Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Agriculture
Open Access

A Research - Civil Society Joint Approach for Soil Conservation in High Natural Value Areas

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RESEARCH ARTICLE

Abstract

Since the existing information on soils level of fertility in the High Natural Value (HNV) eligible area is scarce, a partnership was concluded between a mixed team of soil scientists and civil society environmentalists within the frame of a research project aiming to: (i) appraise the stakeholders perception and views on the importance of soil conservation and environmental friendly land management, (ii) assess the level of fertility in HNV eligible areas and start building-up the first national HNV soil data base and (iii) identify the most relevant soil indicators for designing an expeditious HNV soil monitoring system. The results revealed the strong agreement of the civil society on the recently issued agricultural policies supporting practices under agri-environment measures and a fair existing level of the soil conservation under HNV practices, as long as land and soil careful administration and resource-efficient management are constantly pursued.

Keywords: soil conservation, High Nature Value farming, questionnaire-based survey, stakeholders.

Received: 17 October 2023
Accepted: 30 October 2023
Published: 15 November 2023

DOI:
10.15835/buasvmcn-ag:2023.0020

INTRODUCTION

With regard to the growing recognition for the provision of many environmental benefits and a wide range of public goods delivered by low-intensity farming, an important shift of the European Rural Development funds' distribution and support payment policies has occurred within the last decades. In large areas of some Central and East Europe countries, the High Nature Value (HNV) farming depends to a significant extent to the conservation of traditional agricultural landscapes and continuation of extensive farming practices. The new HNV concept has been developed and documented, in an incipient stage, with the technical support of high professional bodies (IEEP, 2007) and the major contribution of the civil society represented by reputed activist non-governmental agricultural and environment protection organizations (BIRDLIFE et al., 2010). Within the past ten years, the Romanian national planners have set and implement an ambitious scheme for supporting HNV farming through agri-environment payments within the national Rural Development Program and the new CAP Strategic Plan, as the country holds a large amount of potential eligible HNV areas with almost 5 million ha of agricultural land. In terms of scientific

research, there is a great potential for development but HNV farming is still a very young field and investigations and directions have only recently started to be shaped and pursued. Although Romania holds a fair position in Central and East Europe with regard to the number of peer-reviewed articles (Benedetti, 2017), a better interconnected involvement of different stakeholders (scientists, environmentalists, farmers etc) is needed to collect and process new and accurate field HNV data, to understand and substantiate the broad environmental impact and the socio-economic context of the small-scale farming whilst continuing to explore new or improved ways to achieve real participation of society in research and finally, to decision.

In Romania, within the frame of a recently initiated project, a team of soil scientists and local civil society activists has completed the first stage of studies in seeking the development of a national HNV soil data base and to attempt to design an adequate national HNV soil monitoring system.

As proper inventories of stakeholders' perception seem lately to be an adequate and relevant approach in the soil and land management research area (Lange et al., 2015), in the initial phase of investigations, a questionnaire-based survey was performed on-field, focused on perceptions on soil and soil policy issues and aiming to explore views with regard to soil quality, soil threats as well as the existence and effectives of the national and European policies on soil protection. The sociologic approach was followed by a soil fertility assessment carried by soil scientists and backed by the local experience and the sound field knowledge of a non-governmental organization (ADEPT Foundation, Saschiz, Mureș) in Târnava Mare Natura 2000 site (south-eastern Transylvania). Based on the soil survey data and findings, both teams of soil scientists and environmentalists followed a joint approach in order to select the most appropriate type of farm management in the area. Continuing the development of the HNV soil data base, a second soil fertility assessment was performed in Caraş-Severin northern hilly area.

MATERIALS AND METHODS

Questionnaire based survey

The questionnaire was designed and structured on direct questions and semi-ended (mixed) questions with single or multiple answers. A prior pre-testing implementation phase allowed some lacks of clarity and some ambiguities to be eliminated before the survey was launched. The questionnaire was directly managed and applied „face-to-face" with the respondent stakeholders. The overall sample comprised 140 respondents (representatives of various national stakeholders' groups contacted, for a fair national distribution of the survey, in the main historical regions of Romania) out of which 24 representatives of environment and agriculture associations, foundations or NGOs (non-profit, environment pioneering and volunteering civil society organizations). The field inputs were processed with the software Statistical Package for the Social Sciences (SPSS). The stakeholder group of civil society representatives is particularly targeted by the present paper.

Soil fertility survey

Soil sampling was performed in 2018, after hay harvesting in both selected sites, from (i) seven in-depth manual dug profiles and seven additional shallow dug profiles (agrochemical samples) in an HNV financially support eligible area of south-eastern Transylvania (Târnava Mare Natura 2000 site, Mureș County) and (ii) six in-depth manual dug profiles and seven additional shallow dug profiles (agrochemical samples) from Caraş-Severin northern hilly and HNV eligible area (on the sides of Semenic-Cheile Caraşului Naţional Park, Caraş-Severin county). Soil disturbed and undisturbed samples were taken at different levels from the soil profile, according to the on-field identified soil genetic layers. Disturbed samples were used for laboratory measurements according to established methodology and specific national standards (Florea et al., 1987) used for conventional soil surveys as well for soil and crop agro-chemical assessments: organic carbon content (Walkley-Black, modified by Gogoaşă), pH (potentiometric), content of available phosphorus and potassium (in ammonium acetate-lactate solution), total nitrogen (Kjeldahl), calculated C/N ratio, nitrates' content (potentiometric) and soil texture. The undisturbed samples were taken in rings of 200 cm^3 and used for measurement of bulk density, penetration resistance, total porosity, compaction index, saturated water hydraulic conductivity and degree of soil compactness (Dumitru et al., 2009). The microbiological analyses were performed in the samples taken from the upper soil horizons targeting: heterotrophic bacteria number determined by the soil dilutions (suspensions method through dispersion on Topping medium), microscopic fungi number (determined by soil dilution–suspensions method on Czapek nutrition medium) and soil respiration potential level (assessed by substrate-induced respiration method).

Decision support tool

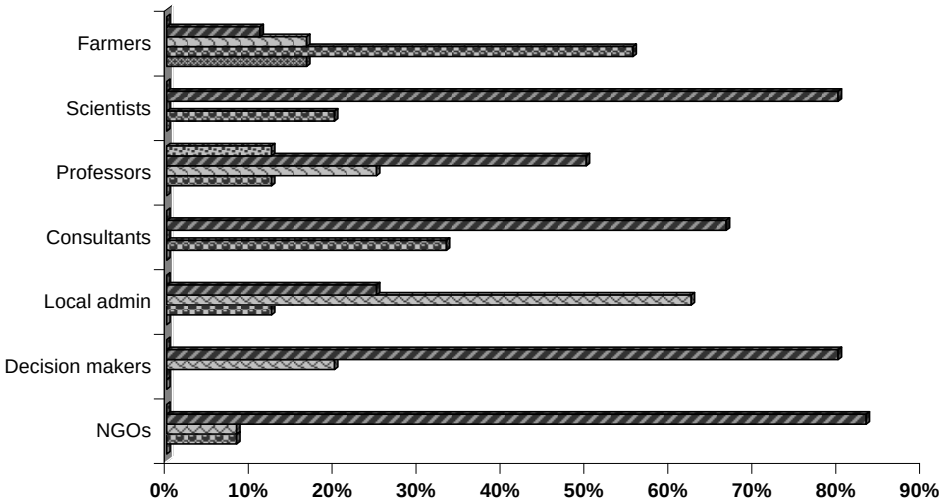
In order to prioritize the most relevant/sensible soil indicators in HNV farming and to select the most appropriate type of farm management in a selected eligible support payment HNV area (in south-eastern Transylvania, Târnava Mare site), a generic decision support system software tool, mDSS version 5 was used (Giupponi et al., 2010), facilitating the involvement of stakeholders (soil experts and environment activists) in an environment decision procedure. The inputs in the computer soft were provided using the data of soil survey

carried in the area, other available regional soil data, local and regional socio-economic statistical data, the expertise of the soil scientists and the local knowledge of the local environmentalists. Four alternative options were considered for the given area: (i) conventional practices, (ii) HNV farming, (iii) organic farming and (iv) HNV farming coupled voluntary and simultaneously with organic farming.

RESULTS AND DISCUSSIONS

Civil society's perception on soil and agri-environmental practices

The most important soil threat perceived by the civil society representatives (multiple answers allowed) was by far, „pollution/contamination" (91.7% of the civil society respondents) followed by the „the loss of organic matter and nutrients" (41.7% of the civil society respondents) and „soil erosion" (33.3% of the civil society respondents). Questioned about who should be the most interested and responsible for the soil quality and fate (single answer allowed), 58.3% of civil society respondents replied „the entire society, the public at large, since much of our daily food is grown on soil", followed by „farmers, researchers and decision makers" (25%). 83.3% of the respondents consider the general public interest on soil issues and soil protection (single answer allowed) as almost „negligible" whilst the rest (16.7%) as completely „absent". 58.3% of the respondents view the current national policies and their enforcement regarding soil protection in Romania (single answer allowed) as „inconsistent". Asked about ticking one option regarding the best technological approach to secure simultaneously the soil fertility, the increasing food demands and the environment protection, the vast majority of civil society respondents, in proportion of 83.3% (the highest among all respondent stakeholders), selected the „environmentally friendly agriculture (agri-environment measures) including traditional land management practices and natural landscape conservation" (Figure 1). The second ranked options selected were „organic farming" and „conservative agriculture/minimum tillage" (8.3% of the respondents for each option). The results reveal the civil society strong agreement on the existing agricultural policies supporting practices under agri-environment measures (including High Natural Value farming and organic farming). The respondents were also asked about the way they may expect an improvement of the acknowledgement of importance of soil sustainability as well as the adoptions of some improved solutions regarding soil protection (multiple answers allowed). Most of the respondent representatives of the civil society selected the option „a governmental program for periodical agro-chemical and soil quality testing of the agricultural land" (75% of the respondents). Half of the civil society respondents (50%) perceived as important a soil quality public awareness raising campaign. Significant shares of civil society respondents selected also the option „a national law for soil and soil protection" and an improved „soil monitoring system" (33% of the respondents for each of two options) whilst some of civil society respondents (16.7%) chose for a „Soil EU Directive".



	NGOs	Decision makers	Local admin	Consultants	Professors	Scientists	Farmers
Conventional	.0%	.0%	.0%	.0%	.0%	.0%	16.7%
Conservative	8.3%	.0%	12.5%	33.3%	12.5%	20.0%	55.6%
Organic	8.3%	20.0%	62.5%	.0%	25.0%	.0%	16.7%
Agri-environment	83.3%	80.0%	25.0%	66.7%	50.0%	80.0%	11.1%
Others	.0%	.0%	.0%	.0%	12.5%	.0%	.0%

Figure 1. Shares of the stakeholders' views regarding the best agro-technological approach to secure simultaneously, the soil fertility, the increasing food demands and the environment protection (%)

Soil fertility assessment of eligible HNV areas

The first soil survey was performed in Târnava Mare Natura 2000 site, more precisely in the habitat type 6210 „Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) with important orchid sites" (a priority habitat according to Annex I of Habitats Directive) as the site was previously subject to an important assessment of the botanical biodiversity of HNV grasslands (Akeroyd and Page, 2011). The survey revealed a medium clayey loamy texture of the soils. Most of the values of soil bulk density and total porosity have a medium level and the calculated average degree of soil compactness features low values (-0.60519% v/v in the upper soil layer and 7.3469% v/v in the second top-down layer). The absence or no more than a slightly compactness of the sampled soils pointed no tracks of mechanical traffic and/or overgrazing (both restricted within the frame of the HNV payments eligibility) and an overall fair HNV soil conservation management in the area. Soil reaction (table 1) varies wide from 5.78 pH values to 8.24, covering a moderately acid to slightly alkaline domain. The soil organic matter, generally well mineralized, reaches fair levels and the high to very high cation exchange capacity ensure good conditions for plants growth and nutrition whilst the nitrogen and potassium supply is adequate. Phosphorus is the only element in short supply - a condition often encountered in Romania, in unfertilized soils. The C/N ratios, with 4.5 to 31.4 values, generally describe a rather well humified organic matter content. Soil nitrates' contents are generally low. Some slightly higher values occur in few samples only (attributed to random animal dejections) but far from raising any contamination concerns. The microbiological analyses reveal intense humification processes, a good integration of the mineral component in the organic material and a well-developed and active microbial population.

It is to be noticed that in the area, the HNV eligibility for financial support is much acknowledged by the local farmers and the carried land management practices are subject to the annual submission to for compensatory payments (Common Agricultural Policy Pillar 1, Measure 10 of the National Rural Development Program), with the large support and involvement of the local NGO which successfully cover locally the already chronic shortage of public agricultural advisory services in Romania.

In Caras-Severin hilly area the soils have a light to medium texture (loamy coarse sand to silty loam) with a clay content (< 0,002 mm) ranging from a minimum of 10% to a maximum of 27.2%. Regarding the values of the soil physical properties, the average soil bulk density in the first (upper) soil layer is 1.13 g/cm^3 (ranging in different sampled soil profiles from 0.86 to 1.32 g/cm^3). In depth layers some significant changes of the physical properties occur: the average soil bulk density is 1.45 g/cm^3 (ranging in different sampled soil profiles from 1.41 to 1.55 g/cm^3) whilst soil permeability may reach quite very low levels (up to 0.18 mm/h), exposing the plant roots to seasonal water-logging. In correlation with the analyzed soil texture, the calculated average degree of soil compactness revealed very low values on top soil and values that feature a slight compaction in depth (-19.74% v/v in the upper soil layer and 6.56% v/v in the depth layer). In some cases, the soil compactness may reach even a moderate compaction (up to 13.95% v/v). However, the average slightly compactness recorded is clearly not a subject of poor HNV soil conservation management in the area but a result of the soil genesis natural process.

Table 1. Statistical parameters of soil chemical properties in Târnava Mare Natura 2000 site.

Properties / Statistical parameters	pH	Humus %	Nt %	C/N	$N\text{-}NO_3$ mg/kg	P_{AL} mg/kg	K_{AL} mg/kg
0-20/25 cm							
n	19	19	19	19	19	19	19
$\bar{x}$	7.15	5.74	0.243	16.6	16	10	268
x_{min}	5.78	1.98	0.107	11.4	5	1	117
x_{max}	8.24	13.80	0.562	31.4	60	16	467
σ	0.88	3.10	0.118	6.4	14	6	92
cv, %	12.3	53.9	48.5	38.8	91.8	60.2	34.1
15-40/50 cm							
n	11	11	11	11	11	11	11
$\bar{x}$	7.41	4.29	0.225	12.7	8	3	152
x_{min}	6.32	2.16	0.103	10.1	4	1	87
x_{max}	8.31	11.76	0.536	15.0	16	7	249
σ	0.82	2.84	0.124	1.8	3	2	49
cv, %	11.0	66.0	55.1	14.4	42.6	75.4	32.2

Soil reaction is moderately-slightly alkaline with pH values ranging from 4.83 to 5.94 in the first/upper horizon (table 2). The values are generally favorable for plants growth even if few of them (from the upper layers) are slightly below the inferior limit of the moderately acid domain.

Table 2. Statistical parameters of soil chemical properties in Caras-Severin northern hilly area.

Properties / Statistical parameters	pH	Humus %	Nt %	C/N	$N\text{-}NO_3$ mg/kg	P_{AL} mg/kg	K_{AL} mg/kg
0-20/25 cm							
n	13	11	11	11	12	11	11
$\bar{x}$	5.31	4.26	0.238	12.7	54.3	7	173
x_{min}	4.83	2.14	0.129	7.2	4.0	3	62
x_{max}	5.94	8.16	0.434	22.5	204.0	14	355
σ	0.37	1.47	0.088	3.9	66.0	3	100
cv, %	7.1	34.4	36.8	30.7	121.6	44.0	57.6
15/20-40-50 cm							
n	9	9	9	9	9	9	9
$\bar{x}$	5.49	1.34	0.081	13.4	7.8	5	55
x_{min}	4.89	0.12	0.037	2.1	2.0	3	30
x_{max}	5.75	2.03	0.239	27.2	25.0	7	138
σ	0.28	0.61	0.062	8.1	8.1	2	36
cv, %	5.2	45.5	76.5	60.1	104.4	31.3	65.7

The organic matter contents vary from low to high and the C/N ratios, with 2.5 to 7.2 values show different stages of humification (a common picture for meadows and grasslands in Romania). The extreme values are rare and reflect either a low organic matter content, usually in the second horizon or a higher organic matter content resulted from different and incompletely humified organic remains. The total nitrogen contents balance generally well the organic matter contents. Excessive nitrate nitrogen ($N\text{-}NO_3$) quantities have been recorded in few upper horizons of the soil profiles although, in the coarse textured soils of the area, the nitrates' dynamic should be more intense than in the clayey loamy soils of Târnava Mare site. Therefore, in these particularly cases, the requirements to the HNV payments eligibility are questionably to be met. The mobile phosphorus contents are low to extremely low (as in many other Romania areas and not only in meadows and grass lands) whilst the mobile potassium contents vary from low to high and very high. The soils contain bacteria and fungi communities of a generally low and moderate level, rarely with high values. The humification processes have generally a slight to an average intensity and a low diversity of the biosynthesis sources has been recorded.

During sampling in the field, the soil science team noticed that local farmers seemed to be not aware or informed about the opportunity for submission to HNV compensatory payments whilst no active organization to back up farmers on the respective issue was locally identified.

Using decision support tools to identify the most relevant soil indicators in HNV farming

In recent years, a certain interest has been recorded on development of frameworks, information platforms and other instruments and processes of knowledge transfer to inform and support decisions. Many research projects in the field of agriculture, environmental and landscape management have used a wide range of decision support systems (IS/DSS) to disseminate accessible and applicable academic knowledge for decision making (Zasada et al., 2017).

The decision support system software tool used by the project (mDSS version 5) allowed the soil scientist to extend the collaboration with some of the stakeholders (the NGO custodian of Târnava Mare Natura 2000 site, directly involved in or affected by decisions and polices undertaken in the area) and to explore possible decision options in a participatory approach within the frame of actual and potential implemented alternative scenarios, emphasizing the importance of locally relevant prior knowledge and the fact that high levels of local knowledge facilitate the formulation of specific objectives (Moran et al., 2021).

Issues at stake were scrutinized by participants from various perspectives and viewpoints and finally, the decision support phase envisaging the use of specific computer support tools was undertaken. The comparison of the four-land management alternative options in Târnava Mare area concluded that organic farming and HNV

farming plus additional top up organic farming seem to be, in terms of soil conservation but also from a socio-economic perspective, the most sustainable alternatives. The most relevant soil indicators seen by scientists were the bulk density, the soil organic matter content, the C/N ratio and the soil respiration potential level, followed by soil pH and total nitrogen. Those perceived as important by environmentalists were soil pH and bulk density, followed by soil nitrates' content and the C/N ratio. Since Romania holds a large proportion of the HNV farmland with roughly 30% of the national total Utilized Agricultural Area eligible to receive financial support, the results of the decision process will be used to feed the design of an expeditious and reliable and cost effective tailored HNV national soil monitoring system. A tighter cooperation between soil scientists and civil society environmentalists within the frame of a prospective set national HNV soil monitoring system may provide multiple mutual benefits including the access to remote locations, reliable information on the local practices, sound soil data and pertinent soil assessments, common agreed local land management alternative options and functional partnership for further proposed joint projects and actions.

CONCLUSIONS

The results of the questionnaire-based survey revealed the civil society strong agreement on the existing agricultural policies supporting practices under agri-environment measures and a certain interest on a periodical agro-chemical and soil quality testing of the agricultural land. The set of an expeditious national HNV soil monitoring system will definitely need a tighter cooperation between soil scientists and civil society environmentalists.

In Târnava Mare site, soil data reveals that the carried HNV farming practices soundly comply with the soil conservation requirements as well as with the provisions of the national rural development payments HNV eligibility criteria. These outcomes may be attributed mostly to the careful local land management, to the active involvement in the area of the local NGO and to the good level of awareness among local farmers regarding HNV financial opportunities. A computer-based search for an improved land management option in the area suggests that coupling HNV farming with organic farming might be an appropriate socio-economic and environmental choice. To a lesser degree, the collected and processed soil data in Caras-Severin pictures a moderate to fair level of soil fertility (with few random excessive soil nitrate nitrogen quantities signaling a potential mismanagement with regard to complying with HNV eligibility criteria). The results suggest that the set of a „green" local NGO may cover, at least partially, the lack of public agricultural advisory services in the HNV farming areas. This conclusion may provide a reconsidering view to a governmental decision (75/2018) regarding the replacement of the local NGOs from the custody and the stewardship of the environmentally protected areas (overlapping HNV eligible areas) with the management of a public administration agency.

Author Contributions: M.D. Designed the conceptual frame and coordinated the overall investigation, performed the field soil sampling and processed the soil survey data; S.L.Ș. Synchronized the multifactor approach, developed and implemented the questionnaire and wrote most of the article; R.V. Stored and processed the sociologic data and performed the SPSS analysis; A.A.U. contributed to inputs provision and data processing to the decision support tool.

Acknowledgments

The investigations were carried under the research project „High Natural Value farming soil indicators sensitivity analyzes and stakeholders' perception assessment with regard to agro-environment practices, soil protection policies and connected societal challenges", PN 18.44.03 02, funded by the „Core" Research Program of the Romanian Ministry of Research and Innovation.

Conflicts of Interest

The authors declare that they do not have any conflict of interest.

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