hrs
$Ev.tij$ = time for supplying fresh fodder per cow in case of non-grazing, Ev being the mean distance between farmbuilding and field lots in 100 m and tij the time needed per cow per 100 m, hrs
$E.tu$ = time per cow in this situation for transporting manure, E being the mean field distance in 100 m and tu the time per cow per 100 m, hrs

From (3a) and (3b) the formula for a block as a whole is:

$$T = [N(tc + (fbh + fbv.fhv/0.6)\,Ew.tw + Ej.tj) + \Sigma F.nm(tm + E.tt + fbv(1 - fhv/0.6)(tz + Evv.tij + Ebv.tu)]/Fk \qquad (4)$$

in which

T = the mean number of manhours per gross ha needed for cattle husbandry
N = the number of holdings
$fbh + fbv.fhv/0.6$ = mean period of dairy grazing as part of grazing season, fbh and fbv being part of area covered by holdings with a house lot ≥ 0.6 and < 0.6 of holding area respectively and fhv area of house lot as part of holding area for the last group

Evv, Ebv = the mean distance of field lots and all parcels respectively of holdings with a house lot < 0.6 of holding area, 100 m

E, Ew, Ej= mean values of field distance, distance of dairy grazing and distance of young stock respectively for both types of holdings, 100 m

Machine cost and cost of traction can be deduced in a similar way. Here too a herd constant has to be accounted for, particularly for milking equipment.

As regards farm output, milk production per cow has to be lowered in case long distances between grazing fields and milking place to be covered. Corrections for supplementary feeding in case of non-grazing in summer and a higher net grassland production can be introduced.

Method of calculation in practice

Putting into practice the system described, most of the parcellation data needed on the present situation can be derived from the Land Division Survey Netherlands described in another paper presented at this Conference (LINTHORST and VAN WIJK, 1974). For some characteristics, e.g.parcel dimensions, for the time being an additional inventory is necessary, for which purpose in most cases test checks will do.

In general, the existing layout will have to be compared with a number of proposals for improvement at different levels of investment, which are characterized by an ever more close adjustment of land layout to farm management. To this purpose some alternative proposals are worked out and evaluated in a similar way as has been done for the existing situation.

Time elements and other characteristics regarding farm labour, machinery and traction mostly can be taken from studies by research institutes specialized in these fields of research. Farm plans and working methods, production levels, etc. can be chosen in consultation with regional advisory officers. Transformation of the physical output into farm income can be performed on the basis of a set of linear programming studies, etc. or by introducing market prices for the relevant factors.

By way of illustration the results of a trial calculation for a small block of arable land are given in table 2 ; table 1 and figure 1 give information on the land layout in the various proposals. In this case a subdivision of total border length (ΣK) has been made in three categories (ΣKs, ΣKh, ΣKg, vide table 1), to be calculated separately, each of them claiming a specific working capacity and crop production. The same can be done for the distances to be covered in case of different road quality (field routes versus metalled roads for example). If necessary, a distinction can also be made between distances to be covered by field products (as for transport to a storage centre), contractor's machinery, etc. Object of calculation in the project concerned was estimating the effect on farm management of maintaining the present situation with its high scenic and nature values by evaluating in a comparative way some proposals with more favourable conditions for agricultural use.

Literature

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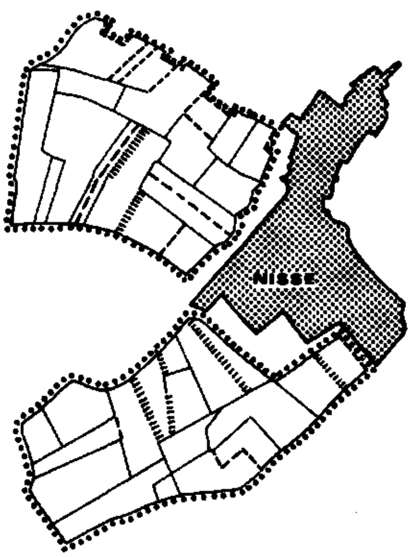
Table 1. Characteristics of land layout at the present situation and for two alternative proposals for a small block of arable land used for a trial calculation. (After Sprik, 1973)

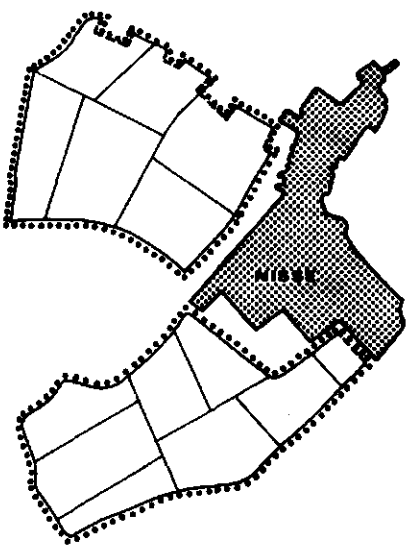
Characteristic of land layout	Symbol	Present situation	Proposal I	Proposal II
Total block area, ha	Fk	47.73	47.73	47.73
Area of cultivated land, ha	ΣF	41.13	42.92	44.51
Mean distance between fields and farmbuildings, 100 m	E	11.00	6.00	6.00
Total border length of the parcels, 100 m	ΣK	192.20	108.40	75.30
of which bounded by ditches, 100 m	ΣKs	143.50	108.40	58.50
the same with hedge boundaries, 100 m	ΣKh	15.30	-	-
bounded by other crop, 100 m	ΣKg	33.40	-	16.80
Totalized maximum width of parcels, 100 m	ΣB	32.40	22.30	14.10
Number of parcels	P	36	14	8
Mean number of parcels per lot	m	1.50	3.50	2
Total number of corners	ΣH	175	74	44

Table 2. Labour requirement, machine cost and gross and net margin for the proposals of table 1, calculated on the basis of the relations discussed in the text for a farm plan with cereals (50% of the area), potatoes (25%) and sugar beets (25%). (After Sprik, 1973)

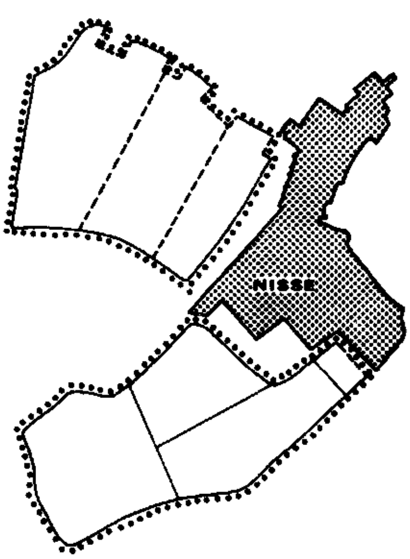
Need of manhours per ha.year	T	47.9	33.9	29.5
Machine cost, gld per ha.year	M	594	449	414
Gross margin, gld per ha.year	V	1783	1897	1990
Net margin, 1 manhour valued at gld 10, gld per ha.year	V-10T-M	710	1109	1281
Profits compared to initial layout gld per ha.year		-	399	571



Initial layout



Proposal I. Hedges removed, parcels enlarged up to about 3 ha



Proposal II. Smaller ditches removed, parcels enlarged up to about 5. 5 ha

block boundary

ditch

hedge

crop boundary