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THE EFFECT OF THE DEVELOPMENT AND EFFICIENCY ON THE PLANNING AND FORECASTING OF AGRICULTURAL PRODUCTION

Vliianie tekhnologii i effektivnosti na planirovanie

ВЛИЯНИЕ ТЕХНОЛОГИИ И ЭФФЕКТИВНОСТИ НА ПЛАНИРОВАНИЕ

И ПРОГНОЗИРОВАНИЕ СЕЛЬСКОХОЗЯЙСТВЕННОГО ПРОИЗВОДСТВА

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EFFECTIVENESS OF TECHNOLOGICAL CHANGES IN POLISH AGRICULTURE

1. Introductory remarks

We define the technology /technique/ of production as a manner of com-
bining basic production factors: labour, technical means /capital/ and
land. We describe the technology of productions with various technical
coefficients which have the form of the coefficients of input absorption
i.e. the input-output relation $/X_i:Y/$ or coefficients of input combina-
tion i.e. the input-input relation $/X_j : X_i$ and $X_j : X_i/$ and also with
the parameters of a multi-factor production function $/Y = A \cap X_i^{e_i}/$, which
are sort of technical coefficients.

We define the effectiveness of technology as quantity relations /at
a given technology/ between the effects and the inputs of production fac-
tors. These relations can have a form of coefficients of partial produc-
tivity of inputs $/Y:X_i/$, coefficients of total productivity of inputs
$/Y : X_i/$ or substitution rate of inputs $/dX_j:dX_i/$.

When aggreageting the inputs and effects we have strictly observed
the rule in order that they have the form of streams. The production fac-
tors have been given the form of streams in the following way:

- the input of land has been calculated by multiplying the agri-
cultural land area, the market price of land the interest rate /0,06/;

- the inputs of capital have been obtained as a sum of purchased
materials and services and inputs of fixed assets that have been brought
to the form of streams by appropriate rates of depreciation /2.5 % for
buildings, 8.5 % for machinery and 5 % for water facilities and permanent
crop plantations/; and

- the labour inputs have been defined by multiplying the number of persons fully employed in agriculture, the standard annual worktime /2100 hours/ and an assumed hourly rate in agriculture /12.5 zł per hour/.

Most calculations have been made in fixed, 1971 prices.

There are two main sources of technological change in agricultural production:

a/ changes in the resources of production factors used in agriculture /and + their quality/;

b/ changes in the level of technical and agricultural knowledge.

The reflection of the first type of change is the substitution of production factors and the changes of the second type are refledted by the technical and agricultural progress /conceived as the totality of improvements in the organization of work and in the methods of plat production and animal breeding/.

The technical and agricultural agro-technical progress normally leads to a reduction of all coefficients of input absorption /or, in other words, to an increase of coefficients of input productivity/, though in varying degrees, depending on the type of innovation.

Instead, the substitution both changes the coefficients of the input combination and the coefficients of input absorption /i.e. the partial coefficients of input productivity/. These changes usually go in different directions - an increase of some coefficients is accompanied by a decline of others.

Thus, the effectiveness of technological changes in production is a total of effects of the substitution process and agro-technical progress. The present paper attempts to quantify these effects.

In the today's agriculture both the intensity of substitution and of agro-technical progress /i.e. also the intensity of technological change/ are determined by the supply of modern technical means and production services for agriculture. Therefore the changes in the technical equipment of agriculture are regarded as the principal determinant of technological change. Other determinants include the ability of the agricultural sector to finance the technological change; the conformity of changes in prices of production factors with the changes in technology; the maturity of the social and technical infrastructure; and other minor factors.

These areas, albeit to a small extent, will be also a subject of our considerations.

2. Main directions of technological changes
   in Polish agriculture

In the quarter of century from 1950 to 1975 the aggregated input of production factors rose by 30 %. Two types of changes were part of it: a small decline in the land and labour inputs and a substantial increase /nearly fivefold/ of capital inputs. As a consequence of these changes the share of labour inputs in total inputs decreased from 72 to 45 % and the share of land input from 15 to 10 %. Instead the share of capital inputs rose from 13 to 45 %. The fast increase of capital input contributed to a relatively fast increase in the technical equipment of labour /an average of 6.5 % annually/ in spite of very slow outflow of agricultural labour force. Equally fast grew the intensity of land use /Table 1./.

These facts prove that in the analyzed period a far-going transformation of production technology took place in the Polish agriculture. The Table 2, containing the basic technical coefficients of production technology in the Polish agriculture in the period 1950-1975 illustrates this transformation in a detailed way.

As can be seen, there was in this period an ample increase in the use of modern production means: mineral fertilizers, compound feeds, herbicides, improved seeds, tractors, combine harvesters, electric power, fuels and others. Moreover, increase was not only per unit of labour or land but also per unit of farm output. There was a substantial change in the structure of the energy power in agriculture: in the fifties horses were the dominant power element /83 %/ and at present dominant the mechanical engines /80 %/. In 1960 the main source of energy used in the process of work were food for men and feeds for draught-horses – their share was amounting to 85 %, the rest consisted of liquid fuels and electricity; in 1975 the energetic value of fuels and electric power equalled the energetic value of food and feed /i.e. 50 % each/. It is projected that in 1980 the proportion of 65:35 will be achieved /Table 3./.

All these changes were accompanied by a growing energy-intensity of agriculture. In 1950 the use of energy contained in mineral fertilizers, pesticides, liquid fuels, electric power, agricultural machinery and imported feed was 5.5 billion Mcal in 1950, 17 billion Mcal in 1960 and some 65 billion Mcal in 1975. The energy use per one calory of the final agricultural product /both home consumed and exported/ rose from 0.2 cal in 1950 to 0.5 in 1960 and 1.4 cal in 1975.

Despite the doubtless progress the production technology in Polish agriculture continues to be insufficiently modern: above all it is very

labour-intensive. This is true especially in the individual farms, a
large part of which is unable to avail of technological and organization-
al innovations due to the size of farms and insatisfactory demographic
situation. It is estimated that the rate of mechanization of work in ag-
riculture does not exceed 40 %. Only some activities in crop production
are highly mechanized /tillage, cereal harvesting, plant protection/. In
animal production the principal activities /giving fodder, removing
manure, watering animals/ are mechanized only to the degree of some 10 %.

In the Polish agriculture some 3 to 4 times as much labour input is
required to produce the unit of farm output than in the Western Europe:
at the same time, however, the equipment of labour with the technical
means and land is also 3 to 4 times lower than in Western Europe /Graph.1/.

The international comparisons lead to a conclusion that the produc-
tion technology used in Polish agriculture tends to be more land-saving
than labour-saving. This conclusion is supported by the fact that the
difference in the land-intensity of farm production /or land productiv-
ity/ in Poland and in Western Europe is relatively small - on the whole
it does not exceed 25 %.

Similar conclusions can be arrived at when observing the changes in
the dynamics and structure of capital inputs in the Polish agriculture
in the period 1960-1975. These changes have been shown in the Table 4.
Taking as a criterion the function in the production process the inputs
of means of production and services were divided into three types:

a/ the inputs stimulating the production growth
/or in other words, land-saving/;

b/ inputs substituting for labour; and

c/ inputs protecting production processes against the
disturbing influence of natural environment.

In the 15 years under review the production stimulating inputs rose
3.5 times and their share in the total capital inputs rose from 52 % to
63 %. Instead of the labour substituting inputs rose by 2.6 times and
their share declined from 25 to 23 %. In the increment of capital inputs
in the period 1960-1975 the share of the former inputs amounted to near-
ly 70 % and the share of the latter inputs amounted only to 22 %. The
above trends are largely a consequence of stressing the maximization of
growth of farm output as the main development objective of the Polish
agricultural policy. The system of regulation instruments, the system
supply of production means for agriculture and - consequently - the di-
rections and the dynamics of transformation of agricultural production
technology are all subordinated to this supreme objective.

The economic policy in Poland has ample possibilities to influence the transformation of agricultural production technology, including the directions and the dynamics of these transformations as well as its intra-farm allocation. Above all, it is practically the only supplier of the means of production and production services for agriculture. It can also influence the change of production technology through prices, credit, scientific and technological information, public investment, legislation etc. Finally, it can use such an important steering instrument as creation of demand for manpower in agriculture.

The complex agrarian structure in Poland consisting of 1700 thousand farms of the size of 0.5-5 hectares covering 25 % of total agricultural land area, 900 thousand farms of the size of 5-10 hectares covering 30 % of area, 400 thousand farms of the size of 10-30 hectares covering 20 % of area and 10 thousand state and cooperative farms of the size of 100-3000 hectares /20 % of area/ does not permit to foster a uniform technology of farm production. In particular, it does not allow to introduce to agriculture a uniform system of labour-saving technical means /including the building equipment/. It is less difficult in this regard to introduce land-saving technical means.

As evidenced by the experience of various highly developed countries, modern technology can be applied in agriculture simultaneously in various variants, in relation to the differentation of the size of farms. In Poland such differentiation is facing numerous difficulties, the principal among them being the underdevelopment of the industry producing means of agricultural production as well as underdevelopment of the social and technical infrastructure in rural areas. Therefore, the entire branches of agriculture /such as cattle, fruit, vegetable and industrial crop production/ are virtually deprived of the access to the modern technologies. There are also difficulties in complementing so called technological sets in these branches, which dispose of modern technologies /for instance cereal production/. The fragmentation of technology leads in the conditions of limited supply of technical means to an increasing technological gap between various farms, and between agriculture and industry as well as to a desintegration of technology at the level of various branches and to formation of various "bottlenecks", which reduces the effectiveness of technolgical changes.

This is why the economic policy in Poland deeply intervenes into the allocation of means of production, including such a drastic instrument as rationing.

A relatively broad access to modern technical means of production have state and cooperative farms. For instance, their share in productive investment /without the agricultural service units/ is close to 60 %. The access of individual farms to technical means of production and to land, which also determines largely the rate of technological change in this sector, is much varied. To some extent also the insufficient propensity of individual farms to innovate is responsible for that in addition to the agricultural policy of the government. A large part of individual farms is in the phase of either a simple reproduction /some 35 %/ or a constrained reproduction /some 20 %/. Some 50 % of total investment in the individual sector is concentrated in about one fifth of farms which show a very high dynamics of production in the range of 12 % annually in the span of 8-10 years. These farms are granted priority in the provision of tractors, agricultural machinery and construction materials. It is assumed that nearly the entire increment of supply of technical equipment for the individual sector in the period 1975-1980 will be concentrated in some 200 thousand specialized farms. They will also be given opportunity to augment their size. It is difficult to say whether such a selective diffusion of modern production technologies is a right approach. At the present moment it is a necessity given the ambitious output targets and the limited availability of technical equipment. It should be also recognized that such a sweeping change in technology – a switch from manual to a highly motorized technique within 10-15 years – exceeds the financial and in quite often also the adaptative capacities of most small farms. The access of these farms to technical and scientific innovation is achieved through the system of agricultural service units – which are fairly well developed in Poland – such as agricultural circles /providing the mechanization and plant protection services/, agricultural extension and training units etc.

3. Effects of substitution of labour and land for capital

We can single out two types of substitution: absolute and relative substitution. The absolute substitution is a replacement of the decreasing production factors /i.e. manpower migrating from agriculture/ and the relative substitution in replacing those production factors which would have been needed to secure the growth of farm output if the change of technology had not taken place.

As we have mentioned, so far the absolute decrease in manpower and land in agriculture has been small. It has been observed at a larger

scale in the individual sector in connection with the shift of production
resources /mainly land/ to the state and cooperative sector. To make for
this decline in the production potential, the decreasing factors had to
be replaced by the capital inputs. We estimate that in the period 1960–
1975 nearly one third of increment of capital inputs in the individual
sector went to replace the diminishing /in an absolute way/ production
factors and thus served to maintain an unchanged level of production;
the rest contributed to the increase of production. In such a situation
the effect of capital outlays should be counted as a sum of two compo-
nents: a real increment of production and a productive /or income/ equi-
valent of the actually replaced factors.

In the socialized sector taken as a whole the latter element does
not come into play, because there is no absolute substitution; converse-
ly, both land and manpower resources are on the increase.

Instead, there is a relative decrease of labour and land in all
sectors. Its size is very substantial. Considering that in the period
1960–1975 the final /gross/ farm output rose by 50 % one would expect
that by 1975 also the inputs of labour, land and capital would have in-
creased by 50 % in the 1960 production technology were maintained. Thus
7.9 and not 4.8 million persons would have to be employed in agricul-
ture; 30 million hectares and not 19.2 million hectares would have to be
cultivated and the capital outplays would have to amount to 68 billion
zlotys and not to 131 billion zlotys. However, the assumptions underly-
ing this calculation are not fully correct. In particular, the manpower
requirements grow more slowly than the farm output because the labour
inputs in agriculture are constant to a large extent /i.e. are indepen-
dent on the volume of output/. Manpower savings are due among others to
an increased scale of production, to higher yields and to higher produc-
tivity of livestock. Thus, they are an effect of: a/ use of means which
increase the productivity of crops and animals, and b/ progress in plant
cultivation and in animal husbandry, in the organization of production
and in a better knowledge of biological processes etc. Our research has
found out that, taken agriculture as a whole, the manpower requirements
grow 2.5 times more slowly than the output. Thus in the period under re-
view /1960–75/ the means of mechanization could replace the work of some
1.5 million persons, out of which the absolute substitution can be esti-
mated at some 0.5 million persons.

Using the equation of the curve of substitution $L = 775 : K_L^{1,036}$
/Graph 2./ and taking into account the above correction we can state
that the substitution of one working day in the period under review re-

quired an average of 32 zlotys of labour-saving means, and in the last
quinquennium /1971-1975/ already 48 zlotys. There are not the full costs
of substitution of labour: they should include also the interest on the
fixed and circulating capital. The coefficient of transformation of in-
puts into costs /π_k/ can be formulated as follows:

$$\pi_k = 1 + p . \sum t_i . u_i ,$$

where: p = interest rate /0.06/, t_i = lock-up time of the i-th component
of the capital inputs, u_i = the share of the i-th component of these in-
puts in the total inputs of the labour-saving means.

By dividing the labour-saving means into fixed and circulating means
we obtain for the former: u = 1/3, t = 7, and for the latter u = 2/3,
t = 1. After appropriate calculations we have concluded that π_k = 1.18.

Thus the cost of substituting one working day in the period 1960-75
can be estimated at 38 zlotys and in the period 1971-75 at 57 zlotys.

In both cases this cost constitutes some 1/2 of the stipulated daily
pay for work in agriculture and 1/3 of the daily rate for hired labour.
Thus it can be concluded that so far, the substitution of labour has been
highly profitable.

Less unequivocal is the effectiveness of substituting capital for
land. The substitution relation between the land input and the land-
saving inputs is described by the equation Z = 490:$K_2^{0.755}$ /Graph 3./.
Using this equation one can conclude that in the period 1960-75 substitu-
tion of one hectare of agricultural land required some 2500 zlotys of
capital input, including some 3500 zlotys /in 1971 prices/ in the last
quinquennium /1971-1975/. For the aggregation of inputs 1500 zlotys have
been assumed as the price of using land. It would mean that either the
substitution of land is unprofitable /though the weak demand for land

both by individual and socialized farms would seem to deny this or the
assuming price of land is too low. It seems that the truth lies inbe-
tween. For the individual farms the cost of using one hectare of land
could be raised by the amount of land tax which now averages 720
zlotys, i.e. to 2200 zlotys. In the socialized farms the price of land
does not exist. The proxy of the price of land in the socialized farms
could be the cost of taking over and bringing into cultivation the land
passed on to the state by the individual farmers. This cost can be es-
timated at some 50 thousand zlotys per hectare. They have a form of a
resource. Thus it would amount some 3000 zlotys per year. One way or
another, substituting technical means for land is not a profitable ope-
ration. The existence of this substitution can be explained by a strong

fostering of this process by the economic policy /i.e. raising prices of agricultural products, subsidizing feeds and mineral fertilizers, financing of agricultural investment from the central budget, etc./, especially in the period 1971-75 due to a fast increase of incomes and to growing demand for food.

4. Effectiveness of technological change in Polish agriculture

The changes of technology of agricultural production in Poland are accompanied by two-way changes of absorbtion coefficients, i.e. the input--output ratios and namely decline of labour-intensity and land-intensity of output and increase in capital-intensity /Table 5./. The latter tendency deserves a special attention because of its sharpness and possibly adverse effects.

In the period 1960-75 the ratio of capital inputs to gross output rose from 0.29 to 0.55 /in 1971 prices/ and the ratio of increment of capital inputs to increment of gross output averaged 0.75.

In the last years the increment of capital input has been even higher than the increment of gross output, which has resulted in a decline of net agricultural product /in constant prices/.

The increase in the capital-intensity of agricultural production has been due mainly to substitution processes, including the replacement of technical equipment. Intersectoral reallocations of agricultural production consisting in the increase of the share of socialized farms /using much more capital-intensive technologies than individual farms/, as well as inter-branch reallocations of agricultural production consisting in a rising share of livestock production /which is more capital-intensive than crop production/ also contributed to this process.

The experience of countries which has lived through the stage of technical reconstruction of agriculture proves that the increasing capital-intensity of agricultural production /especially with regard to fixed assets/ is a transistional stage characteristic of the phase of an intensive "reforming" of production technology. The Polish agriculture is only entering this phase and as evidenced by the findings of various projections, the capital-intensity of agricultural production will continue to grow in the next 10 years /especially the fixed assets; output ratio/. The rising capital-intensity is often taken for a declining effectiveness of capital inputs. It is a very simplified approach since it does not take into consideration the substitution effects of capital. It would be equally wrong to take the decline in labour-intensity and in

land-intensity for an increase in the effectiveness of labour and land inputs.

As a matter of fact, one does not really know what are actual changes in the effectiveness /i.e. net productivity/ of inputs of single production factors.

In order to assess this we have attempted to measure the net productivity of labour /L/, land /Z/ capital inputs /C/ and agrotechnical progress /U/ in the bookkeeping individual farms in the period 1957/58 - 1973/74. We have used to this purpose the multifactoral production function. We have split the period under review into three sub-periods: the sets of data for the sub-periods have consisted of cross-sectional and time series data. And these are obtained production functions:

First sub-period /1957/58-1962/53/
$$P = 5,96 \; L^{0,484} K^{0,592} Z^{0,189} e^{0,009t}; \quad R^2 = 0,955$$

Second sub-period /1963/64-1968/69/
$$P = 8,91 \; L^{0,394} K^{0,606} Z^{0,194} e^{0,014t}; \quad R^2 = 0,965$$

Third sub-period /1969/70-1973/74/
$$P = 10,50 \; L^{0,345} K^{0,640} Z^{0,190} e^{0,018t}; \quad R^2 = 0,968$$

Where: P = gross output in zlotys /current prices/,
    L = labour inputs in days,
    K = inputs of fixed assets /measured by depreciation/
       and purchased materials and services in zlotys
       /current prices/,
    Z = agricultural land area in hectares and
    t = time /1.2.../.

In turn, we have calculated the rates of marginal productivity of individual inputs. They are the following /cost of using individual inputs is given in brackets/:

	First sub-period	Third sub-period
dP/dL, zlotys per day	47/52/	79/102/
dP/dZ, zlotys per hectare	1680/2000/	3400/2300/
dP/dK, zlotys per zloty	1,67/1,18/	2,21/1,18/
U , zlotys per year	450	1940

As it results from the above data, the net productivity of inputs of each factor has been rising, including capital productivity despite the rise of the capital-output ratio in the bookkeeping farms from 0,36 to 0,46 /in fixed prices/ in the period under review. The comparison of productivity of particular factors with the cost of their use proves that the inputs of capital have been the most profitable and the inputs of labour the least profitable. Taking agriculture as a whole the situation may be different. The detailed research proves that the efficiency of mineral fertilization is declining /Graph 4./ as well as use of concentrate feeds. It could mean that the effectiveness of all capital inputs is declining, too.

To sum up, however, the changes in the production technology do not lead to deterioration of effectiveness of agricultural production but, on the contrary, to its improvement.

It is supported by the changes in the relation of the output to the inputs of all production factors /Table 5./. This relation, i.e. total effectiveness of inputs, was rising by 0,9 % annually in the period 1960-1975. This improvement is a joint effect of agro-technical progress and of the substitution of capital for labour. It is difficult to quantify the impact of each particular factor on the improvement of the said effectiveness.

Some light on this is thrown by the analysis of unit-input changes in the individual branches of agricultural production /Table 6./. In crop production the effects both of the substitution process /visible in a sharp decrease of unit labour inputs/ and of agrotechnical progress /visible in a simultaneous decrease of unit inputs of capital, labour and land/ have become evident. Thus the progress in crop production was all inputs-saving as well. In livestock production the decline of unit inputs of labour has been observed. This is undoubtedly an effect of both substitution /especially in the state farms, where the mechanization of livestock servicing grew substantially/, as well as of organizational improvements /increased scale of production/. Instead, the share of zootechnical progress has been - as it seems - rather small, since no decline of capital-intensity, which usually such a progress accompanies, has been noted.

The improvement of the effectiveness of inputs in the period 1960-1975 should be assessed as not significant. In many countries the improvement was more substantial: 1,7 % in the USSR /1950-1970/; 1,8 % in the USA /1950-1972/; 2 % in Mexico /1940-1965/ and in the Federal Republic of Germany /1962-1972/, 2,8 % in Finnland /1950-1969/ and 4,6 % in France /1957-1972/.

It was also too low to compensate for rising cost of use of production factors, especially labour /as a result of a high increase of incomes of non-agricultural population/. In the period 1960-1975 the daily rates for hired labour rose 2.3 times /from 80 to 180 zlotys/. Even higher was the increase of consumption expenditures of farmers per working day /from 52 to 142 zlotys/. There was also an increase of prices for means of agricultural production /by 30 %/ and of the cost of land use /by 20 %/, but these increases were relatively low. Changes in the relation of prices of production factors were providing an incentive to change the production technology, and especially so to substitute labour. However, inadequate supply of means of mechanization and limitation of manpower migration from agriculture were an obstacle to thus process. It could not but lead to a sharp increase of costs of agricultural production. For instance, in individual farms in 1960-1975 the cost of production of grain cereals rose from 215 to 396 zlotys; of potatoes from 62 to 144 zlotys; of sugar beet from 53 to 118 zlotys; of milk from 230 to 450 zlotys; of pigs from 1800 to 4100 zlotys; and of eggs from 2500 to 4600 zlotys.

It can be estimated that the cost of physical unit of gross output rose by some 5 % annually in the period 1960-1975. In these conditions the improvement of effectiveness of inputs /less than 1 % annually/ could only partly attenuate the economic difficulties of agriculture.

5. Financing the changes in production technology

The changes in agricultural technology are accompanied by a sharp increase in the material, financial and information linkages of agriculture with the remaining sectors of national economy. It is enough to say that in the course of the last 15 years the supplies of materials, investment goods and services to agriculture were rising some 10 % annually, instead the gross output of agriculture was rising some 2.9 % annually. In 1960 the supplies of capital goods amounted to 25 % of gross output, in 1970 45 % and in 1975 66 %; their increment was 40 % higher than the increment of gross output /in 1971 prices/. At the same time, labour costs rose sharply too. Thus it is understandable that without financial strengthening by the budget the technological changes in agriculture would have been impossible. Financing the technological changes in agriculture by the state took a form of price increase and extension of credits and subsidies. In the period 1960-1975 prices of agricultural products rose by 68 %. The effect of price increase /120 billion zlotys/

was a direct source of 2/3 increment of gross revenues of agriculture
/the remaining part being an effect of increase output/.

It is true that meanwhile there were also price increases for means
of production and for consumer goods but the price changes were on the
whole benefical for agriculture. In particular they were a strong in-
centive to use land-saving techniques /stimulating growth of output/.

There was also substantial increase in the subsidies /from 12 to 72
billion zlotys/ and credits. They were directed mainly to support the in-
vestment and current production activity; from this source were covered
some 60 % of outlays for augmenting the production assets and the use of
materials and production services. However, the financing of technologi-
cal change in agriculture by the state did not end here. Substantial
subsidies for the industrial branches producing agricultural means of
production should be also taken into account. These subsidies amounted
in 1975 to some 25 % of the value of production means supplied to agri-
culture. At present, as a result of the price reform of July 1976, a
large part of those subsidies has been removed, but this has only a tem-
porary character.

It should be noted that despite such an intensive financial injec-
tion the income parity of agricultural population did not improve /in
relation to the incomes of non-agricultural population/. Also the tech-
nological gap between agriculture and industry has not been filled: on
the contrary it has widened; as manifested by the fact that the relation
of technical equipment of labour in industry and in agriculture rose
from 1.85 in 1960 to 2.14 in 1975 /in 1971 prices/.

Fig

Fig
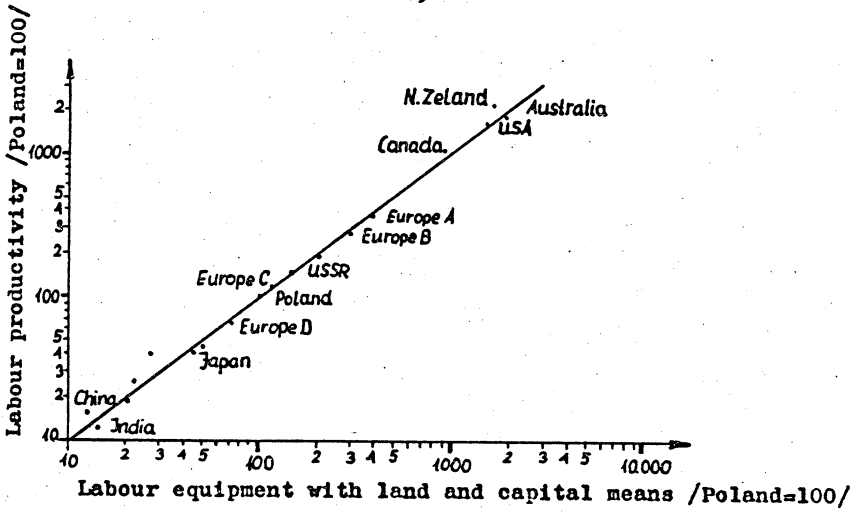
Fig. 1. The relationship between labour equipment with land
and capital means and labour efficiency in world ag-
riculture /data for 1970; own estimates/.

$$L = 775 \cdot K^{-1,036}$$
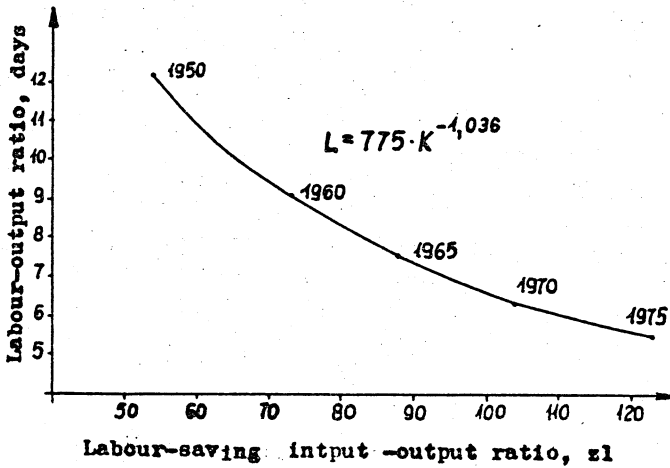
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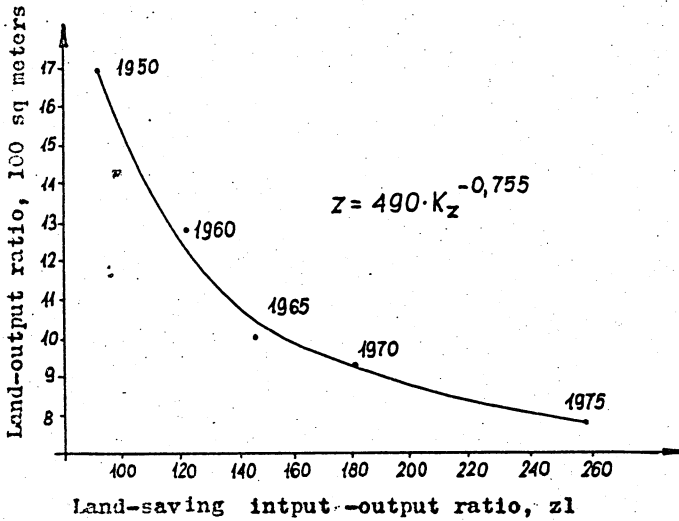
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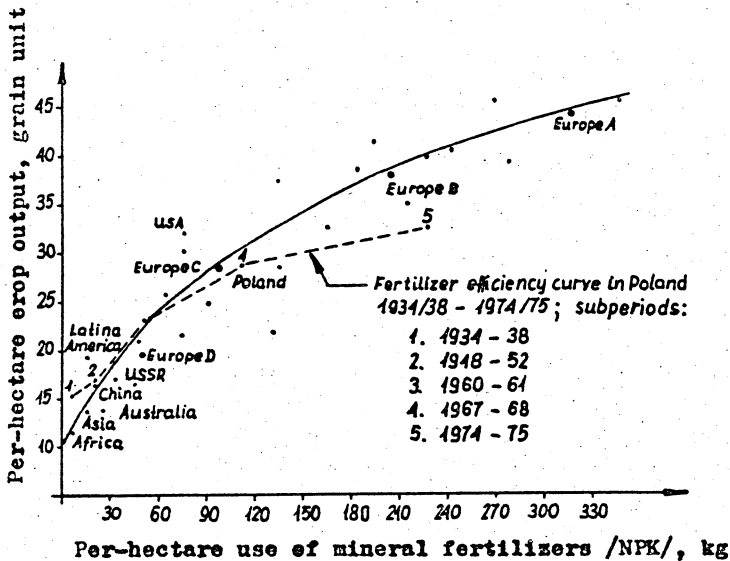
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culations/.

Table 1. Gross farm output and production factors in Polish agriculture 1950, 1960, 1970, 1975

| Items	1950 whole agriculture	1960			1970 whole agriculture	1975		
		whole agriculture	individual farms	state and co-operative farms[a]		whole agriculture	individual farms	state and co-operative farms[a]
Gross output:								
– at 1971 prices /billion zlotys/	125,0	157,0	138,8	18,1	198,3	237,9	184,6	50,4
– at current prices / " " /	.	121,5	107,6	13,9	183,1	294,5	228,9	62,3
Productive fixed assets, at 1971 prices /billion zlotys/[b]	472	548	412	93	684	850	570	228
Employment /thousand persons/	5 410	5 290	4 870	420	4 895	4 820	4 265	544
Agricultural land /thousand ha/	20 440	20 090	17 420	2670	195 210	19 210	15 180	3620
Purchased materials and services at 1971 prices /billion zlotys/	12,3	27,6	19,8	7,8	61,3	100,4	62,1	33,8
Total inputs of production factors at 1971 prices /billion zlotys/	204	218	190	26,5	247	290	219	63
including /%/								
– labour	72	65	69	43	54	45	53	23
– capital[c]	13	21	17	42	34	45	37	68
– land	15	14	14	15	12	10	10	9
Fixed assets per person employed /thousand zlotys/	87	104	85	221	140	176	134	420
Agricultural land area per person employed	3,8	3,8	3,6	6,4	4,0	4,0	3,6	6,7
Capital inputs per 1 ha of agricultural land /thousand zlotys/	1,3	2,3	1,8	4,2	4,4	6,8	5,3	11,9

[a]State and cooperative farms /inclusive of workers plots/. [b]Including the basic stock; without fixed assets in agricultural circles. [c]Including purchased materials and services and inputs of fixed assets /measured by depreciation/.

Source: Authors' own calculations based on the data of the Central Statistical Office and Institute of Agricultural Economics.

Table 2. Basic technical coefficient of agricultural production
in Poland, 1950-1975

Items	1950	1960	1970	1975 whole agriculture	1975 state and cooperative farms[a]	1975 individual farms[b]
1	2	3	4	5	6	7
Use of mineral fertilizers /NPK/						
- per 1 ha of agricultural land /kg/	18	38	128	180	308	152
- per 1 grain unit of principal crops /kg/	1,6	2,7	7,2	9,0	19,5	7,2
Use of pesticides and herbicides per 1 ha of harvested area /kg/	0,4	3,8	3,4	4,1	.	.
- share of herbicides /%/	0	1	12	27	.	.
Use of electrical energy						
- per 1 ha of agricultural land /kWh/	7	30	74	155	236	136
- per 1 grain unit of agricultural production /kWh/	0,3	1,2	2,3	3,9	6,6	3,3
- per person employed in agriculture /kWh/	26	113	300	616	1640	483
Use of liquid fuels						
- per 1 ha of agricultural land /kg/	3	13	38	73	165	52
- per 1 grain unit of agricultural production /kg/	0,2	0,5	1,2	1,8	4,5	1,3
Supplies of improved seeds per 1 ha of area under cereals /kg/	.	30	60	79	160	67
Power in agriculture[c]						
- per 1 ha of agricultural land /h.p./	0,6	0,8	1,4	2,0	1,9	2,0
- per person employed in agriculture /h.p./	2,2	3,2	5,6	8,0	13,0	7,2
- per 10 grainnits of agricultural production /h.p./	3,0	3,3	4,3	5,0	5,3	5,0
- share of animal draught power /%/	83	68	39	24	3	29
Agricultural land area per tractor /ha/	720	320	87	48	39	50
- average power of tractor /h.p./	22,2	30,7	31,0	32,9	36,5	31,3
Number of combine-harvesters per 1000 ha of sown area	0	0,3	1,7	2,6	10,4	1,5
- share of combine harvested land under grains /%/	0	3	15	25	100	17

1	2	3	4	5	6	7
Use of compound feeds						
– per 1 feeding unit /kg/	7	50	250	330	485	290
– per 100 kg of live-weight[d] livestock unit[d] /kg/	2	14	60	80	101	71
Farm output per person employed /grain units/	73	98	133	157	240	145
Farm output per ha of agricultural land /grain units/	19	26	33	40	37	41

[a]State and cooperative farms.

[b]Individual farms and agricultural circles.

[c]Nominal power of mechanical engines and draught horses.

[d]Following conversion rates have been applied: 100 kg pig /liveweight/ = 83 kg cattle or poultry /liveweight/ = 625 liter milk = 2000 egs.

Source: Authors' own calculations.

Table 3. Work-energy sources in Polish agriculture, 1960 and 1975

Items	Total use /million Mcal/			Use per 1 Mcal of consumed and exported agricultural products		
	1960	1975	incre-ment	1960	1975	incre-ment
Food products[a]	6 820	6 560	-260	0,19	0,14	-0,02
Feed for horses	9 750	9 720	-30	0,27	0,21	-0,00
Liquid fuels[b]	2 650	13 720	11 070	0,07	0,29	1,02
Electric energy	520	2 560	2 040	0,01	0,05	0,19
Total	19 740	32 560	12 820	0,54	0,70	1,19

[a]Consumed by persons employed in agriculture per year.

[b]Including agricultural circles.

Source: Authors' own estimates based on the data by the Central
Statistical Office and Institute of Agricultural Economics,
Warsaw.

Table 4. Material inputs in Polish agriculture in 1960 and 1975
/1971 prices/

Type of input	Value /billion zlotys/		Structure /%/		Incre- ment
	1960	1975	1960	1975	
Total material inputs					
External inputs[a]	45,3	131,0	29	45	62
Internal inputs[b]	109,0	161,0	71	55	38
Total	154,3	292,0	100	100	100
External inputs by type					
Materials and services including:	27,6	100,4	61	77	85
1/ Materials of agricultural origin	11,4	49,0	25	37	44
– feed	7,3	30,1	16	23	27
– seeds and breed animals	4,1	18,9	9	14	17
2/ Inputs of industrial origin	11,2	35,5	25	27	28
– mineral fertilizers, pesti- cides and herbicides	3,8	18,6	8	14	17
– fuels and elctric energy	3,4	7,2	8	5	4
– spare parts and repair materials	2,4	5,9	5	5	4
– other materials	1,6	5,9	5	5	4
3/ Production services	5,0	15,9	11	12	13
– agricultural[c]	2,6	9,6	6	7	8
– other	2,4	6,3	5	5	5
Input of fixed assets	17,7	30,6	39	23	15
Total external inputs	45,3	131,0	100	100	100
External inputs by function in the production process					
Inputs stimulating growth of production[d]	23,4	82,2	52	63	69
Inputs substituting labour[e]	11,4	30,2	25	23	22
Other[f]	10,5	18,8	23	14	9

[a]Including purchased material inputs and services and inputs of fixed
assets measured by depreciation.

[b]Including farm produced inputs /feeds, seeds, manure/.

[c]Including veterinarian and mechanization services /delivered by the
agricultural service units/.

[d]Including mineral fertilizers, compound feeds, pesticides, seeds,
breed animals, and use of melioration facilities.

[e]Including input or means or mechanization.

[f]Including input of buildings.

Table 5. Inputs of production factors per 1000 zlotys of gross output in 1960 and 1975 /1971 prices/

Inputs	1960			1975		
	whole agri-cul-ture	indi-vidual farms	state and co-opera-tive farms	whole agri-cul-ture	indi-vidual farms	state and co-opera-tive farms
Productive fixed assets /zlotys/	3490	2970	5140	3570	3090	4520
Manpower /days/	9,1	9,5	6,3	5,5	6,2	2,9
Agricultural land /ha/	0,13	0,13	0,15	0,08	0,08	0,07
Purchased materials and services /zlotys/	176	143	431	422	336	671
Input of fixed assets /zlotys/	113	89	188	129	101	182
Total capital inputs /zlotys/	289	232	619	551	437	853
including:						
– inputs stimulating production /zlotys/	149	109	348	346	255	583
– inputs substituting labour /zlotys/	73	62	155	127	109	181
– other /zlotys/	67	61	116	78	75	89
Total inputs of produc-tion factors /zlotys/	1390	1370	1465	1220	1185	1250

Source: Authors' own calculation based on the data of the Central Statistical Office and Institute of Agricultural Economics, Warsaw.

Table 6. Changes in unit inputs in selected branches of production
in individual farms /in the years 1960-1973/1974/; and
in state farms /in the years 1961-1962-1972-1973/ in
constant prices

Relative increment of decline calculated for 10 years /in %/

Type of product	Individual farms			State farms		
	material inputs	labour inputs	total inputs	material inputs	labour inputs	total inputs
Rye	-1	-36	-17	-12	-75	-24
Wheat	-6	-39	-21	-2	-75	-15
Barley	0	-37	-18	-14	-73	-24
Rapeseed	+22	-31	-6	+8	-70	-5
Sugar beets	+8	-22	-11	+9	-46	-12
Potatoes	-3	-32	-20	+3	-50	-11
Milk	+5	-26	-12	0	-26	-5
Beef cattle	+5	-26	-12	-16	-43	+6
Pigs	+13	-20	-1	-11	-47	-15

Source: Authors' own calculations based on the data of the Institute of
Agricultural Economics, Warsaw.

Table 7. Financing the capital-means in flow to agriculture
          1960, 1970 and 1975 /billion zlotys/

Items	At current prices			At 1971 prices		
	1960	1970	1975	1960	1970	1975
Gross output	114,5	183,3	294,5	155,8	198,3	237,9
Purchased materials and services	22,4	58,0	111,5	27,5	61,3	100,4
Productive investment	10,0	25,7	58,2	12,0	28,1	56,4
All material goods and services	32,4	83,7	169,7	39,6	89,4	156,7
- as percentage of gross output	28	46	58	25	45	66
Personal consumption of agricultural population[a]	82,0	109,3	168,0	100,0	115,5	144,3
- as percentage of gross output	72	59	57	64	58	60
Required personal consumption in agriculture[b]	x	125,0	189,0	x	131,0	175,0
Taxes and other payments	14,4	19,8	28,1	16,8	20,9	26,1
Balance of credits	1,8	5,8	9,1	2,1	6,1	8,5
Expenditures on agriculture from the budget[c]	12,0	28,8	72,0	14,0	30,4	66,9
Investment in agriculture service units	1,3	8,1	·14,4	1,6	8,7	14,4
Total financial revenues[d]	128,3	217,9	375,6	171,9	234,6	313,3
Total expenditures	130,1	220,9	280,2	158,0	234,5	314,5

[a]Including non-productive investment.

[b]Calculated under assumption, that beginning with 1960 per person consumption in agriculture would increase at the same rate as in the rest of national economy.

[c]Including agriculture service units.

[d]Excluding own-labour inputs of farmers in the investment activities on the farm.