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STUDIES AND STRATEGIES REGARDING THE EVOLUTION OF CROP YIELDS PER UNITOF LAND AREA IN ROMANIA

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Abstract

The crop yields' index – aka the agricultural output per unit area (hectares – ha) of cultivated land – is the best and most synthetic tool for analysing the agricultural sector's technological level and/or its overall competitiveness. In this regard, Romania is a truly special case. Before WW2, the country's main crop yields were largely comparable to those of other European countries. After the war, Romania invested greatly in its agriculture as it was finding it increasingly difficult to keep pace with the most agriculturally advances nations in Western Europe. Yet, rather than diminishing, the gap registered with regard to crop yields per hectare grew increasingly larger. At present, the cereal crop yields per hectare in Romania compares negatively to agriculturally advanced countries in Western Europe reaching only between 3-4 tonnes/ha. Aware of this dire situation, Romanian specialists proceeded to draft agricultural strategies that made the higher productivity yields envisaged wholly dependent on the proper allocation of inputs to this end. This paper is a synthesis of the studies and strategies carried out over the past decades aiming to meet a host of envisaged performance indicators in the area of crop yields/agricultural outputs per unit area (ha) of cultivated land. Rehabilitating irrigation systems while observing the existing environmental protection measures in place, doubling (at least) the quantities of chemical fertilizers used to this end and solving a host of apparently intractable management issues are the main factors that may help with reaching such indicators.

Key words**:** *crop yields per hectare, indicators, performance, strategy*

INTRODUCTION

The crop yields' index is the main qualitative indicator of agricultural economic efficiency. At the same time, seeded and harvested yields per hectare represent a direct productivity component which, in turn, measures work rate efficiency at all levels i.e. per economic unit, productivity sector, economic branch and/or nationwide even. On the other hand though, leaving aside the work rate productivity issue for now, it is useful to remember that land productivity multiplied by the areas of cultivated land must ensure the world's ever-growing population's means of sustenance.

The ratio juxtaposing the world's population growth against that of the agricultural production has long been researched since the bedrock of every form of societal organisation rests with securing the population's means of sustenance. Though we shan't be discussing here the infamous Malthusian spectre of an impending return to subsistence levels, given that the population increases geometrically while the production of food resources only increases arithmetically, there are plenty of competent studies forecasting either that humanity can secure its sustenance or is, in fact, on the brink of starvation [9,10].

Those most engrossed by the food security issue are the politicians and the civil servants requesting solutions to increasing the land's productivity mainly because of the significant costs involved in land reclamation (while considering land as a means of production, the agronomics specialist, Popovici-Lupa, opined that "the breadth of land is limited"[2]).

Out of the literature published on the subject, we will consider the Report on the Limits of Growth [10] – where it is shown that the best half of the 3.2 billion hectares of land suitable for cultivation is already in use as the preparation i.e. the soil tillage of new plots of land is prohibitely expensive. As such, it is hardly surprising to see the researchers' quest for extending the breadth and the productivity

of cultivated areas being echoed by the civil servants and the politicians' undertakings of extending such areas while increasing the yields per surface units.
This paper is important as it is timely since the cultivated land's lesser productivity is the main problem facing Romania's agricultural sector at the present time.

MATERIALS AND METHODS

Economics' research materials compile data available in a host of papers informing this field. Official documents were consulted to ascertain the given subject-matter's long-term evolution. The materials that were eventually selected were then interpreted using specific methods of selection, analysis, synthesis, drawing conclusions and suggesting concrete proposals.

RESULTS AND DISCUSSIONS

Outputs per surface unit and the zoning of agricultural production.

One of the factors that may bring a decisive contribution to the growth of outputs per surface unit is that of zoning agricultural production i.e. cultivating only the types of cultures or raising the cattle best suited to a particular region [2].
In accordance to this principle, over the 1975–6 period, an ample territorial allotment programme – involving Romania's entire agricultural production – was undertaken on the occasion of the Eleventh Congress of the Romanian Communist Party. This agricultural development programme was meant to set out the country's long-term outlook, according to its national economy planning strategy, until the 1990s horizon. (Fig.1)
Every one of the country's research institutes and experimental stations researchers together with the Ministry of Agriculture and County DGs specialists had taken part in the drafting of this (White) Paper.
This Paper was coordinated by a central zoning commission led by the incumbent Minister of Agriculture together with a host of local county commissions that were, in turn, led by the heads of their respective DGs. The resulting drafts were edited and compiled into one Country Synthesis (namely, The Study Book no.105 IEA - ASAS) accompanied by some forty papers for each one of the constituent counties by the Academy of Agricultural and Forestry Sciences' (ASAS) Agrarian Economy Institute. The Research Paper's temporal horizon was 1980–1985–1990.

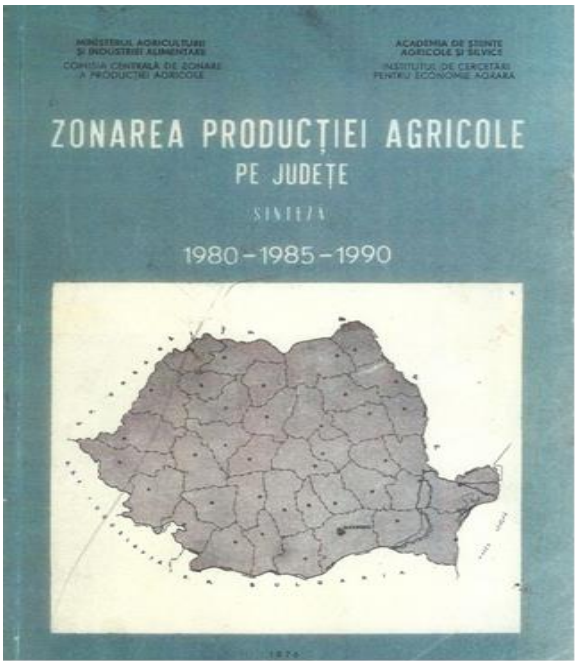

Fig. 1. The Cover of The agricultural production zoning

From this paper, which had been conceived as a social ordering manifesto, resulted that the yields produced by the agricultural sector were to cover the internal consumption needs as well as provide a surplus big enough to be exported, based on using, with maximum efficiency, the available natural, technical and human resource factors.
From a methodological standpoint, linear programming had been modelled nationwide using 40 models for each of the country's counties, in one or two versions. Also, mathematical economic models were used for the first time ever using electronic calculation techniques – with the Felix 235 computers being used to this end. [4]
While specifically important as well as being a world premiere, too, this 1975–1976 Zoning Project did not stop at allotting territorial units while structuring the entire agricultural sector into socio-economic sectors (the state sector,

the cooperative one and the small, non-cooperatively assembled – hence, privately-owned – plots of land).

Social and economic resources were being zoned now based on product-specific technologies for which economic and technical indicators – including the net income (profit), used as the main target function in economic and mathematical modelling.

Based on the available mathematical and economic models, in the '90s, agricultural yields had been forecasted to reach between 29.1% and 36.6% nationwide. Following zoning works that combined an entire complex of natural, economic and social factors, twenty republican zones with a more or less complex profile were created (Fig.2).

Zone's profile

1. Meat , milk , maize , sugarbeet , sunflower
2. Meat , milk , maize , sugarbeet
3. Meat , milk , maize , sunflower
4. Meat , milk , maize , vegetables
5. Meat , maize , sunflower
6. Meat , maize , sugarbeet
7. Meat , maize
8. Meat , maize , vineyards
9. Meat , maize , soyabean
10. Milk , meat
11 Vineyards , meat
12 Vineyards , milk , meat
13 Orchards , meat , wheat
14. Milk , potatoes, wheat
15 Milk , potatoes , wheat , flax
16. Milk , wheat
17. Wheat , milk
18. Wheat , milk , orchards
19. Meat , milk , wool , potatoes
20. Meat , milk , wool

Fig. 2. Romania's Production Macro-zones
Source: Lup A. (2007): An Introduction into the rural-agrarian economy and politics [7].

Aside from the zoning of land parcels according to designated uses, the setting up of macro-zones was aimed at zoning various groups of cultures (for ex. vegetables), and the grouping of the principal cultures: wheat, maize, sugarbeet, according to existing ecological conditions and/or their importance considering that a variety of cultures vie for the most fertile parcels of land (Fig. 3).

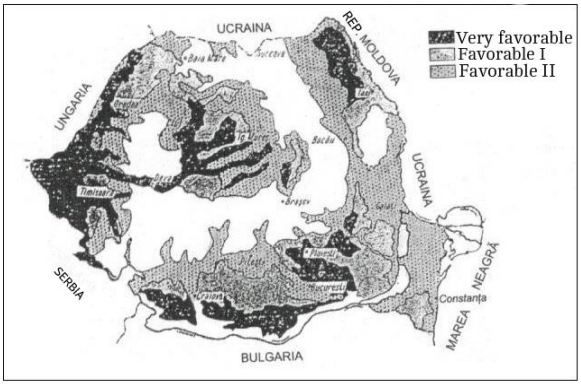

Fig. 3. The ecological zoning of wheat cultures
Source: The Institute of Pedology and Agrochemistry

Though agricultural production zoning was meant as a long-term development strategy, it was beset by a host of less appealing aspects – inherent to the centralised command conditions under which it operated.

Firstly, productivity parameters' projection was unduly optimistic as were the much reduced production costs all of which resulted in such high levels of economic efficiency.

Overall, the set objectives were overly ambitious, even when considering their being set against the 1990's horizon, at a time when they were supposed to reflect the ongoing agricultural modernising and intensifying processes (such as the completion of the reclamation works, the modernisation and growth of the numbers of tractors and other agricultural machinery and/or the modernisation of animal husbandry facilities so to enable a substantial growth of the livestock).

Table 1. Outputs per surface units forecasted in the Zoning Paper compared to levels prior to the drafting of this Paper and compared to the final years of the command economy in Romania.

Cultures	Years				
	1973-1975	1980	1985	1990	Real 1987-1989
Wheat	2,150	3,240	3,744	4,320	3,246
Maize	2,597	4,440	5,920	7,400	2,651
Sunflower	1,417	2,176	2,368	3,200	1,533
Sugarbeet	22,396	40,150	51,100	65,700	22,049

Source: Zoning agricultural production in Romania's Yearbooks of 1976 and 1990 [13]

For example, cereal production ought to have reached by then in excess of 30 million tonnes – with wheat yields of over 7 million tonnes

and maize yields of over 21 million tonnes – while livestock ought to have numbered in excess of 10 million bovines, almost 20 million porcine and some 21 million ovines.

The Methodology used for calculating yields. To ensure that the reported yields per hectare had been properly reasoned prior to their release, The Pedology Institute's Quality Assurance Certificates – issued on zones and sub-zones – were used here. [11]

Thus, the starting point to our research endeavour rests with the natural QA Certificates – whose value (measured in yield kilos per QA point) rose as technological and other agricultural production factors (such as the use of fertilizers, for instance) were underscoring the soil quality improvements being undertaken at the time.

In the end, five successive yield scenarios, that were dependent on assuring the above-mentioned conditions, came out of this:

Scenario 1: 2,750 thou ha irrigated; 3,000 thou tonnes chemical fertilizers etc.; 125 thou tractors (1990 level);

Scenario 2: 3,700 thou ha irrigated; 3,400 thou tonnes chemical fertilizers etc.; 150 thou tractors;

Scenario 3: over 5,000 thou ha irrigated; 3,960 thou tonnes chemical fertilizers etc.; 185 thou tractors. N.B. This scenario, which had been envisaged for the 1990 temporal horizon, fell in line with the Romanian Communist Party's XIth Congress directives;

Scenario 4: over 5,000 thou ha fully operational land reclamation works; approximately 4,850 thou tonnes of chemical fertilizers etc.; 200 thou tractors, meaning full agricultural mechanization; high-standard biological agricultural materials;

Scenario 5: over 5,000 thou ha irrigated, completing all land reclamation works started, eliminating soil salinization / acidity, using 5,500–6,000 thou tonnes of chemical fertilizers; products with a high content of soil mineral substances (mineral oil, sugar); highly qualified workers. 2000s' temporal horizon.

Of the five scenarios, the first one corresponds to the 1980s temporal horizon, whereas Scenario 3 corresponds to the 1990s horizon. Meanwhile, Table 2 presents the main economic indicators in the agricultural production zoning context. Considering this data globally, at an agricultural sector level, renders the differences between these five scenarios largely insignificant. It is interesting to note that while the resulting yields hovered around the estimated values (V_2), the material costs incurred as a result were considerably higher than planned, which diminished the net income. [13]

Table 2. The main economic indicators of zoning (Billion lei)

Economic indicators	Central proposals 1990			Resulted from zoning works			Achieved 1984
	V_1	V_2	V_3	$V_{2.1}$	$V_{2.2}$	$V_{2.3}$	
Global agricultural production	194	219	241	223	226	220	197
-vegetable	102	114	123	121	120	120	107
- livestock	92	105	118	102	106	100	90
Material costs	98	113	124	126	130	117	106
Net production	96	106	117	97	96	103	
Payroll costs	41	43	48	43	45	44	
Net income	55	63	69	54	51	59	
Productivity rates %	39.6	40.4	40.1	32.0	29.1	36.6	

Source: Zoning agricultural production in Romania's Yearbooks of 1976 and 1990 [13]

Zoning Agricultural Production in Romania is the only Research Paper of this kind tackling the issue of evaluating the economic effects of such works. On the last of the table's (eight) columns, the figures registered there correspond to the global and net yields achieved between 1986–8 [5] showing that the zoning estimates had been too optimistic still despite the fact that over the more than twenty years' period separating the time when the Paper had been published and the final years of planned agriculture, the evolution of prices had a positive effect on those figures.

In reality, the economic indicators which the Romanian agriculture grew accustomed to had been negative mainly because of a failure to achieve the planned production quotas.

In turn, this failure owed to the fact that the allocated resources were well below the level required by those designing these scenarios. For instance, as regards Scenario 1, designed for the 1980 temporal horizon, the irrigated surfaces had been of a mere 1611 thousand ha, instead of the 2750 thou ha required, while the chemical fertilizers allocated were a mere 1,114 thou tonnes instead of the 3,000 thou

tonnes that would have been needed.
Likewise, in 1989 (with the 1990 horizon in mind) only 2,527 thou ha were irrigated instead of the more than 5,000 thou ha needed, while there were 30 thou fewer tractors than were required [6]. Similar to nationwide zoning, forty county-level zoning works were now undertaken.

Table 3. The production zone's profile in the Constanta county

Zone	Agricultural products characterising the geographical zoning profile (in order of their respective percentages)
1	Meat, grapes, fruits, wheat, sunflower, linseed, veg. oil
2	Meat, grapes, maize, wheat, suflower, linseed, veg. oil
3	Meat, maize, milk, sunflower
4	Meat, maize, milk, sugarbeet, sunflower
5	Eggs, meat, milk, maize, vegetables
6	Meat, maize, vegetables, sunflower, soya
7	Meat, maize, soya, vegetables
8	Meat, maize, soya
9	Maize, meat, milk, soya
10	Meat, maize, milk, grapes, fruits

Sursa: Agricultural production zoning in the Constanta county

Fig. 4 illustrates the zoning of the vegetable and livestock production in the county of Constanta, whereas table 5 presents a profile of these ten county zones [5].

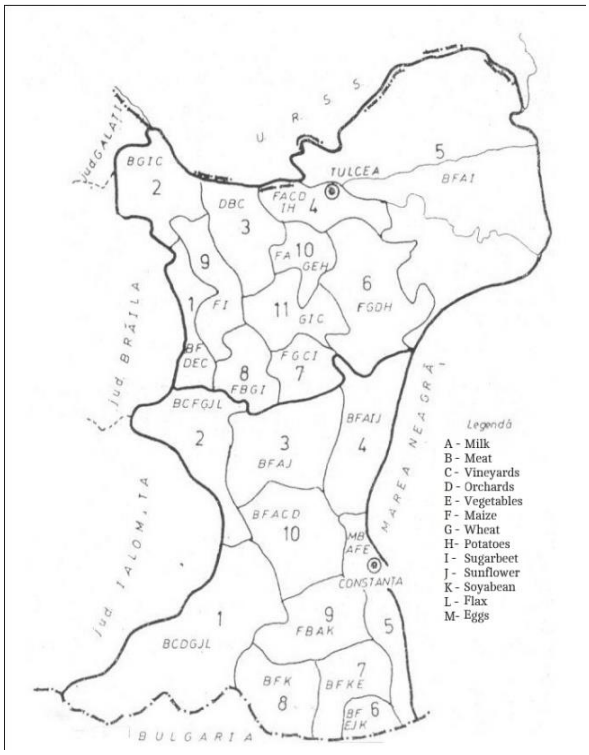

Fig. 4. The disposition of agricultural production zones in the Constanta county
Source: Agricultural production zoning in the Constanta county

Studies, proposals and strategies regarding the evolution of yields per ha in market economy conditions (after 1990). The political decision taken to adopt a market economy upon adhering to the European Union was taken in the context of abolishing the old, planned agriculture system and, with it, doing away with all of the old structures of production. It is fair to note that the old agricultural cooperatives' system had been a functional one whereby the agricultural sector would benefit from a moderate allocation of production factors, irrigation systems, a steady if largely insufficient supply of fertilizers, tractors and a decades-old managerial experience asked to compete on a safe if none-too-advantageous market.
Given these conditions the lowering of yields became but a logical consequence. A redressal of sorts did take place eventually yet, it did so with varying results given that while, on the one hand, large farming enterprises, practicing agriculture at the highest European standards, have since been reconstituted, these are being swamped by no fewer than 3.6 millions small family businesses, where subsistence farming is being undertaken using traditional farming techniques that generate extremely low yields. A weighted average between these two types of farming and their respective yields remains modest. As such, specialists, administrators, local government officials and foreign firms are all trying to decipher the likely tendencies of the resulting yields given the Romanian breeds' potential and the technological progress to be had.
The Romanian cereals' market and its exporting outlook. In 1997, the World Bank did a market study by trying to put to the test Romania's cereals' production and storage capacity [6]. This study's conclusions are being presented in the Table below.

Table 4. World Bank proposals with regard to the yields' tendencies in 2000, 2005 and 2010 (kg/ha)

Culture		2000	2005	2010
Wheat	Min.	3,400	3,700	4,000
	Max.	3,400	3,900	4,400
Maize	Min.	3,600	4,000	4,500
	Max.	3,600	4,300	5,000

Source: Romanian Grain Market and Export Project, Buharest,1997

Extrapolating the 1970–'90 period reveals a positive trend if, and only if, the dramatic drop in yields after 1990 remains unaccounted for.

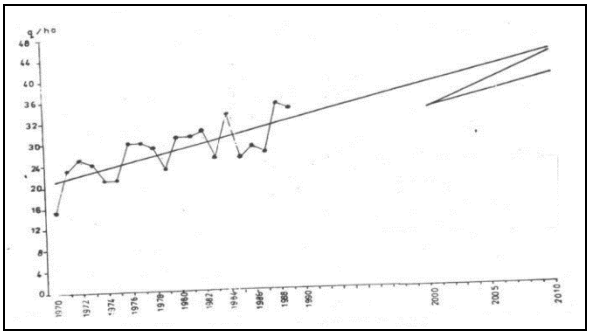

Fig. 5. Simulating possible trends of average yields of wheat in Romania, based on the 1970–'90 yields.
Source: Romanian Grain Market and Export Project,Bucharest,1997

Nevertheless, the authors still appeared to believe there was scope for improvement in Romania's agriculture though the yields for the 2000 horizon remain relatively optimistic.

The Agrarian Economy Institute's Forecasts [3]. In chapter 29 of *The Ago-alimentary Economy* study, A. Gavrilescu and Daniela Giurcă publish a series of forecasts regarding the evolution of the principal cultures' yields under four scenarios: ideal, moderat, pesimistic and crisis. The results of the first three scenarios are presented in Table 5.

Table 5. Different yields' proposals for the 2005–2020 period (kg/ha)

Culture	2005	2010	2015	2020
A Pessimistic Evolution				
Wheat	3,000	3,100	3,300	3,300
Barley	3,500	3,800	4,000	4,300
Maize	4,200	4,500	4,800	5,000
Soya	2,000	2,100	2,200	2,400
Sunflower	1,300	1,500	1,800	2,200
Sugarbeet	19,000	21,000	24,000	25,000
Potatoes	15,000	16,000	17,000	19,000
A Moderate Evolution				
Wheat	3,200	3,300	3,400	3,600
Barley	3,800	4,200	4,500	4,700
Maize	4,500	4,700	5,000	5,400
Soya	2,000	2,100	2,300	2,500
Sunflower	1,500	1,700	2,000	2,500
Sugarbeet	20,000	23,000	25,000	30,000
Potatoes	15,000	16,000	18,000	20,000
The Ideal Scenario				
Wheat	3,300	34,000	3,600	4,000
Barley	4,000	4,500	5,000	5,000
Maize	4,800	5,300	5,800	6,000
Soya	2,000	2,200	2,500	2,700
Sunflower	1,500	1,900	2,400	2,800
Sugarbeet	22,000	25,000	30,000	35,000
Potatoes	18,000	20,000	22,000	25,000

Source: Gavrilescu D., Giurcă Daniela, 2000, Agro-alimentary Economy

The Development Strategy of Romania's Agriculture, Food Industry and Silviculture [14]. This strategy was drafted by the line ministry's specialists in 2001 and it encompasses the 2000, 2005 and 2010 horizons. The figures in Table 8 indicate a significant rise from the 2000s level to that of 2010, being seen as a fairly reasonable bet.

Table 6. The yields being put forward by Romania's Ministry of Agriculture and Rural Development with regard to wheat, barley, maize and sunflower cultures for the 2000, 2005 and 2010 horizon (kg/ha)

Culture	2000	2005	2010
Wheat	2,280	3,300	4,000
Barley	2,700	4,400	5,000
Maize	2,600	4,100	4,500
Soya	600	1,850	2,000
Sunflower	820	1,600	2,000

Source: The Ministry of Agriculture and Rural Development [14]

Romania's National Strategic Framework for Sustainable Rural Development [17]. This is a remarkably complex study drafted by a highly qualified team of specialists. Regarding yields forecasting it focuses on the 2020–'30 horizons using the 2010 yields as a starting point (Table 7).

Table 7. Main cultures yields forecasting for the 2020–2030 period by comparison to the 2010 yields (kg/ha)

Culture	Romania			The European Union		
	2010	2020	2030	2010	2020	2030
Wheat	2,688	4,000	6,300	5,909	6,346	
Barley	2,540	3,500	4,600	4,387	4,646	
Maize	4,310	5,500	7,300	7,185	7,348	
Oleaginous plants	1,687	1,834	2,790	2,651	2,798	
Potatoes	13,354	20,000	26,000			
Vegetables	14,704	21,000	27,000			

Source: The National Strategic Framework 2010-2020-2030 [17]

It is considered that by 2030, the main culture yields in Romania might reach the levels reached by 2020, in the rest of the European Union.

CONCLUSIONS

Analising the crop yields per unit area of land's long-term evolution reveals the fact that, over time, their growth had become highly accelerated being influenced by a multitude of factors, the most important of which being the extension of irrigated land

surfaces, the creation of high-performance biological materials, the use of ever-larger quantities of fertilizers and last, but by no means least, the increasing use of high yield farming techniques.

If one considers the fact that more than two millennia were needed to reach yields of 1,000 kg/ha of wheat – starting from yields of around 300 kg/ha in classical, Greek–Roman antiquity – a mere century-and-a-half would be needed to raise 1,000 kg/ha yields to yield levels of 3,000 kg/ha, with the next tripling of yields being possible in just another half century – fifty years, more precisely.

On the other hand, regional differences have a significant role to play here. Considering things from this perspective makes Romania a rather special case. Significant crop yields per unit area of land's evolution takes a lot longer to occur in Romania despite its researchers' best efforts to bring about tehnologies that would enable high-yield farming agriculture.

As with inter-regional differences, the gap between the experimental yields, obtained in controlled research conditions and production yields in the field are considerable. The quality of the techniques and the technologies employed to this end greatly influences the land's productivity performance.

In Romania, for example, the considerable investment effort that had been made over the latter half of the twentieth century reflected poorly in terms of the yields that were generated mostly due to chronic management deficiencies.

At present, the reduced national yield average owes to the improper weighting of the two categories of farmland exploitation – whereby millions of subsistence farming on plots of privately-owned land are weighing heavily on the few if high-performance exploitation enterprises. The solution to this conundrum rests with incorporating the former into the latter types of agricultural concerns, including pooling them together, eventually.

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