CASE STUDY ON THE ELABORATION OF FERTILIZATION MANAGEMENT ON A FARM IN PRUT VALLEY – IASI COUNTY

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Abstract

Agrochemical mapping aims to monitor soil fertility to determine fertilizer requirements and includes field research, laboratory determination and mapping of the distribution and range of pH and essential nutrients by conventional signs and colors. Soil fertility is its fundamental and specific ability or capacity to provide plants with the necessary and balanced amounts of nutrients, permanently and simultaneously, in the context of the other vegetation factors (water, light, temperature, other physical and biological factors). Basically, fertility results from the complex and dynamic interaction of soil constituents (primary and secondary minerals, clay minerals, humus, salts, etc.) with some physical properties (texture, structure, aerobic regime) and other soil-specific processes (humification - mineralization, adsorption - desorption - ion exchange, solubilization and nutrient cycling between ecosystem components). The composite agrochemical sample consists of a number of subsamples, as follows: 25 for uniformly fertilized soils, 30 for weakly and moderately eroded soils and 40 for strongly eroded soils, non-uniformly fertilized, depleted and organic soils, soils from orchards, greenhouses and solariums. Geomorphologically, the territory of Probota village belongs to the Moldavian Plain. This geomorphologic unit is a broad-veined hilly plain consisting of more or less fragmented hilly interfluves. The Moldavian Plain is of sculptural origin, formed in the presence of a slightly erosive sandy-clay substratum, unlike the oolitic sandstones and limestones of the neighboring regions. The land is situated in the Prut valley, bounded on the long side by drainage canals, and another partly divides the plot in two. The altitude is between 39 and 41 m.

Key words: fertility, agrochemical mapping, soil, nutrients

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Nutrients derived from fertilizers owe their usefulness both to their quantitative participation in biomass production and to their specific roles related to their involvement in essential plant metabolic processes (Adebayo et al., 2025). Their classification considers not only their percentage representation in the dry plant mass (dry matter = dry matter) but also their multiple and decisive roles in crop formation (Table 1).

Table 1

Classification of nutrients-fertilizers (Lăcătușu R., 2006 after Bergman, 1992)

Group of nutrients			The essential nutrient
Basic organogenic constituents with physiological-metabolic role			C, O, H
Constitutive and metabolic mineral nutrients, essential agrochemical-fertilizer	Macronutrients	primery	N, P, K
		secondary	S, Ca, Mg
	Micronutrients	primery	Fe, Mn, Cu, Zn, B, Mo, Cl
		secondary	Al, Co, Na, Ni, Si, V

Macronutrients have essentially plastic, constitutive roles, with nitrogen being involved in the quantitative increase in plant production, and phosphorus and potassium with nutrient balance effects in relation to nitrogen and with a decisive role in crop quality (Canarache A., 1990).

Micronutrients have primarily enzymatic roles, with essential metabolic implications (boron also has plastic roles) and their application is linked to specific agrochemical conditions, determining their chemistry or depending on the application of macroelements and reaction modifications to which these elements show interactions (Florea N., 1994).

To obtain the effect and efficiency of fertilization, the knowledge of the specific and particular roles of each element is considered, supporting the efficiency of their interactions and, obviously, the nutritional properties of soils and agricultural crops (Jităreanu G. et al., 2020)

RESEARCH LOCATION

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The agricultural field is located in the Prut valley, delimited on the long side by drainage canals. The altitude is between 39 and 41 m. We studied the physical block 460 - Canal 7, 37 ha in area, which was cultivated with winter wheat from which four agrochemical composite samples were collected. This field is exploited by S.C. AGRICOLA 96 S.A. Ţigănaşi, Iasi county.

The Prut plain is a well-defined relief subunit with geomorphologic features that distinguish it from the rest of the territory. It was constituted in the Holocene due to intense alluviation and is characterized by thick accumulations of about 20 m, having the following composition:

– at the base over the Basarabian clays and marls are gravel;

– follows sandy silt;

– clayey alluvium with lenses of sands occur at the top (Filipov F., 2005).

Fine sands lie on top of the clayey alluvium in the gravelly areas.

The meso- and microrelief forms are represented by microdepressions, inter-microdepressions, wider depressional areas, and grains of different heights (Figure 1).

Figure 1 **Drainage canal near the studied plot**

In general, the land is horizontal with a gentle slope from north to south. The overall drainage is moderate to imperfect in the areas of the grind, poor in the area of the plain proper and very poor in the micro-depressions (Bhuyan et al., 2025).

Despite the fact that the plain has been heavily modified by banking works, drainage canals, irrigation canals and stream bed straightening, these phenomena are still occurring and are making agricultural operations more difficult. Due to the banking of the Prut River, this sector is not flood-prone.

MATERIAL AND METHOD

The agrochemical mapping was carried out in a system prescribed by the methodologies elaborated and perfected by the National Research and Development Institute for Pedology, Agrochemistry and Environmental Protection - ICPA Bucharest, which are generally accepted in Romania.

In agrochemical mapping, several stages are distinguished, including preparatory, field, laboratory and actual mapping.

A. Preparatory stage

This stage initially includes establishing the objectives of the work, especially if there are some aspects that require further study in relation to the framework methodology. The choice of the topographic scale is also decided, which is necessary as a basis for soil sampling and the realization of the following stages.

B. Field stage

In order to collect agrochemical samples, it is necessary to establish a material base and set certain sampling criteria, depending on the nature of the land use, the degree of soil uniformity and fertilization.

The topo-pedological base is used for the constitution of the plots for the collection of agrochemical composite samples. Their size depends on pedological complexity, use and fertilization background.

Sampling is carried out with agrochemical probes. The probe itself consists of a metal rod with a 30-40 cm long channel in which the sample is collected when the probe is inserted into the soil. In our case, the WINTEX 1000 sampling mechanism is attached to the HONDA ATV (Figure. 2).

Sampling depth is 0-20 cm, the area of land corresponding to a composite soil sample is mapped with broken lines and is called a sampling plot. These plots with similar characteristics form the fertilization plots, which are mapped with a solid line.

Figure 2 **Soil agrochemical sampling set-up**

C. Laboratory stage

After conditioning the samples by drying, removal of organic residues and fine grinding to determine the humus content, the samples enter the current analytical flow. Aqueous pH, P and K soluble in AL are determined. The exchangeable bases (CEC) and the hydrolytic acidity (Hg) are determined to assess the nitrogen supply, both necessary to calculate the degree of base saturation, which is used together with the humus content value to calculate the nitrogen index (NI).

If necessary, soluble forms of magnesium and trace elements can also be determined.The samples were analyzed in the laboratories of the Research Institute for Agriculture and Environment of the Iasi University of Life Sciences according to the working instructions, standards and methods of work previously mentioned.

Mapping stage

According to the analytical data, climate and soil conditions, the specific nutrient consumption, depending on the crop, the expected yield and the agrochemical properties of the soil, the following analytical data interpretation is done following the instructions given for this purpose. Interpretation values are given in this paper for each physical block, relating to pH, content in mobile forms of P and K, soluble in AL, NI, as well as content in salts (where applicable), magnesium, microelements.

The elaboration of agrochemical maps and the agrochemical report are the main objectives of this work stage.

Depending on the amount of plant-assimilable nutrients contained in the analyzed plot, the crop plant and the expected yield, the fertilization plan was drawn up.

Soil reaction is an indicator that determines the ratio between the concentration of hydrogen and hydroxide ions. The scale adopted, from 0 to 14, tells us what kind of substrate we are dealing with. This is particularly important because of the need to prepare the soil to grow specific plants.

The pH values are noted to one decimal place at the top of each sampling plot or in the mapping table and the scale of interpretation is given in Table 2.

Table 2

Characterization ranges of soil reaction in aqueous suspension

pH	Soil reaction status
< 5	Strongly acid
5.1 – 5.8	Medium Acid
5.9 – 6.8	Slightly acid
6.9 – 7.2	Neutral
7.3 – 8.4	Slightly alkaline
> 8.5	Medium, strongly alkaline

The limiting factors for plant growth on acid soils are the acid-forming ions: H^+, Al^{3+} şi $Al(OH)^{2+}$. Acidity generates aluminum to such an extent that at pH < 5.0 exchangeable aluminum predominates among the exchangeable cations. More than 80% of the exchangeable acidity consists of aluminum ions.

To assess the nitrogen potentially accessible to plants, consisting of exchangeable and soluble ammonium, nitrate and nitrite, the nitrogen index (NI) is used in agrochemical mapping, calculated according to the equation:

$$NI = H \times BS / 100$$

where: H - humus content (%)

BS – base saturation (%).

NI helps to differentiate organic fertilizer rates, which are inversely proportional to the NI value, with rates decreasing as the NI value increases.

Representation of the nitrogen status of the soil (Table 3) is made according to the scale below according to the value of IN.

Table 3

Interpretation values (ICPA București, 1981**)**

Nitrogen index	Supply level
< 2.0	Low
2.1 – 4.0	Moderate
4.1 – 6.0	High
> 6.1	Very high

The characterization of the phosphorus supply situation is done according to Table 4.

Table 4

Soil phosphorus status (ICPA București, 1981)

P_{AL} (ppm)	Supply level
< 8	Very low
9 - 18	Low
19 - 36	Moderate
37 - 72	Good
> 72	Very good

Available potassium is also determined in ammonium acetate-lactate extract at pH 3,75, determined by the Egner-Riehm-Domingo method using the atomic absorption apparatus, flame technique - CONTR AA 700 (STAS 7184/18-80).

The description of the phosphorus supply status is given in Table 5.

Table 5

Soil potassium status (ICPA București, 1981)

K_{AL} (ppm)	Supply level
< 66	Low
67 - 132	Moderate
133 - 200	Good
> 200	Very good

RESULTS AND DISCUSSIONS

Agrochemical characterization of the 460 land parcel - Canal 7.

The responsiveness and nutrient supply status of soils is presented in Table 6.

Table 6

Nutrient content of BF 460

	pH		Mobile P, ppm		Mobile K, ppm		Humus %	NI
	Minimum	Maximum	Minimum	Maximum	Minimum	Maxim		
Values	6.9	7.6	15	26	308	331	4.7	4.5
Status	Neutral	Slightly alkaline	Low	Moderate	Very good	Very good		
Average	7.1		19		315			
Status	Neutral		Moderate		Very good		Good	Good

The pH values are reported to one decimal place at the top of each sampling plot. pH values range from 6.9-7.6, resulting in neutral to slightly alkaline soils (Table 7).

Table 7

Allocation of sampling plots according to soil reaction (pH)

Interpretation	Sample number
Strongly acid	
Moderate acid	
Slightly acid	
Neutral	419; 420; 421.
Slightly alkaline	418.
Moderate, strongly alkaline	

The mobile phosphorus (P) content is expressed in ppm (parts per million) and is written in integer numbers in the middle of each harvest plot.

In general, the mobile phosphorus content ranges from 15-26 ppm P_2O_5, so soils are low to moderately supplied with mobile phosphorus, as shown in Table 8.

Table 8

Level of supply of available phosphorus

Supply level	Sample number
Very low	
Low	418;419;421.
Moderate	420.
Good	
Very good	

The values expressed in ppm K are inscribed in the outline of each sample plot, with integers immediately below the value indicating the mobile phosphorus content.

In total, within this plot, the mobile potassium content has values between 308-331 ppm K, indicating that the soils have a very good mobile potassium status (Table 9).

Table 9

Level of supply of mobile potassium

Supply level	Sample number
Low	
Moderate	
Good	
Very good	418; 419; 420; 421

The fertilization plan designed for the main agricultural crops within the physical block is shown in Table 10.

Table 10

Fertilization plan for physical block 460

Crop	**Estimated production (kg/ha)**	**Nutrient values** (December, 2019)					
		NI			**P**	**K**	**S**
		3.3			63	243	
		Annual amount of fertilizer with soil application, kg/ha active substance (a.s.)					
		N a.s.	**N (autumn)**	**N (spring)**	**P_2O_5**	**K_2O**	**S**
Wheat	5000	117	47	70	42	28	
	6500	138	58	80	66	54	
	7000	144	64	80	73	62	
Winter barley	4000	78	28	50	18	-	
	5000	94	34	60	40	-	
	6000	107	37	70	59	-	

As these nutrients are deficient it is recommended that they are applied foliar during vegetation. At the time of application, all requirements and restrictions of the manufacturer of the selected products should be respected.

The variations in soil reaction and nutrient content within the physical block for each agrochemical soil sample are shown in Figure 3.

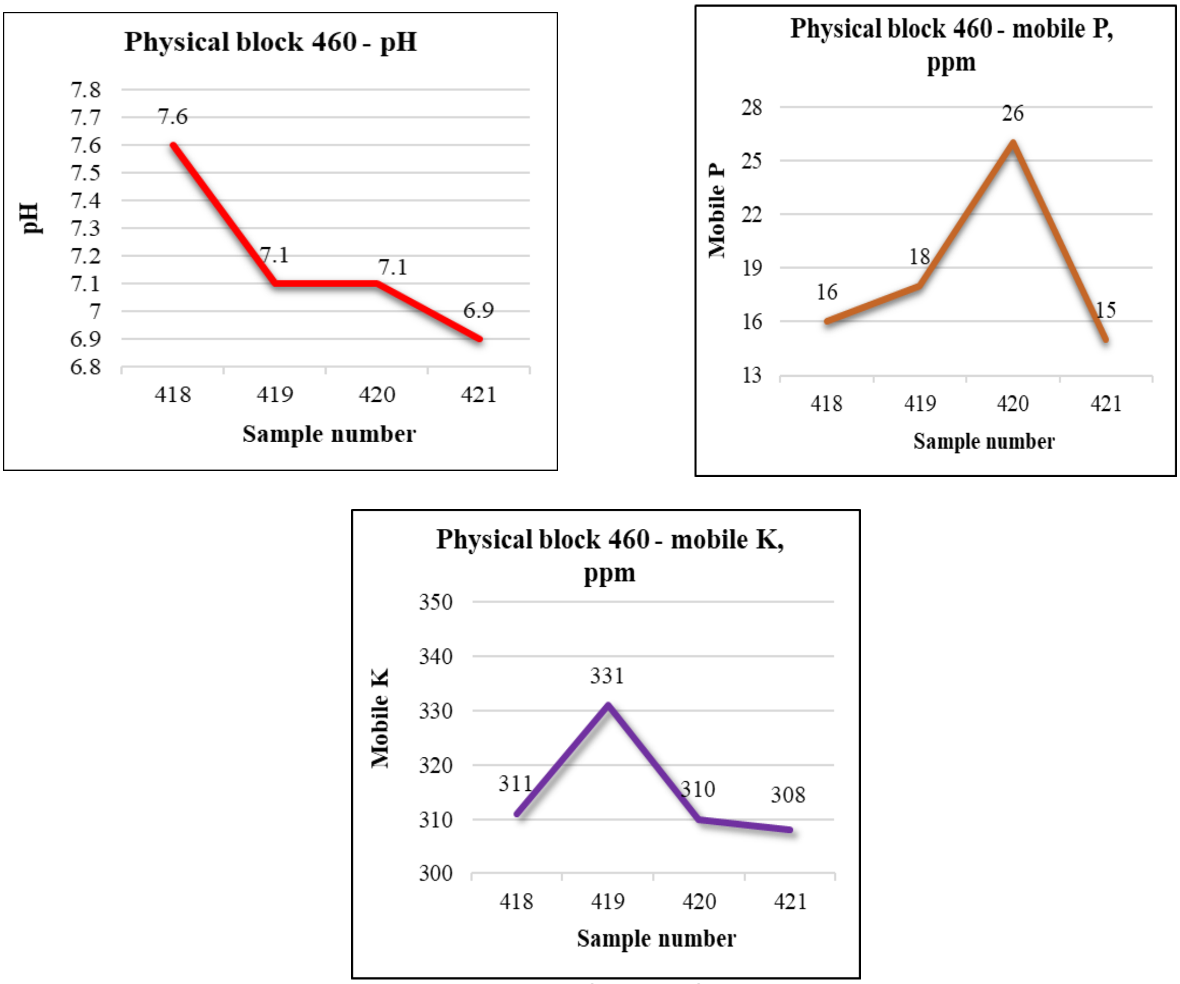

Figure 3 **pH, P_2O_5 and K_2O values**

The maps include the topographic features, the limits of the agrochemical composite sample plots. Maps shall be drawn for each agrochemical indicator measured: pH, N, P, K supply status, etc. In each analytical unit, the order numbers of the samples and the analytical results obtained shall be recorded (Figure 4).

Fertilization plots remain valid until a new cycle of agrochemical mapping.

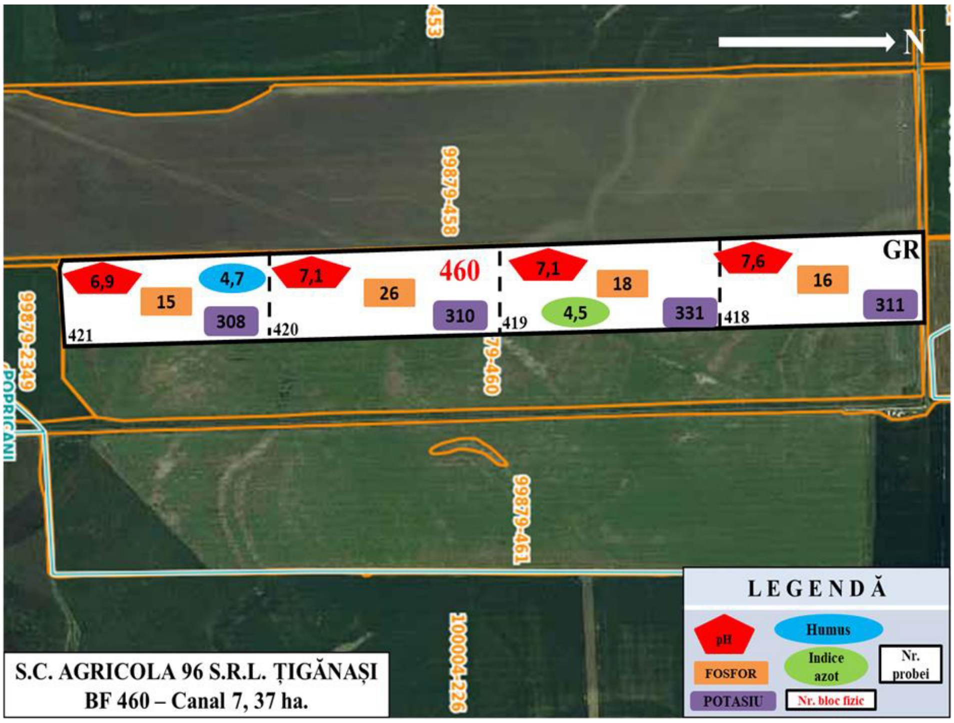

Figure 4 **Agrochemical sampling plots and analysis results**

CONCLUSIONS

The fertilization plan is a useful tool for calculating fertilizer doses and choosing the right time to purchase the required quantity and quality of mineral or organic fertilizers.

On the basis of the data obtained from this plan, we can also:

– developing the crops plan;

– to manage fertilizers properly, economically and environmentally;

– to determine the dosages of organic and mineral fertilizers;

– decide the type of fertilizer;

– determine the timing of fertilizer application;

– establish the supply and/or availability of fertilizer.

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