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Pannon Agrártudományi Egyetem, Állattenyésztési Kar, Kaposvár
Pannon University of Agriculture, Faculty of Animal Science, Kaposvár

Some economic consequences of the accumulation and depletion of the soil nutrient content in crop production in Hungary

P. Urfi, Zs. Bacsi[1]
Pannon University of Agriculture, Georgikon Faculty of Agronomy, Department of Farm Business Management
[1]Department of Social Sciences, Keszthely, H-8360 Deák F. u. 16.

ABSTRACT

In the 1990s a large proportion of Hungarian crop growers have based their production on utilising the nutrient content of the soil accumulated during the previous two decades. The characteristics of the recording and cost accounting system leave a gap between the real processes and the economic processes: the increase in the soil nutrient content which occurred in the 1980s was expressed in the records as a decrease in the financial resources of the enterprise concerned, while, due to the virtual incomes generated by the exhaustion of the nutrients accumulated in the soil, the loss of soil nutrients in the nineties is presented in the accounts as an increase in the net assets of the enterprise. The adjustment of the recording and accountancy system also seems advisable from the aspect of environmental policy, as the present system attaches undue disadvantage to the application of manure in comparison with chemical fertilisation, and does not allow the recording of nutrient balances, without which the excess nutrient application cannot be taxed. This paper describes the main principles of an adjustment package which overcomes all the above three weaknesses of the present system, while not requiring the introduction of either a new tax form or a fundamentally new recording system
(Keywords: fertilisation, nutrient content, excess nutrient tax, nutrient accounts)

ÖSSZEFOGLALÁS

A tápanyagvagyon felhalmozásának és felélésének néhány közgazdasági konzekvenciája a magyarországi növénytermesztésben
Urfi P., [1]Bacsi Zs.
Pannon Agrártudományi Egyetem, Georgikon Mezőgazdaságtudományi Kar, Üzemtani Tanszék
[1]Társadalomtudományi Tanszék, Keszthely, 8360 Deák F. u. 16.

A növénytermesztéssel foglalkozó magyarországi gazdálkodók nagy része a kilencvenes években a termelést az előző két évtizedben felhalmozott tápanyagvagyon felélésére alapozza. A nyilvántartási, költségelszámolási sajátosságokból adódóan azonban a reál- és a gazdasági folyamatok elszakadtak egymástól. A nyolcvanas évek tápanyagvagyon-növekedése a nyilvántartásokban vagyoncsökkenésként jelent meg, a kilencvenes évek tápanyagvagyon-csökkenése pedig - a vagyonfelélésből származó látszólagos jövedel-

meken keresztül - a számvitelben kimutatott vagyon növekedéséhez vezet. A nyilvántartási rendszer átalakítása környezetpolitikai szempontból is időszerű lenne, hiszen egyrészt a szervestrágyázást hátrányos helyzetbe hozza a műtrágyázással szemben, másrészt nem ad lehetőséget az üzemi szintű tápanyagegyenlegek kimutatására, amelyek nélkül a tápanyagfeleslegek adóztatása elképzelhetetlen. A cikkben olyan változtatáscsomag elveit vázoljuk, amely lehetővé tenné mindhárom említett hiányosság kiküszöbölését, új adónem bevezetése és alapvetően új nyilvántartási rendszer kialakítása nélkül.

(Kulcsszavak: műtrágyázás, tápanyagvagyon, tápanyagtöbblet-adó, tápanyagkönyvelés)

INTRODUCTION

The severe crisis in Hungarian agriculture at the beginning of the 1990s cannot be easily explained solely by the changes in the social and economic system; the unfavourable processes started as early as the 1970s and 1980s. Due to the rocketing oil prices of the seventies and the resulting protectionist tendencies emerging in the agricultural markets of the world the possibilities for the export of agricultural products became limited, and at the same time the prices of industrial materials used in farming, particularly energy prices, increased much more rapidly than the prices of agricultural products (*Németi,* 1986). An even more serious situation was created by the fact that at the end of the seventies and at the beginning of the eighties the role of agriculture within the economy of Hungary underwent a major change: before this date agriculture was, clearly, supported by the national budget, but afterwards agriculture became a net payer into the budget, while the government-controlled price system also extracted substantial incomes from agriculture (*Szabó et al*., 1989; *Vági*, 1990).

The change of the political and economic system which took place at the end of the eighties made the earlier "latent crisis" (*Sipos & Halmai*, 1993) quite apparent; at the beginning of the nineties an overall crisis developed in agriculture. There ensued a serious decrease in production; investments decreased to an even greater degree, and reduced spending on current costs came close to endangering the continuity of production. The level and duration of the crisis was, however, different in different areas of production (*Mohr*, 1998). From 1994 signs of growth were observed in gross production, investments and income generating capacity, but nutrient management remains at a very low level.

At the beginning of the nineties the level of fertilisation, continuously high in the seventies and the eighties, decreased to the level of the 1960s. By the middle of the decade the size of the total population of livestock providing manure had decreased to half that of the beginning of the decade. The nutrient balances of the soil remained in the negative, the majority of crop growers basing their production on using up the nutrients stored by the soils, accumulated during the intensive fertilisation practices of the past two decades. Fertilisation with limited amounts of N with no P or K nutrients became general practice, and this reckless management led to negative nutrient balances as early as the beginning of the nineties (*Kádár,* 1997). The drastic decrease in the number of livestock provides no hope for the substitution with manure of the neglected chemical fertilisation.

The decrease in fertilisation also implies a decrease in the negative environmental effects usually resulting from excess fertilisation, but the present reckless management cannot be maintained for long, since the economic foundation will be lost when the accumulated nutrient content of the soil is exhausted. The present transitory period provides a unique opportunity and time for establishing a harmonised legal and economic framework which is capable of keeping the expected future growth of fertilisation between limits acceptable from agronomic, economic and ecological aspects.

THE INCONGRUITIES OF THE REAL AND THE ECONOMIC PROCESSES

The loss of value in the wealth of Hungarian agriculture became widely known and evident after the years immediately following the change of system, but this process actually began as early as the 1980s. *Balogh & Harza* (1998) estimated the decrease in the value of the agricultural machinery between the years 1982 and 1990 to be 232 billion HUF (Hungarian forints) at 1996 prices *(Table 1)*, another 292 billion HUF should be added, this representing the increase in the debt of agriculture. Thus, the total loss of value was as high as 524 billion HUF in the given eight-year period.

Table 1

The estimated value of agricultural equipment in billion HUF, at 1996 prices, according to *Balogh & Harza* (1998)

Item (1)	1982	1990
Book value of equipment on large-scale farms (2)	1835	1624
Estimated value of equipment in small-scale farms (3)	619	598
Estimated value of land (4)	693	693
Total (5)	3147	2915

1. táblázat: A mezőgazdasági eszközállomány becsült értéke 1996. évi árakon, Balogh & Harza (1998) számításai szerint (milliárd Ft)

Megnevezés(1), Az eszközök mérleg szerinti értéke a nagyüzemekben(2), A kisüzemek becsült eszközértéke(3), A termőföld becsült értéke(4), Összesen(5)

The rate of wealth loss and withdrawal of capital accelerated between 1991 and 1995. The main components of this wealth loss were estimated by *Balogh & Harza* (1998) at 1996 prices, as below (in billions of HUF):

decrease in livestock	160
decrease in value of inventories and buildings used in livestock enterprises	85
decreased value of crops in field	50
plantations removed or aged	20
obsolete machinery and vehicles	60
other decreases	75
Total:	450

Due to the limitations of the present records and accounts system, it cannot take into account the fact that during the 1980s, when the investments accounted for in the balance sheets decreased significantly, the farm enterprises accumulated a substantial level of nutrient wealth through the amounts of fertilisers introduced into the soils. This "quasi-investment" is not accounted for in any enterprise record, but the authors are convinced that knowing the level of this activity should significantly modify our view on the loss of wealth in agriculture.

Kádár (1997) found that in the second half of the 1980s an average of 191,000 tonnes of excess nitrogen, 141,000 tonnes of excess phosphorus and 83,000 tonnes of excess potassium above the level required for the balance of the soil nutrient content was applied to the soil each year. With respect to nitrogen, according to *Horváth* (1997) "the overuse of fertilisation was totally senseless (the excess amount was lost)", but the other two nutrients accumulated in the soil. If the annual average excess phosphorus and potassium are valued at 1996 nutrient prices, then the annual average phosphorus accumulation can be estimated at a value of 13.2 billion HUF, and that of potassium at 2.7 billion HUF. This represents an average 15.5 to 16 billion HUF annual increase in nutrient value, equal to 125 to 130 billion HUF for the eight-year period used by *Balogh & Harza* (1998) in their estimations. The loss of wealth in agriculture calculated by *Balogh & Harza* (1998) for the eighties should therefore be diminished by the above value if the change in the invisible, unrecorded nutrient value is also taken into account.

In accordance with the annual average nutrient balances calculated by *Kádár* (1997) for the first half of the 1990s the soil received 181,000 tonnes less nitrogen, 76,000 tonnes less phosphorus and 170,000 tonnes less potassium than was needed for soil nutrient balance. If the lacking phosphorus and potassium amounts are valued at 1996 prices, then the annual value of the depletion of nutrients is about 12.6 billion HUF: a total of 60 to 65 billion HUF for the five-year period. This amount should be added to the loss of value calculated by *Balogh & Harza* (1998) in the 1990s if the depletion of soil nutrient content is taken into account.

A part of the invisible nutrient value is transformed into a visible value where crop growers achieve profits while soil nutrient balances are negative. The additional profits generated by such a situation are calculated as the difference between the value of the amounts of nutrients utilised during crop growth and the value of the P and K nutrients applied. The estimation of the profit generated was based on the two most important arable crops, wheat and maize, according to the methodology described below.

– Taking the actual average yields (data provided by AKII, the Research and Information Institute of Agricultural Economics) and the average nutrient contents of yields provided by the relevant literature (*Antal et al.*, 1979), the amounts of nutrients utilised by the crops were calculated, and then valued at the respective nutrient prices. (The nutrient prices were the averages of prices offered by several fertiliser merchants in western Hungary.) In calculating the amounts of nutrients extracted by the crop the assumption made by *Kádár* (1997) was applied: that is, 20% of the N and P content and 70% of the K content of the above-ground crop is in the by-product, all the by-product of maize remaining in the field, while on one third of wheat fields the by-product of wheat remains in the field.
– The amount of manure was estimated on the basis of data provided by the KSH (the Hungarian Central Statistics Office) relating to farm enterprises. The nutrient content values of manure were calculated according to the coefficients provided by *Nagy* (1992), and then the calculated nutrient amounts were valued at the fertiliser nutrient prices for the current year.
– The average fertiliser costs determined in a representative survey performed by the Research and Information Institute of Agricultural Economics (AKII) were divided into N, P and K fertilisation costs. Two versions of this division were made, as follows.

I. By means of data from our own surveys for 83 wheat fields and 47 maize fields in the county of Fejér the nutrient content proportions were determined by crop, the nutrient price rates for 1994, 1995 and 1996 being used.

II. The nutrient proportions were calculated as the national average of the nutrient proportions in fertilisers sold in 1994, 1995 and 1996 (data provided by the Hungarian Central Statistics Office), the nutrient price rates for the years 1994, 1995 and 1996 being used.

The difference between the value of nutrients extracted from the soil during production and that of those applied to the soil during fertilisation was calculated for the three nutrients (N, P and K) together, and also for only the two "immobile" nutrients, P and K, together. The latter gives the so-termed "virtual profit" presented in *Table 2*, either version I or version II, these being estimates of the profit arising from the exploitation of P and K nutrients previously introduced into the soil. This virtual profit was also expressed as a proportion of the average actual profit of farm enterprises recorded by AKII. The magnitudes of the figures in *Table 2* show that a substantial proportion of the accounted profit of the agricultural enterprises in the nineties is shown as an increase in the net worth of the enterprise, although it is actually nothing more than the transformation of an "invisible", non-valued property, the nutrient content of the soil, into a valued property.

Table 2

The profits generated by wheat and maize production, and profits adjusted for nutrient balances

Item (1)	1994	1995	1996
WHEAT (2)			
Profit, HUF/ha (3)	13306	8108	28763
N,P and K nutrient balance HUF/ha (4)	-4509	-3298	-842
P and K nutrient balance I, HUF/ha (5)	-2529	-2945	-2345
P and K nutrient balance II, HUF/ha (6)	-2377	-2488	-1522
Share of NPK shortage in profit, % (7)	34	41	3
Share of virtual profit I, % (8)	19	36	8
Share of virtual profit II, % (9)	18	31	5
MAIZE (1 0)			
Profit, HUF/ha (3)	2327	5183	40158
N,P and K nutrient balance HUF/ha (4)	-627	-1508	-3747
P and K nutrient balance I, HUF/ha (5)	-1145	-2359	-4036
P and K nutrient balance II, HUF/ha (6)	-780	-1603	-2780
Share of NPK shortage in profit, % (7)	27	29	9
Share of virtual profit I, % (8)	49	46	10
Share of virtual profit II, % (9)	34	31	7

2. táblázat: A búza- és kukoricatermelés jövedelme, valamint a tápanyagegyenleggel számított korrekciók

Megnevezés(1), Búza(2), Jövedelem, Ft/ha(3), N, P és K tápanyagegyenleg, Ft/ha(4), P és K tápanyagegyenleg I., Ft/ha(5), P és K tápanyagegyenleg II., Ft/ha(6), NPK-hiány aránya a jövedelemben, %(7), Látszólagos jövedelem aránya I., %(8), Látszólagos jövedelem aránya II., %(9), Kukorica(10)

The redistribution of incomes between the 1980s and the 1990s was possible because the value (that is, the cost) of the nutrient accumulation in the eighties was a profit-diminishing factor in the year of application, and so was included in the accounts as decrease in the net worth of the enterprise, while during the nineties it contributed to the increase in production, as well as profit, and also the "visible" book value of the enterprise. *This is a typical example of a situation in which the real processes move in opposition to the economic processes: the increase in the nutrient content values of the soil shows a decrease in the net worth of the enterprise in the accounts, while the decrease in the nutrient content values of the soil during the nineties - through the virtual profits - leads to increased net worth of the enterprise in the accounts.*

THE INFORMATION REQUIREMENTS OF THE ECONOMIC TOOLS FOR ENVIRONMENTAL POLICY

The neglected use of manure and fertilisation, together with the new "reckless exploitation", became typical features of farming in Hungary when the entry of the country into the EU became a realistic possibility for the near future. However, in the interest of both ensuring the chances for accession and improving the position of the country after accession it is necessary to prove that the environmental burden of the Hungarian economy is not as great as that of the present EU member states, and that this will continue to be the case in the future (*Varga,* 1997). The reason for this is that the present member states would consider it an unacceptable market disadvantage if Hungary were allowed to produce under less strict environmental requirements (*Bokor*, 1997), while distrust in Hungarian products arising from looser environmental control would create handicaps for the products of the country which would be intolerable to Hungary.

It is, then, absolutely clear that the tendencies in nutrient management in the present member states of the EU must necessarily be accepted in Hungary, both from the aspect of improving the position for accession and for the purpose of improving the competitiveness of the country on the EU market. As far as the nutrient management tendencies of the EU are concerned the changes which have occurred in the past few years are unmistakable. At the beginning of the 1990s several developed European countries introduced limitations, apparently too severe for the situation in Hungary, to prevent harmful nutrient accumulation (*Kádár,* 1992, 1993; *Szolnokiné,* 1994). During this decade, particularly since the introduction of the European Nitrate Principle (91/676 ECC), an increasing number of studies have been carried out to analyse the expected impact of the formerly neglected economic measures of environmental policy (*Berentsen & Giesen*, 1995; *Kuhlmann & Brodersen*, 1998; *Oude Lansink & Peerlings*, 1997). Special attention is accorded by the authors to a newly initiated research project (NITROTAX) covering six European countries - five EU member states and Hungary - which deals with the possibilities for introducing taxes on nitrogen use (*Podmaniczky*, 1997). Both the above research and common sense dictate that, although the acceptance in Hungarian agriculture of the above *target* - that is, the avoidance of the harmful nutrient accumulation in the soil - might be "automatic" and free of problems, but the choice of *measures* for achieving this aim requires particular care; the starting point of this must be the present situation in Hungary. The introduction of economic measures should be considered seriously, so that these do not enhance the present reckless exploitation of the soil, but their application convinces the EU member states that this country aspiring for accession does not intend to find short-term competitive advantages at the expense of neglect of the environment.

At the present level of fertiliser use and with the present livestock densities the global nutrient accumulation in the soils of Hungary is not a real danger, so the aim of control cannot be the *overall* decrease of NPK utilisation, which would undoubtedly occur if a fertiliser input tax similar to that in force in Austria and Sweden were introduced in Hungary. At the same time however, even in Hungary there is still a significant risk of local nutrient concentration, "point-wise" pollution (e.g. in livestock production sites without arable land), and this pollution would not be affected by the introduction of fertiliser input taxes.

As the aim is not a decrease in fertiliser use, but rather a decrease in losses and leaching originating from nutrient cycles in the form of unused, accumulated nutrient surplus, this aim can be achieved by measures concerning the whole of the cycle and not only a few components of it. Consequently, instead of the fertiliser input tax the taxation of surplus nutrients may be a more successful measure which would also be acceptable to large numbers of farmers. Another fact in favour of this tax is that it is a measure successfully practised in the Netherlands (*Breembroek et al.,* 1996). However, the identification of nutrient surpluses requires the introduction of a suitable "nutrient account" system at farm level, to cover the nutrients generally used (that is, each of the N, P, K nutrients in each phase of the nutrient cycle), and is at the same time simple and possible to control.

ASPECTS OF IMPROVING THE PRESENT RECORDING SYSTEM FOR NUTRIENT MANAGEMENT

The contradictions of the present recording system

In the present accounting system the number of years over which the fertilisation costs are spread depends partly on the number of years the crop is grown on the field where the fertiliser was applied, and partly on whether the fertiliser was applied before or after the year of the first yield in the case of long-term plantations. If, for example, fertiliser is applied to an apple plantation when it is established, then the fertiliser cost is accounted for as a part of the investment itself, and is depreciated together with the whole investment. If the fertiliser is applied at the time of establishment of perennial legumes, then it is handled as a cost element of the establishment of the plantation, and is accounted for as divided cost in three successive years. If the fertiliser is added to annual crops such as wheat or maize, or to plantations which are already in the yielding phase, then the value of the fertilisation is fully accounted for as direct cost occurring in the year of harvest. In this latter case - and this is the most frequent case in Hungarian agriculture - fertilisation is handled as an action with impact prevailing for only one year.

The costs of applying manure, regardless of the duration of the crop under which the manure is spread, are accounted for as cost items distributed over several years. The value of manure used when a plantation is established becomes part of the value of the investment, and will be depreciated together with the whole investment. The cost of the manure applied for the establishment of legumes is spread over three successive years as cost associated with the establishment of the plantation. In other cases (e.g. when manure is applied for wheat, maize or barley) the value of the manure application is distributed over 2 to 4 years, in decreasing instalments (*Erős & Gyurikné,* 1994; *Sutus*, 1994).

This means that whenever the same amount can be spent on the application of nutrients using either manure or fertiliser, manure has an *a priori* competitive disadvantage, because fertiliser can most often be accounted for as an annual cost, and so can decrease the pre-tax income for one year, while the cost of manure has to be spread over several years.

Thus, the weaknesses of the present recording and accounting system regarding nutrient management can be summarised as follows.

– The system favours fertilisers over manure from the aspect of finance and taxation.
– There is no room for expression of the fact that fertilisation is an action with impact over several years, and thus separates the real processes from the financial processes. (This practice has lead to the strange situation that the costs associated with fertilisation were accounted for in the 1980s, and the incomes arising from fertilisation were seemingly generated in the 1990s, while the income taxes due are to be paid in full now, in the rather weak state of agriculture prevailing at present).
– The system does not facilitate the recording of nutrient balances, and without this nutrient surpluses cannot be taxed.

The principles of a new nutrient accountancy and costing system

In the following section the outline is drawn for an adjustment package to facilitate the fulfilment of all of the three requirements mentioned above, *without the need for creating a new recording system or the introduction of a new for of tax*. The preconditions for fulfilling the requirements are present in the framework of the current system. The movements and transfer of materials and tools influencing nutrient balances are recorded and accounted for within the enterprise, and now also between enterprises. Both the minimisation of excess work associated with nutrient balance accounts and the need for controllability suggest that the nutrient accounting system should be integrated into the present system of financial accounts. Then there would be no need for new records to include nutrient balance accounting in the present accounting system; only the present inventory record sheets would be extended somewhat such as to include, in addition to their usual content, the NPK content values of the inventory items (such as livestock feed, fertiliser, crop products, etc.) related to the nutrient balances of the farm. (The nutrient content values would be determined either by authorised laboratories or - when these are unavailable - by taking the legally permitted level of nutrient content values for each inventory item.)

The nutrient content values recorded could be introduced into the accounts *parallel to the account of the financial value of the economic event*, in the same accounting process, into a new subsystem of nutrient accounts for N, P and K. The naming of the nutrient accounts could be the same as that of the inventory accounts used in the financial accounting process, but some new accounts would be added, to be used only in the nutrient balance accounting system. These would be the following.

– The *outer nutrient balance* accounts show differences between incoming and outgoing nutrient content values with respect to N, P and K nutrients.
– The *inner nutrient balance* accounts show the N, P and K nutrient amounts used in the production process, or extracted with the main products and by-products. If the balance is positive, it signifies nutrient amounts "left in the soil", lost or accumulated. A negative balance indicates tendencies of excess use, or reckless exploitation of the nutrient capacity of the soil.

The value of the fertiliser or manure applied in the production process should be fully accounted for as cost; then at the end of the year, in the knowledge of the respective nutrient balances, adjustments would be made. The value of the inner nutrient balance per hectare would be compared to a limit value (which may be different in different geographical locations). Then if the positive nutrient balance were above this limit the surplus would be evaluated at the actual purchase price of the nutrient amount in the fertiliser; this figure should then be added to the financial accounts relating to various methods and nutrients.

In the case of P and K nutrients the surplus would be considered not as cost in the current year, but as investment. Accordingly, the fertilisation costs of the current year's crop production would be reduced by this amount (for which several techniques can be used, although these will not be dealt with in detail here), and the value of the *nutrient property*, which is a new line in the balance sheet as a new component of the capital assets, would be increased by this amount. As the production costs of the current year would be reduced by this amount, the pre-tax profit would be increased automatically. Nutrient property depreciation (in its economic sense) could subsequently be calculated, but this "delayed cost accounting" would obviously be less favourable to farmers than when they were previously allowed to account for the whole cost of fertilisation in the year of application.

Thus, by introducing the term "nutrient property" the weaknesses of the recording and costing system related to nutrient management can be strengthened, as follows.

- The "competitive disadvantage" of the application of manure would disappear from financial accounts and taxation.
- The "delayed cost accounting" applied through the nutrient property would act as an automatic stabiliser, which would render unnecessary the taxation of surplus P and K over the limits.
- The gap between the financial and the real processes would be narrowed, as the nutrient property would provide a way of expressing the multiyear characteristics of fertilisation.

For nitrogen the *surplus over the limit* for the inner nutrient balance can be understood as loss, and regarded as environmental pollution. Accordingly, the value of this surplus should not be included in any account, but when the income tax is computed, this value should be taken into account as an item increasing pre-tax income.

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Corresponding author (*levelezési cím*):

Péter Urfi
Pannon University of Agriculture, Georgikon Faculty of Agronomy
H-8360 Keszthely, Deák F. u. 16.
Pannon Agrártudományi Egyetem, Georgikon Mezőgazdaságtudományi Kar
8360 Keszthely, Deák F. u. 16.
Tel.: 36-83-312-330, Fax: 36-83-315-105
e-mail: up@georgikon.pate.hu