**Transition and ecological sustainability in Romanian agriculture**

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After the start of the transition in Central and Eastern Europe and the Former Soviet Union the environmental situation of the respective countries has received significant attention. Expectations were expressed that the environment in the transition countries will improve and the damages caused by the economic activities in the socialist era will be mended. However, contrary to the expectations, the changing conditions did not always lead to an improvement of the environment. This has been the case in Romanian agriculture, where parallel with transformations like privatization, downsizing of the farms and changing from collective to individual farming, the areas of land affected by environmental problems have either remained constant or have increased. The paper analyzes the relationship between the changes in the macroeconomic environment in Romania and the changes in the ecological aspects of agriculture. The macroeconomic changes are linked to the ecological aspects through their impact on the land management potential of the households, which further influences their land management practices and thus ecological aspects. For the purpose of the study literature review, qualitative analysis, descriptive statistics and econometric analysis—logit and multinomial logit regressions—are used. The research relies on in-depth interviews conducted with agricultural engineers and on an agricultural household survey from 2003. The study shows that the main characteristics of agriculture resulting from the transition process, such as old age, low agricultural education, poverty, subsistence characteristics of the farmers and their small, fragmented lands negatively influence land management practices and thus ecological performance and ecological sustainability.

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## 1. Introduction

After the start of the transition in Central and Eastern Europe and the Former Soviet Union the environmental situation of the respective countries has received significant attention. Expectations were expressed that the environment in the transition countries will improve and the damages caused by the economic activities in the socialist era will be mended. However, contrary to the expectations, the changing conditions did not always lead to an improvement of the environment. This has been the case in Romanian agriculture, where parallel with transformations like privatization, downsizing of the farms and changing from collective to individual farming, the areas of land affected by environmental problems has either remained constant or has increased. The paper analyzes the relationship between the impact of the changes in the macroeconomic environment in Romania and the changes in the ecological aspects concerning agriculture and therefore ecological sustainability.

Sustainable agriculture refers to the ability of agro-ecosystems to remain productive in the long term and concerns ecological, economic and social sustainability (van der Werf & Petit 2002). Ecological sustainability is defined as the maintenance of the "natural capital" —the stock of environmentally supplied goods which ensure a flow of useful goods and services—both as a "source" of inputs and as a "sink" for waste (Goodland 1995). There are several methods in the literature to evaluate the ecological impact of agriculture, considered as a condition for the implementation of sustainable agriculture (Hansen 1996). The evaluation can focus on different levels (Kruseman et al 1996) or the cause ("means") and/or the effect of the agricultural activities on the environment can be analyzed (van der Werf & Petit 2002).

The present study describes the changes in the macroeconomic environment and ecological aspects of agriculture, specific environmental problems concerning land at the village level and the land management potential as well as the land management practices of the households at the household level. In this framework ecological sustainability on the village level is approached from the effect side, by mapping the current environmental problems, while at the household level the farm management practices are considered—the so-called "means" causing environmental impacts. The linkage between the changes at the macroeconomic level and the soil environmental problems is through the impact of the macroeconomic changes on the socio-economic characteristics of the agricultural producers, the so-called land management potential of the households, which further influences their land management practices and thus environmental conditions.

For the purpose of the study literature review, qualitative analysis, descriptive statistics and econometric methods—logit and multinomial logit models—are used. The econometric methods help in analyzing the influence of land management potential and other factors on the land management practices. The study relies on a Romanian

agricultural household survey from 2003 (AHS 2003)[2], in-depth interviews conducted with Romanian agricultural engineers[3] and national statistics.

The study contributes to the understanding of what characteristics of the agricultural actors resulting from the transition process influence environmental degradation. It offers information to policy makers on what factors to address for the improvement of environmental performance of agriculture and therefore ecological sustainability.

## 2. Ecological aspects of communist agriculture

Since official statistics are unreliable during the socialism, it is difficult to form an exact picture of the environmental "quality" caused by agricultural activities in this period. The main sources of information in this respect are the literature, the interviews conducted with agricultural engineers and insights obtained from the peasants.

Environmental damages were mainly the result of the general macroeconomic environment and development policies pursued by the socialist government of Romania. Romania, just like the other socialist economies, put the accent on industrial development and concentrated mainly on heavy industries, which were in themselves energy and resource intensive. Moreover, within the heavy industry the energy use intensity was very high as compared to other developed countries. All these characteristics led to the excessive exploitation of natural resources and pollution of air, soil and water during the communism (OECD 1993, Klarer&Moldan 1997).

The transformation of the agricultural sector in Romania had itself a significant impact on the quality of the environment. Due to the collectivization of agriculture, the connection between rural communities and the environment weakened. On the positive side the industrialization process had as a result that many rural dwellers have moved to the urban areas, thus a part of agricultural land in remote places was left fallow. Protective measures were also applied, like planting trees to decrease erosion on the hilly pastures and turning the arable land on some slopes into hay-land and orchards (Muica&Zavoianu 1996).

Usually there was an intensification of agriculture, common pastures or hayfields being turned into agricultural land. This has increased the pressure on the remaining land, like pastures. Those pastures, which were not converted into agricultural land, were usually steep, therefore intensive grazing on them caused and intensified erosion (Muica&Zavoianu 1996).

[2] The AHS 2003 was conducted in 304 households in 15 villages all over Romania. The sites were chosen with the help of multistage stratified representative random sampling. The questions have referred to year 2002 and partly concerned land management practices.

[3] The interviews at the village level with the agricultural engineers focused on the overall characteristics related to the village while some questions referred to the change in land quality over the last 5 years and the current ecological parameters and problems concerning land.

In line with the intensification of agriculture, the soil was excessively tilled, over fertilized in order to achieve the unrealistically high expected production levels (DeBardeleben 1991). Large-scale intensive farming deteriorated the soil structure through the cultivation of monocultures and irrigation. Inappropriate uses of fertilizers, the use of excessive chemical as compared to organic fertilizers have increased soil pollution. Cultivation with heavy machinery caused the phenomenon of "hard pan" [4] over a significant territory (Muica&Zavoianu 1996). The inappropriate management of livestock was a major source of pollution itself. The animal manure has polluted the ground waters and the soils.

On a large area of about 2.5 million hectares irrigation schemes were implemented. However, by the 1980s, the size of the irrigation territory has decreased and poor land management has caused the salinization of about 25 thousand hectares. At the same time the area affected by dryness increased (Muica&Zavoianu 1996).

Consequently, the socialist agriculture had significant negative influence on natural resources and on land in particular, despite the fact that in Romania, just like in most other socialist countries a comprehensive environmental law has been passed in the 1970s and there was an environmental policy present. That is, there was an administrative framework, laws and regulations, reporting and monitoring framework and an enforcement mechanism (OECD 1993, Jancar-Webster 1991).

The reasons for failure are manifold. The lack of coordination between economic and environmental policies, having always the production goals as a priority, the lack of necessary institutional structure, the lack of enforcement of environmental policies and the inability of the public to protest for solving some environmental problems have all contributed to inadequate environmental protection (OECD 1993, Klarer&Moldan 1997, Mainland 1991). Indeed, protective measures, although well-planned at the central level, were poorly implemented by enterprises without relation to the local farmers and by specialists with no personal interest in the results. This example underlines the problem of lack of coordination between environmental and economic policies in the particular case of agriculture (Muica&Zavoianu 1996).

The interviews with the agricultural engineers and households revealed both positive and negative aspects of socialist agriculture. There was a very small share of localities with no history of communist agricultural cooperatives of production. In the rest of the villages, depending on whether people had problems with acidity of the land or of erosion, they were positively talking about the time of the communism, when the land was treated against acidity regularly respectively anti-erosion measures like perpendicular ploughing, terracing, protective vegetation were used. In the south of Romania, where there used to be irrigation equipments on large territories people were recollecting the benefits of irrigating during central planning.

[4] Hardpan is "a hardened impervious layer, typically of clay, occurring in or below the soil" (The Concise Oxford Dictionary 1999).

The fact that all the soil-improving measures mentioned were used does not mean that the quality of the respective measures was good. People tend to idealize sometimes the previous era, when financial security and a functioning agriculture were in place. Even if there were efforts for soil improvement their effectiveness may have been decreased by the lack of motivation of those who were responsible for their implementation.

**3. Changes in transition in agriculture and in ecological aspects**

The economy of Romania and within it the agricultural sector has undergone a restructuring process during the last decade. The focus was placed on the transformation of the agricultural sector to a market-oriented system through macroeconomic and sectoral adjustments. At macroeconomic level central controls were abolished, prices liberalized and hard budget constraints introduced. Sectoral reforms focused on the privatization of land, changing from collective to individual agriculture, as well as the downsizing of farms (Lerman 1999).

Some important changes in the agricultural sector comprised the decline of labor productivity: the contribution of agriculture to GDP has dropped from 23% to 12%, while its share in employment has risen from 29% to 41% between 1990 and 2001 (National Commission of Statistics - NCS - 2001). In fact the increase in the agricultural employment was caused mainly by the closure of enterprises in urban areas leading to massive layoffs and urban unemployment. This has led to reverse migration, from urban to rural areas[5] and to the absorption of the unemployed in agriculture. The increase in agricultural employment was interrelated with the accentuation of poverty during the transition[6].

A cause for a major change in agriculture was the privatization of the agricultural land, starting in 1991, with the adoption of the Law on Land Resources from 1991 (LLR). The law contained provisions related to obtaining private property right on the land that is owned by the agricultural production cooperatives. The land was to be returned to the prior owners, their heirs and cooperative members who did not contribute land (LLR).

By re-establishing the situation before collectivization, the land reform has contributed to the fragmentation of agricultural lands. This need not have been a problem in general, if the land markets were developed, since in that case the farm sizes would have adjusted to their efficient levels. However between 1991 and 1998, the restituted land was banned from selling, therefore causing inefficiency and high transaction costs in agriculture. The law on leasing agricultural land was only adopted in 1994 and it was simplified in 1998, thus hindering the early development of the leasing market. On the other hand, renting the land was not very attractive from the tenant's point of view, since due to the accentuated land fragmentation, transaction costs of coordinating with other tenants for obtaining a larger piece of land were very high (Tesliuc 2000).

[5] The rural population has decreased in the period 1992-1997 with an average of 2.7% per year, while it has increased in the period 1997-1999 due to the reduction of workplaces in the cities. At the same time the aging of the rural population has been observed (Vincze 2000 p. 80).

[6] The poverty rate has increased from an estimated 7% in 1989 to 44% in 2000 (UNDP 2001).

Besides land fragmentation, other problems of agriculture concerned the decrease of the machine park, the deterioration of the existent equipment and the decline in the use of all inputs like fertilizers or certified seeds. The decline in the use of the inputs is related to the input and output side of production organized by state companies in the socialism (Kenneth 2003, OECD 2000). The reforms did not target the restructuring of down and upstream sectors in line with the needs of the individual farmers, therefore the input and output markets were not suitable for them (Tesliuc 2000). Moreover several input providing factories have been closed during the transition, therefore making access to inputs even more difficult.

No significant changes have occurred in the land use during the transition. Between 1992 and 2000 the area of arable land, of vineyards and orchards slightly decreased in favour of pastures and hayfields, indicating a shift towards more extensive farming (NCS 2001).

There have been changes in the land quality during the transition. Table 2 illustrates the increase in the size of the area of agricultural land between 1992 and 2000, influenced by different land quality limiting factors. The area affected by the listed factors has either been constant or has increased during the transition. The increase in area for some of the factors could have been hindered through adequate land management practices.

**Table 2. Major limiting factors affecting soil quality of agricultural land (Millions of hectares affected)**

| | **1992** | **2000** |
|---|---|---|
| Wind soil erosion | 0.38 | 0.38 |
| Water soil erosion<br>(*of which anti-erosion arrangements*) | 2.80 | 6.30<br>(2.27) |
| Landslide | 0.70 | 0.70 |
| Frequent drought<br>(*of which arrangements for irrigation*) | 3.80 | 7.10<br>(3.21) |
| Waterlogging<br>(*of which arrangements for drainage*) | 4.00 | 3.78<br>(3.20) |
| Soil compaction due to inadequate works ("plough sole") | 6.50 | 6.50 |
| Strong and moderate acidity | 2.30 | 3.42 |
| Low level of nitrogen | 3.60 | 5.11 |
| Low level of mobile phosphorus | 4.50 | 6.33 |
| Chemical pollution (due to different socio-economic activities) | 0.90 | 0.90 |
| Salinisation | 0.60 | 0.61 |

Source: NCS 2001

Those areas which have remained constant show degradation inherited most probably from the time of the communism. This is the case for problems like wind soil erosion, land slides, soil compaction, chemical pollution and salinisation.

Some factors that have extended over large areas during the transformation are water soil erosion or frequent drought. There were facilities that could improve the soil problems on a large part of the affected territory but these arrangements have not been maintained and thus could not be used (NCS 2001). The level of nitrogen and phosphorus decreased significantly and it parallels the decrease in the use of chemical fertilizers in agriculture during the transformation. Indeed, the use of Nitrogen as a fertilizer has decreased from 1990 to 2000 2.4 times, and that of phosphorus 3.6 times (own calculations from NCS 2001). At the same time on other parts of agricultural land the area affected by acidity has increased.

However, the changes indicated by the figures in Table 2 may not necessarily reflect the actual changes from 1992 to 2000. Changes may be the result of the reevaluation of land quality initiated after 1992. An example underlying the above hypothesis is a mention in the literature (Muica&Zavoianu 1996) about five million hectares affected by erosion around 1989. This suggests a much smaller increase to 7 million hectares by 2000 than the change from 3 million hectares in 1992 as reflected in Table 2. Another author talks about 30% of Romania's arable land affected by erosion in 1991, which means 4.2 million hectares, another value different from that in the national statistics (Mainland 1991).

**4. Changes in ecological aspects at the village level**

The agricultural household survey was conducted on 15 study sites in 15 counties. The study sites were dispersed all over Romania, with a diversity of landscapes. Table 3 presents information about the landscape and land quality on the study sites as approximated by the agricultural engineers of the respective villages. The names of the study sites refer to the name of the respective county, the interviews were conducted in a randomly selected village from the county. The information in the table refers only to the villages and the areas surrounding them, the county names are used only for an easier distinction of the areas.

Low humus content was a problem in three mountain villages. The agricultural land had high salt content in three villages, located in saline areas of Romania while in five cases acidity was high. In ten villages erosion was present to a smaller or larger extent and these villages coincided with the ones located in hilly or mountainous areas. Soil compaction was a difficulty in four cases and it was rated as a seldom problem.

Other problems, not presented in the table but specifically mentioned by the agricultural engineers were the inappropriate storage of animal manure polluting the water and thus the soil. This was the case in Iasi, Mures and Alba. Additionally in Mures chemical pollution was significant. The village is close to a city having intensive industrial activity and in a nearby village there is a big pig farm, the animal manure from which is polluting

the ground water. The river in the neighbourhood is polluted by motorine due to a previous explosion, affecting some part of the land as well.

**Table 3. Characteristics of the study sites**

| Study sites | Landscape | Humus cont. | Salt cont. | Acidity | Erosion | Water content | Soil compaction [2] |
|---|---|---|---|---|---|---|---|
| **Harghita** | Mountain | Low | High | High | Often | High | Seldom |
| **Iasi** | Hill | Med.[1] | Partly | med. | seldom | Med. | Seldom |
| **Vaslui** | Hill | Med. | Med. | med. | Often | Low | Never |
| **Vrancea** | Hill | Med. | Med. | med. | seldom | Low | Seldom |
| **Braila** | Plain | Med. | High | | | Med. | |
| **Constanta** | Plain | Med. | Med. | med. | Never | Low | Never |
| **Ialomita** | Plain | Med. | Med. | med. | Never | Low | Never |
| **Oltenia** | Plain | Med. | Med. | med. | Never | Low | Never |
| **Valcea** | Hill | Med. | Med. | High | seldom | Med. | Seldom |
| **Mehedinti** | Mountain | Low | Med. | Low | Often | Low | Never |
| **Arad** | Plain | Med. | Med. | High | Never | Med. | Never |
| **Bihor** | Hill | Med. | Med. | High | Often | Med. | Never |
| **Cluj** | Hill | Med. | High | med. | Seldom | Med. | Never |
| **Alba** | Mountain | Low | Med. | High | Often | Med. | Never |
| **Mures** | Hill | Med. | Med. | med. | Often | Good | Seldom |

Source: Village level interviews
[1] med. = medium
[2] Categories at soil compaction: always, often, seldom, never.

Table 4 presents the change in the direction of the land quality in the last five years, as recollected by the agricultural engineers. The "+" sign indicates an improvement, that is, better land quality, productivity, less problem with soil salinity, acidity, water content or soil compaction. The "-" sign indicates the opposite, worse land quality, productivity, more problems with soil salinity, acidity, water content or soil compaction. "0" indicates that there are no changes. A first examination of the table shows, that ecological problems have increased during the transition: the table contains eighteen minus signs and only three plus signs.

The first characteristic, ***land quality***, has deteriorated in three villages, while it improved in one. There are several reasons for the predominant deterioration of land quality. The excessive deposition of animal manure on the fields contributes to the pollution of waters and thus soils in the village from Iasi. The agricultural engineer complained, that although there is a manure collecting place established by the mayor's office, most of the people do not carry the manure there. There are also environmental problems related to the unappropriate use of crop rotation. In the village from Vaslui erosion and landslides damage land quality. The land quality is also decreased by the lack of natural fertilizers. In the village from Bihor the increase in the land acidity was the main reason for the

degradation of land quality. The reason for increase in acidity is explained at the acidity problems.

In Constanta, the agricultural engineer reported that land quality has improved during the transition. The excessive amount of fertilizer applied during the communism has decreased the quality of the land. Nowadays people do not have money for fertilizers and a singificant part of the land is left fallow, all contributing to the recovery of the soil.

**Table 4. Change in the direction of land quality**

| Study sites | Land quality | Land productivity | Salt concentration | Acidity | Humidity | Soil compaction |
|---|---|---|---|---|---|---|
| Harghita | 0 | 0 | do not know | - | 0 | - |
| Iasi | - | - | 0 | 0 | 0 | 0 |
| Vaslui | - | - | 0 | 0 | + | 0 |
| Vrancea | 0 | 0 | 0 | 0 | - | - |
| Braila | 0 | + | - | Missing | 0 | 0 |
| Constanta | + | - | 0 | 0 | - | 0 |
| Ialomita | 0 | - | 0 | 0 | 0 | 0 |
| Oltenia | 0 | 0 | 0 | 0 | 0 | 0 |
| Valcea | 0 | 0 | 0 | 0 | 0 | 0 |
| Mehedinti | 0 | 0 | 0 | 0 | 0 | 0 |
| Arad | 0 | 0 | 0 | 0 | 0 | 0 |
| Bihor | - | - | 0 | - | - | 0 |
| Cluj | 0 | 0 | 0 | 0 | 0 | 0 |
| Alba | 0 | - | 0 | - | 0 | 0 |
| Mures | 0 | 0 | 0 | 0 | 0 | 0 |

Source: Village level interviews

In one case ***salinisation*** has become more severe than five years ago. In Braila the land has high salt content and this characteristic has accentuated. The locality from Braila was one where the highest number of households used irrigation. From 20 households 5 used irrigation and two out of this five households reported that their irrigation equipment was leaking.

In three villages, Harghita, Bihor and Alba, the ***acidity*** of the land has increased. The main reason behind this is the lack of financial means of the villagers, who cannot afford to buy the lime and treat the land against acidity. The lack of financial means have repercussion on the use of fertilizers as well, according to the engineer from Harghita for example, „people buy whatever is available and cheap", without ecological considerations. The cheapest fertilizers have high content of nitrogen thus contributing to the worsening of acidity. In Bihor, where the land has high acidity only on the hills, in addition to the above mentioned problems causing acidity the lack of animal manure also determines acidity problems to worsen. People do not have enough animals, and even if they have as much as to have the necessary manure to treat their land, they usually cannot transport the manure to their land, due to the lack of means of transportation and the fragmented nature of their land. Another problem is that lime, which is needed for the improvement of acid land, is sold only at about 300 km distance in Targu Mures, and it is

too far to transport from there. There was such a factory in Arad (150 kms away), but this has been closed down.

Besides the villages with worsening acidity problems there are two more villages in the sample with high land acidity but no report of worsening of the problem. The reasons are the availability of lime or animal manure to improve the quality of their lands. That is, in Valcea, as a local initiation from the part of the mayor's office, lime and its transport is for free. In Arad there is a large animal stock, providing the necessary manure for the land.

## 5. Ecological aspects at the household level

In what follows ecological characteristics and therefore sustainability at the household level is analysed. Sustainability is approached from the land management perspective of the farmers, which indirectly assesses the environmental impacts on agriculture. The indicators of farm management at the household level are classified into farm management potential, corresponding to the socio-economic characteristics of the households and into the actual farm management practices[7] (Abdegalil and Cohen 2001, OECD 2001). The farm management potential is impacted by the transition process, which has changed the characteristics of the actors of agriculture, while the land management potential further influences land management practices, having a repercussion on environmental problems of the soil.

### 5. 1. Farm management potential

Some impacts of the macroeconomic changes on the agricultural household have been mentioned before, like the increase in agricultural employment, poverty or land fragmentation. The survey data illustrates in more detail these and other characteristics which affect the sustainability of agriculture from an ecological point of view and are included under the heading of farm management potential.

The economic difficulties during the transition resulted in the increase in poverty. Pensions and wages have decreased in real value, unemployment increased. Privatization has assured the return of land to former owners and cooperative workers, therefore a large part of those getting back their land were quite old. These aspects had as a result that relatively old people compose the agricultural households as well as the lack of their financial resources (Table 5).

[7] Abdegalil and Cohen (2001) use human capital, income and property rights for an approximation of "sustainable" land management potential. OECD (2001) distinguishes between farm management capacities, focusing mainly on farmer education as well as financial resources, and farm management practices (2001).

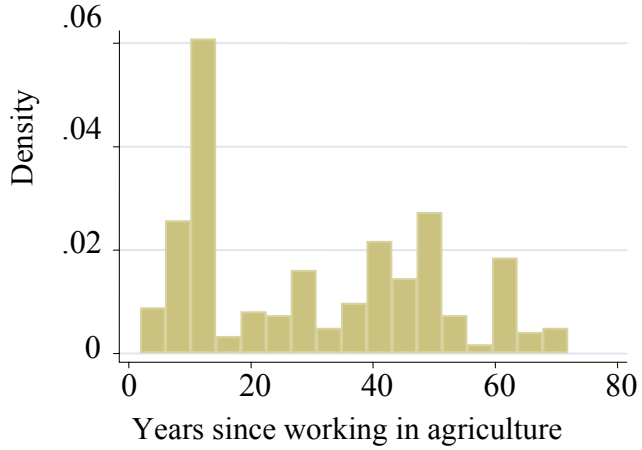
**Table 5. Summary statistics on household characteristics**

| Variable | Obs. | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Age of the head of the household (years) | 304 | 59.7 | 13.6 | 26.0 | 91.0 |
| Average age of adult household members (years) | 304 | 53.7 | 13.4 | 26.0 | 89.0 |
| Number of household members (no) | 304 | 3.2 | 1.7 | 1.0 | 10.0 |
| Per capita cash income in 2002 (Euro) | 304 | 754.0 | 1248.0 | 11.0 | 17742.0 |

Source: Own calculations from AHS 2003
Legend: Obs.=number of observations, Std. Dev.=standard deviation, Min.=minimum, Max.=maximum.

Lack of adequate human capital and labor influences negatively sustainable agricultural production is the household. The households have usually old members, the head of the household is on average 60 years old, while the adult household members have an average age of 54 years[8] (Table 5). The old household members cannot work their land completely, leaving some land fallow, and mostly do not have the money to employ other people. The lack of enough labor hinders the practicing of labor intensive soil conservation practices, like terracing or drainage. The old household members are usually agricultural producers only because they need to complement their low income from pensions and other sources (own interviews).

**Graph 1. Histogram of years of work in agriculture in 2003**




Source: AHS 2003

A large number of people have returned to agricultural production only during the transition due to the loss of their workplace and/or because they got back their lands owned before the communism. Therefore they do not have the necessary farm management experience and knowledge to perform the right land management practices. Graph 1 shows how long the head of the household worked in agriculture. One can see that a significant increase in the agricultural activities have occurred with the start of the land restitution, 12 years before the data collection—in 1991.

[8] Adult household member is defined as older than 14 years.

Indeed only 11% of the farmers have participated in some kind of courses for agricultural producers, or attended some form of education with agricultural focus. On the other hand the education level of the household heads is quite good, 45% have at least 12 classes or university and only 4% have less than 4 classes of education (AHS 2003).

An illustration of the lack of necessary land management knowledge is the fact, that a large share of farmers could not given any answer to the questions about whether the acidity level of their soil was good and whether the acidity level or the salt content of their soil has changed in the last 5 years (Table 6). However the farmers could almost always give an answer when they were asked to characterize the productivity of their land or the change in the productivity in the previous five years and they were also aware of the soil texture.

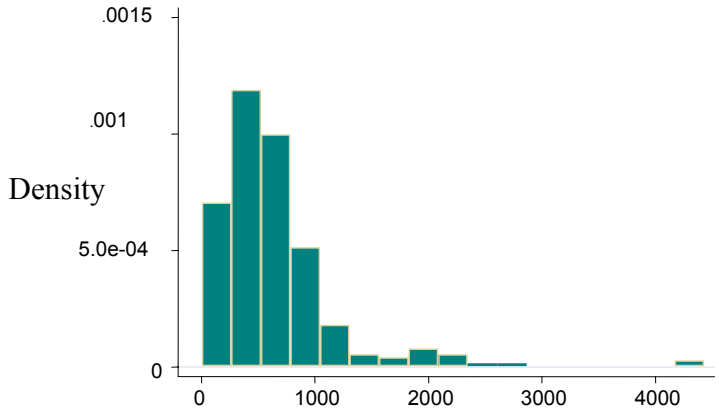
**Table 6. Knowledge of the farmers about the composition of their land.**

| | Do not know | Any answer, other then do not know |
|---|---|---|
| Has your land too high acidity/the right amount/ too low? | 72% | 28% |
| Did the salt content of your land in the last 5 years increase/decrease or remain the same? | 73% | 27% |
| Did the acidity of your land in the last 5 years increase/decrease or remain the same? | 82% | 18% |

Source: Own calculations from AHS 2003

Good land management can be hindered by the lack of financial resources, which indirectly impact environmental decisions. Farms can remain profitable even if they do not invest in environmental improvements, at least over the medium term. However, profitable farms can afford more to take the environmental considerations into account when deciding about farm management practices (OECD 2001).

**Graph 2. Histogram of per capita income in 2002 for households earning below 5000 Euro**




Source: AHS 2003

The histogram of per capita yearly cash income is presented in Graph 2. There were only 3 households who had more than 5000 Euro in a year, and they were left out of the histogram because otherwise the 0-1000 Euro yearly income category could not be observed in detail. An illustration of the low income of the households is that in 2002 for example 86% of the households had a yearly per capita income of less than 1000 Euro.

The low per capita income has repercussions on the sustainability of land use. Poor farmers cannot afford to buy fertilizers or buy the cheapest one, which often leads to the increase of the acidity of the land, as it was mentioned at the village level analysis. There is no money to analyze the composition of the soil or to treat the soil against acidity. Even a relatively well off farmer has done a soil nutrient balance test only sometimes 7 years before the interview. He did not send the soil sample for analysis any more, though he thinks that it would be useful to find out the current composition of the soil, but the financial costs involved in it are too high (own interviews).

Another reason which leads to in-adequate land management is the size of the land plots a consequence of the privatization process. Table 7 shows that the average size of cultivated land was 5.1 has, with large deviations, average plot size was 1.1 ha while that of owned land was 0.9 ha. The average plot size in case of leased land was much higher. However, leasing land for cultivation has occurred only in 9% of the cases.

**Table 7. Summary statistics on land**

| Variable | Obs. | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Size of owned land (ha) | 296[9] | 3.6 | 3.8 | 0.0 | 30.0 |
| Size of cultivated land from that owned (ha) | 296 | 2.8 | 3.0 | 0.0 | 27.0 |
| Total size of cultivated land, both owned and leased (ha) | 296 | 5.1 | 26.7 | 0.1 | 402.0 |
| Number of land plots (nr) | 296 | 4.7 | 4.4 | 1.0 | 36.0 |
| Size of one land plot (ha) | 296 | 1.1 | 3.0 | 0.1 | 36.0 |
| Size of cultivated land plots from own land (ha) | 292 | 0.9 | 1.2 | 0.1 | 10.0 |
| Size of cultivated land plots from leased land (ha) | 27 | 4.3 | 11.8 | 0.1 | 52.0 |

Source: Own calculations from AHS 2003

Legend: Obs.=number of observations, Std. Dev.=standard deviation, Min.=minimum, Max.=maximum.

The small and fragmented land size has several repercussions on sustainability. Small and dispersed land plots make it difficult to practice anti-erosion measures like terracing or perpendicular ploughing[10]. Small land plots may not motivate the farmers to invest into land conservation practices, they prefer to look for other income sources and cultivate the land without additional conservation efforts. The size of the land is related to the lack of financial resources as well: the larger the size of land the more agricultural income it can provide to its owner.

[9] Questionnaire 24, 43, 53, 55, 76, 182, 202 and 203 is left out of the analysis after cleaning.

[10] Some peasants were saying that some of their land plots were so small, that the tractor could not even turn around without driving on the neighbor's territory. Moreover, usually the plots were measured long up the hill, therefore being long but not large, which makes perpendicular ploughing with a tractor impossible (own interviews).

Small land size, land fragmentation, moreover the low input and output access brought about by the transition have represented constraints for the agricultural households, leading to increase in subsistence production. That is, the households receiving back their lands have returned to traditional crops, requiring low quantity of inputs and diversified their production, not selling but mainly consuming in the household their agricultural production (Tesliuc 2000).

Subsistence farming can in itself have ambiguous impact on sustainability. On the one hand low commercial orientation brings about low income from agricultural activities, therefore not being affordable and rentable to invest in soil protection, on the other hand subsistence farmers use low levels of inputs, which may for example bring about the recovery of the soil if the soil is still suffering because of over-fertilization from the time of communism.

However, in general commercial farmers have a long term planning and they are likely to consider the importance of soil protection activities, to ensure good productivity in their future agricultural activities. In this context subsistence farming may be another negative factor for sustainability. 57% of the surveyed farmers have sold some agricultural product, and those selling agricultural products sold on average 23% of the value of total agricultural production, suggesting a strong subsistence character of the agricultural producers (AHS 2003).

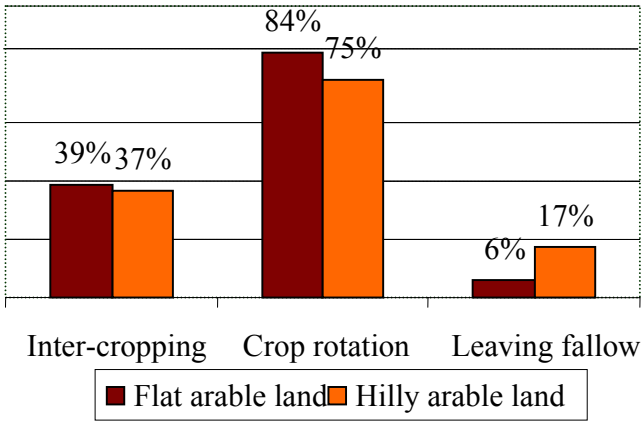
All the above characteristics, age, education, land size, income and subsistence character are indicators of farm management potential. In what follows the actual farm management practices are analyzed.

### 5. 2. Farm management practices

A first set of farm management practices analyzed are intercropping, crop rotation and leaving the land fallow. The beneficial effects of intercropping are widely acknowledged in the literature. Intercropping encourages ecological diversity and it often reduces pests, diseases as well as problems with weeds unlike growing the same crops in monoculture (Theunissen 1997, Coolman and Hoyt 1993). One of the frequently practiced intercropping patterns of the Romanian households was the growing of maize and beans together. The literature mentions as one of the advantages of the legume and cereal combination and therefore also that of beans and beans the increase in yields due to different Nitrogen fixation patterns of the intercropped species (Coolman and Hoyt 1993). Crop rotation is beneficial since it usually reduces exposure to pests and diseases, replenishes the nutrient in the soil and improves soil structure (Rigby et al 2001, Bamire 1999, OECD 2001). Fallow land contributes to the reduction of soil erosion and of soil fertility losses (Swinton and Quiroz 2003).

Intercropping and crop rotation was practiced by a significant number of households while leaving the land fallow was not often done. This result is presented in Graph 3, which separately displays the percentage of households with flat respectively hilly arable land practicing intercropping, crop rotation and leaving the land fallow.

**Graph 3. Percentage of households using a given land management method on a specific soil type**




Another measure concerning crops is the collaboration between the farmers of the neighboring plots with respect to what crops are planted, to reduce the chance of planting incompatible crops next to each other. According to the survey 35% of the households collaborated with the owners of neighboring plots in this respect.

**Table 8. Summary statistics for land management methods against erosion**

| Method | Obs | Mean (Average over households of using the specified method - marked with 1- or not –marked with 0[11]). | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Crop rotation | 64 | 0.2 | 0.4 | 0.0 | 1.0 |
| Protective vegetation | 64 | 0.1 | 0.3 | 0.0 | 1.0 |
| Mulching | 64 | 0.02 | 0.1 | 0.0 | 1.0 |
| Planting strips of grass on the hill downslope | 64 | 0.03 | 0.2 | 0.0 | 1.0 |
| Trees and hedges as windbreaks | 79 | 0.1 | 0.3 | 0.0 | 1.0 |
| Contour ploughing | 64 | 0.2 | 0.4 | 0.0 | 1.0 |
| Terraces | 64 | 0.03 | 0.2 | 0.0 | 1.0 |
| Minimum tillage | 64 | 0.1 | 0.3 | 0.0 | 1.0 |
| Acceptable number of cattle | 39 | 0.03 | 0.2 | 0.0 | 1.0 |

Legend: Obs.=number of observations, Std. Dev.=standard deviation, Min.=minimum, Max.=maximum.
Source: Own calculations from the AHS 2003

Land management measures like those against erosion were registered only for the households who reported that there is a certain degree of erosion or there are land slides on their land. These households were 79 out of 296 households (Table 8). From the 79

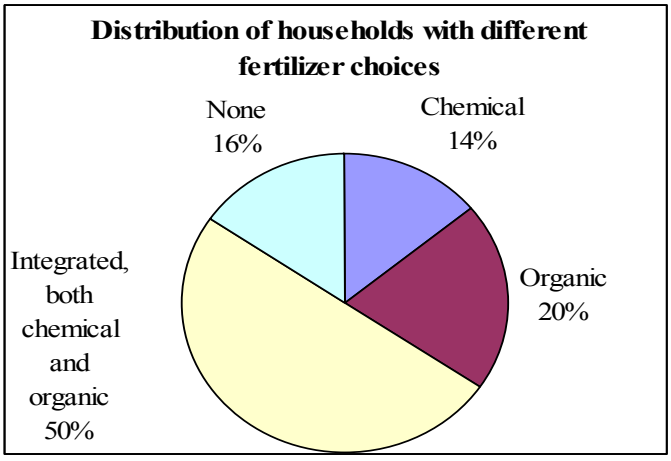
[11] The method is the following. First the questions, e.g. do you use crop rotation against erosion was asked for both arable flat and arable hilly land. If a household possessed only one type of land, his answer yes=1, no=0 was used for calculating the average over households. If a household had both arable flat and sloped land, then first an average of the measures used on these two types of land was calculated and the obtained value was further used in the calculation of the index.

households the questions are addressed only to those households who had flat or hilly arable land, excluding those with vineyards, orchards, pastures and hayfields. There are two exceptions: the measure of using trees and hedges as windbreak was asked for all land types, while the grazing of an acceptable number of animals was only asked for those possessing pastures and hayfields. Crop rotation and contour ploughing was used in the case of 20 percent of the households, while mulching, grazing of adequate number of animals, planting strips of grass on the hill downslopes and terraces were used in a very few cases.

As concerns irrigation and drainage, having repercussions on both salinisation of soil and water logging households only 5% practiced irrigation and 9% used some kind of drainage (AHS 2003). In the lowlands of Romania during the communism irrigation has been extensively practiced, during the transition most of the irrigation and drainage equipment has deteriorated and the farmers could not also afford for example the high costs of water use (Dragos 2001, Lubieniechi 2001).

Soil tests are an important tool of nutrient management since they show the level of nutrient in the soil and allow the farmers to match the crop needs with that of nutrient application. Applying fertilizers without soil tests can lead to over- or underfertilisation (OECD 2001). In Romania soil tests are rarely done, only 8% of the households monitor regularly their soil composition.

**Graph 4.**



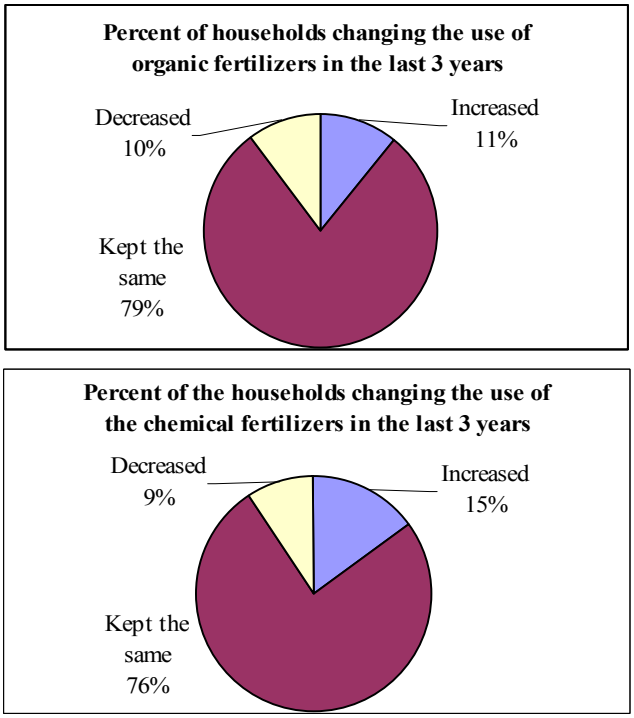

Source: AHS 2003

The choice of fertilizer and the decision about its application are very important in the soil nutrient management. As mentioned already at the village problems utilization of not adequate fertilizers or lack of animal manure can lead to worsening acidification problems, chemical pollution or decrease in soil nutrient content. Graph 4 illustrates the choice of fertilizers applied by the households, the lowest percent applying only chemical fertilizers, and almost half of the households combining organic fertilizers like animal manure, composted fertilizers and green manure with chemical fertilizers.

The impact of use of fertilizers is ambiguous since the continuous decline in the use of chemical fertilizers during the transition has been associated up to 1997 with a Nitrogen surplus –probably due to the still over fertilized soils from the communism-, however from 1997 on there was already a loss of Nitrogen from the soil (Lubieniechi 2001). This means that if not applied excessively all types of fertilizers are currently beneficial for the improvement of the soil nutrient content.

As concerns the change of fertilizer use in the last 3 years one can notice a slight intensification. There were a higher percentage of households increasing the use of chemical fertilizers as well as that of organic fertilizers than those decreasing them (Graph 5).

**Graph 5.**




Source: AHS 2003

There were no much changes and there are no many changes planned in the land use between arable and other types of land, like orchards, hayfields, pastures and forests. There are slightly more households who have converted or want to convert arable land to other uses, than those who have converted or want to convert orchards, hayfields, pastures and forests into arable lands (Table 9). These result parallels the results reported in the national statistics, slight decrease in the size of arable land and increase in hayfields and pastures (NCS 2001). Contrary to the use of fertilizers this suggests a slight decrease in the intensity of cultivation of agricultural land.

Since during the communism there were large territories of land converted into arable land even if they were not appropriate for intensive cultivation, the conversions of land

between different uses and especially from arable into other uses suggests that there is an improvement in the land use patterns of the Romanian agricultural households –another irrationality of the communist land management starts to be outbalanced.

**Table 9. Change in land use**

| Intensification of agriculture | % of households |
|---|---|
| Change of arable land into orchards/hayfield/pasture/vineyards/forest in the last 5 years | 12% |
| Change of orchards/hayfield/pasture/vineyards/forest into arable land in the last 5 years | 7% |
| Plans to change arable land into orchards/hayfield/pasture/vineyards/forest in the next 5 years | 12% |
| Plans to change orchards/hayfield/pasture/vineyards/forest into arable land in the next 5 years | 8% |

Source: AHS 2003

### 5. 3. Linkage between farm management potential and farm management practices

Socio-economic characteristics are frequently analyzed in the literature in the quality of determinants of soil conservation measures and all kinds of land management decisions – e.g. fertilizer application. Variables usually used are the age of the household head, family size, level of education, farming experience, amount of family and hired labor, access to information – e.g. membership in a professional association, contact with extension officers or agricultural engineers-, farm size, farm income, ownership of land and region specific variables – e.g. the existence of specific environmental problems in the region for which the land management practice is adequate, agro-ecological, landscape characteristics, distance of the village to the nearest town or fertilizer availability (Adesina and Chianu 2002, Bamire 1999, Bamire et al 2002).

Accordingly, the variables considered to influence different farm management practices in this study are the age of the household head, gender, education, participation in a specific agricultural training and cultivated land size including both leased and owned, owned land size, average size of one owned plot, per capita income which can be further differentiated into per capita non-agricultural and agricultural income and an indicator of commercial orientation. Additional variables are the total labor available in the household for agricultural purposes, hired in labor, work of the household members outside own household, number of cattle and horses.

Education is an ordered variable with values from 1 to 5, 1 being the lowest and 5 the highest level of education, while the categories are less than 4 years of education, primary school, 8 classes, 12 classes and university or high school. Participation in a specific agricultural training is binomial, taking the value of 1 if the household head has participated in any kind of agricultural courses or studied in an agricultural domain. Commercial orientation is the percentage of the value of sold agricultural output from the value of total output.

Location specific variables are four dummies for the distinction of five agroecological zones, Transylvania inner- or the Carpathian depression-, Transylvania outer –or Transylvania plains–, Moldova, South Romania plain and South Romania mountainous regions. Moreover slope is considered, taking the value between 1 and 3, calculated as an average of the slope values of two types of lands of the households: hilly and flat arable land. Market access is an indicator calculated from 3 different variables, the distance of the village to the closest city, the distance of the village to the main city of the county and the road quality[12]. Market access has the value of 0, 1 and 2, 0 representing the lowest access, or isolation, and 2 the highest access.

In what follows the determinants of crop rotation, leaving the land fallow, organic, inorganic and integrated choices of fertilization, monitoring the soil composition and conversion of arable land into other uses respectively conversion of other land into arable are analyzed. For this purpose the above described explanatory variables are used, with the possibility of leaving out one or the other variable depending on the land management practice.

A first set of regressions uses logit and analyses the determinants of crop rotation, leaving the land fallow temporarily and leaving the land fallow permanently. Crop rotation and leaving the land fallow temporarily concerns arable land, while leaving the land fallow permanently concerns all types of lands. The temporary fallow refers to those households who leave periodically some parts of their land fallow, for land conservation purposes. However the households with temporary fallow can also have some land declared at total owned land as permanently fallow. Permanent fallow refers to those households who have declared at land use that they are constantly not using some part of their land, not specifying its type. The households with permanent fallow can have arable land temporarily left fallow as well. The reason why the analysis does not exclude the mixed households (with both temporary and permanent fallow) from the regression is that there are very few households leaving their land only temporarily or only permanently fallow. Therefore excluding them would not provide the necessary variation for the analysis. The results of the regression are presented in Table 10.

In the first regression, crop rotation is the independent variable and it takes the value of 1 if the household has practiced crop rotation on at least one of hilly and flat arable land pieces. The explanatory variables are those listed in Table 10. Some variables from the Table 10 are not considered, for example cultivated land and not owned land is used, only non-agricultural per capita income is considered because total per capita income correlates with the variable of commercial orientation (correlation coefficient 0.50) and the labor variables are left out because crop rotation is not labor intensive. The location specific dummy variables Transylvania inner and Transylvania outer are joined into a

[12] The road indicator takes the value of 1 if there is international, European, national, or county road leading to the village and the value of 0 if the road is communal. The average of the distance to the main city of the county and the closest city of the county was rated the value of 1 if this distance was less than 25 km and 0 otherwise. The indicator market access was calculated as the sum of the road and distance indicators.

single dummy, Transylvania, because Transylvania outer alone predicts success- crop rotation- perfectly and therefore cannot be separately analyzed.

**Table 10. Logit regression for crop rotation, temporary and permanent fallow.**

| Name of the explanatory variables | Crop rotation (coef./SE) | Leaving land fallow temporarily (coef./SE) | Leaving land fallow permanently (coef./SE) |
|---|---|---|---|
| Age head (years) | -0.04(0.02)** | 0.05 (0.03)* | 0.01 (0.02) |
| Gender head (1-male, 0- female) | 0.65 (0.47) | 0.37 (0.68) | -1.29 (0.54)** |
| Education head (1-5, 1 lowest, 5 highest) | -0.19( 0.26) | 0.14 (0.34) | -0.19 (0.30) |
| Agricultural education (1-yes,0-no) | 1.30(0.72)* | -1.41(1.10) | -0.01 (0.73) |
| Cultivated land (ha) | 0.30(0.13)** | | |
| Total owned land (ha) | | 0.23 (0.08)*** | 0.20 (0.07)*** |
| Average size of one land plot (ha) | -0.33(0.19)* | 0.18 (0.20) | 0.26 (0.20) |
| Commercial orientation (%) | 3.70(1.73)** | -3.81(2.61) | |
| Per capita income (Euro) | | | 0.00003 (0.00) |
| Per capita non-agricultural income | 0.001(0.00)* | 0.001 (0.00) | |
| Family labor (mandays/month) | | 0.01(0.01) | -0.01 (0.01) |
| Hired labor (mandays/month) | | 0.01(0.02) | -0.02 (0.03) |
| Family labor outside the household (mandays/month) | | 0.03 (0.02)* | -0.03 (0.02) |
| Transylvania inner | | 1.91 (0.80)** | 0.77 (0.59) |
| Transylvania outer | | -0.86 (1.08) | -2.15 (1.08)** |
| Transylvania | 2.51(0.59)** | | |
| South Romania plain | 2.11(0.58)** | | -1.73 (0.81)** |
| South Romania mountainous | -0.22(0.56) | | -1.61 (0.97)* |
| South Romania | | -1.89 (0.98)* | |
| Access (0-low, 1-medium, 2-high) | -0.41(0.24)* | -1.88 (0.54)*** | -1.10 (0.38)*** |
| Constant | 1.88(1.72) | -6.18 (2.49)*** | -0.55 (2.04) |
| LR $chi^2$ | 86.88 | 60.62 | 72.98 |
| Pseudo $R^2$ | 0.33 | 0.35 | 0.35 |
| Prob>$chi^2$ | 0 | 0 | 0 |
| No. of observations | 279 | 279 | 288 |

Legend: *** Significance at the 1% level, ** Significance at the 5% level,* Significance at the 10% level.
Coef. coefficient, SE Standard Error

The results show that the age of the household head influences crop rotation negatively while the participation in agricultural courses has a positive impact. These results may be related to the fact that older household heads do not plan on the long term, therefore they are not interested in soil protection and may not have the necessary man power to organize, supervise or effectuate crop rotation activities, while agricultural courses contribute to the understanding of the importance of crop rotation.

The larger is the cultivated land size –therefore the larger the farm is- the more crop rotation will be practiced, and crop rotation will not be practiced so often if the size of the average land plot is high. The impact of cultivated land size and commercial orientation indicate similar issue. The larger the farm, the more agricultural products are sold, the

more important to ensure a good productivity of land and practice crop rotation. The more commercial is a household—the more it sells from the agricultural production—the more likely the practice of crop rotation. The sign of the variable of land plot size is paradoxical. It is expected that the smaller the land plot size, the less commercial farming can be practiced, and the land plot size maybe so small that cultivation with machinery may not be rentable and even possible, therefore crop rotation cannot be practiced. The fact that here the average land plot size has a negative impact on crop rotation is paradoxical and needs further analysis. Besides the above, nonagricultural income influences crop rotation positively, however its coefficient is so low that it does not have any economic meaning.

Crop rotation is practiced more often in Transylvania and the plains of South Romania. The influence of Transylvania (and especially outer Transylvania) and South Romanian plain on crop rotation may concern, that there are larger agricultural territories on plains in these regions which brings about larger cultivated land size, larger average land plot size and more easy access with machinery. An interesting result is that the lower the access to the markets, the more crop rotation will be practiced. A possible explanation is that low market access means fewer alternative work opportunities and the farmers are more dependent on agricultural production and on land productivity, therefore they would practice crop rotation.

Leaving land fallow temporarily as well as permanently is measured by the independent variable taking the value of 1 if the land is left temporarily or permanently fallow and 0 otherwise. The difference from the variables used at crop rotation is that instead of cultivated land size owned land size is used, directly related to leaving land fallow, since only if the household has sufficient land in its ownership can afford to leave either temporarily or permanently land fallow. Leased land is not considered because usually a household leasing land is not thinking of leaving it fallow, prefers not to lease it instead. One possible reason of leaving the land fallow besides land management consideration is the lack of the necessary labor force in the household to cultivate the land, therefore labor variables are included in the model.

There are two differences in the explanatory variables of the two fallow-regressions. In the case of temporary fallow just like at crop rotation commercial orientation and non-agricultural per capita income are considered as explanatory variables. This is because leaving temporarily land fallow is a land management decision which targets the improvement of the soil, therefore it should be positively influenced by commercial orientation. If non-agricultural income in addition is sufficiently high it may allow the household to afford to leave land fallow therefore it has an expected positive impact as well. Leaving land fallow permanently is related to the constraints the household faces when accessing some land plots, which may represent higher transaction costs than working some other parts of land intensively, therefore in case the total per capita income is sufficient the household is more inclined to leave some parts of its land permanently fallow. Since total per capita income correlates with commercial orientation, in this case commercial orientation is left out of the analysis. At temporary fallow instead of South

Romanian plain and South Romanian mountainous region South Romania is used since the dummy of the South Romanian mountainous region predicts perfectly no-fallow.

The regressions show that temporary fallow is positively influenced by the age of the household head which may also be related to the lower ability of older household heads to work all the land. The larger the total land size in the possession of the household the more land will be left temporarily or permanently fallow, which is related to the argument mentioned above that if there is sufficient land in the possession of the household for cultivation and there remains some excess one can take the decision of leaving fallow.

Male household heads are less likely to leave land permanently fallow. Indeed usually women have less labor force to work all their land partly because they have more tasks in the traditional Romanian household besides agricultural activities as compared to men– for example cooking and taking care of the children. The more labor is allocated outside the household the more likely is that some land will be left temporarily fallow. More labor outside the household means more income to the household and therefore it is not so important to cultivate all the agricultural land for subsistence.

Low market access positively influences leaving the land both temporarily and permanently fallow. The argument can be in the case of temporary fallow that the household being in an isolated environment, depends on agriculture as the main income source and on good soil quality, therefore in order to ensure the protection of the soil has to leave from time to time the land temporarily fallow. Moreover, usually isolated villages are located in mountainous, hilly regions, with low quality land, which if not protected sufficiently may deteriorate very fast. Low quality land and dispersed plots, which is typical in the mountainous regions implies too high costs of cultivation of all the land plots, therefore households are likely to leave some land permanently fallow in these regions. In the case of permanent fallow low market access also means that fewer agricultural products can be sold, which suggests that the household will work only the part of the land necessary for subsistence, therefore leave the plots which are in excess fallow. A related variable is commercial orientation which negatively influences leaving the land fallow, however it is not significant.

The Transylvania inner region is significant in influencing leaving the land fallow temporarily while those in South Romania are not likely to leave land fallow temporarily. Moreover permanent fallow is not likely to occur in Transylvania outer and the South Romanian regions. The variation of leaving the land fallow in different regions is related again to the quality of land and landscape. In the hilly parts of Transylvania where the land is also very fragmented more land is left fallow—in Transylvania inner regions—, while less likely is leaving land fallow in South Romania and in the outer Transylvanian regions with fertile soils and not so fragmented lands.

A second land management aspect to be analyzed is the different choices of fertilizer. For this purpose a multinomial logit model is used, which has four outcomes: only chemical, only organic, integrated—both organic and chemical—and no fertilizer choices. The no

fertilizer choice is used as a base group or group of comparison. The explanatory variables are the same as at crop rotation or fallow, however at the fertilizer choice the percentage of land dedicated to wheat, maize, potato and sunflower is included, because these are the most frequent crops cultivated by the surveyed households (96%), and they are usually the crops for which fertilizers are most likely to be used as compared to other cultivated crops used. Another important number of households is cultivating for example grapes and hay, crops usually not treated with fertilizers at all. The share of land cultivated with grapes and hay are not included in the model because they correlate with the share of land cultivated with wheat, maize, potato and sunflowers. The number of cattle and horses are included because they are the main source of animal manure used on the fields. Transylvania is not distinguished into Transylvania inner and outer because Transylvania outer perfectly predicts the use of chemical fertilizers.

**Table 11. Multinomial logit regression for the fertilizer choice**

| Name of the explanatory variables | Only chemical (coef./SE) | Only organic (coef./SE) | Integrated (organic and chemical) (coef./SE) |
|---|---|---|---|
| Age head (years) | -0.05(0.03)* | -0.03(0.02) | -0.02(0.02) |
| Gender head (1-male, 0- female) | -0.07(0.69) | -0.11(0.66) | -0.66(0.63) |
| Education head (1-5, 1 lowest, 5 highest) | -0.24(0.35) | -0.26(0.31) | -0.21(0.31) |
| Agricultural education (1-yes,0-no) | -0.18(1.03) | 1.05(0.80) | 1.49(0.79)* |
| Cultivated land (ha) | 0.09(0.16) | 0.07(0.15) | 0.10(0.15) |
| % of land cultivated with wheat, maize, potato and sunflower | 0.81(1.07) | -1.09(0.84) | -1.00(0.90) |
| Number of cattle and horses (no) | 0.41(0.32) | 1.30(0.27)*** | 1.30(0.27)*** |
| Per capita income (Euro) | 0.001(0.00)* | 0.0001(0.00) | 0.0005(0.00) |
| Family labor (mandays/month) | -0.01(0.01) | -0.01(0.01) | 0.00(0.01) |
| Hired labor (mandays/month) | -0.32(0.21) | -0.01(0.07) | 0.00(0.07) |
| Family labor outside the household (mandays/month) | -0.08(0.02)*** | -0.04(0.02)** | -0.03(0.02)* |
| Transylvania inner | | | |
| Transylvania outer | | | |
| Transylvania | 4.42(1.03)*** | 2.30(0.97)** | 5.75(0.99)*** |
| South Romania plain | 0.98(0.76) | 0.14(0.61) | 1.22(0.69)* |
| South Romania mountainous | 3.10(1.02)*** | 2.30(0.87)*** | 3.96(0.91)*** |
| South Romania | | | |
| Access (0-low, 1-medium, 2-high) | -0.65(0.34)* | -0.07(0.31) | -0.75(0.32)** |
| Constant | 2.47(2.76) | 2.07(2.42) | 0.60(2.41) |
| | | | |
| LR $chi^2$ | 247.76 | | |
| Pseudo $R^2$ | 0.34 | | |
| Prob>$chi^2$ | 0 | | |
| No. of observations | 291 | | |

Legend: *** Significance at the 1% level, ** Significance at the 5% level,* Significance at the 10% level.
Coef. coefficient, SE Standard Error

Note: No fertilizer is the base group.

Table 11 presents the results of the regression. The younger the household head the more likely he will use chemical fertilizers, while agricultural education is important when deciding for integrated fertilizer management. The number of cattle and horses are important in both the use of organic and integrated fertilizer choices. Per capita income is significant in the case of chemical fertilizer, however with a very low value. The importance of income for chemical fertilizer is intuitive since the chemical fertilizers are very expensive. Family labor outside the household influences negatively all choices of fertilizers, which suggests that the more labor is allocated outside agriculture, the more likely that the household will not fertilize the soils, since agriculture is not going to be its main income source.

The Transylvanian and South Romanian mountainous regions play a significant role in all kinds of fertilizer choices, while the South Romanian plains are significant in using integrated fertilizer choices. Interestingly the lack of access or isolation is again significant in the use of chemical and integrated fertilizer choices, which suggests that given that there are no other income earning opportunities the households have to concentrate on agricultural activities and use fertilizers.

**Table 12. Logit regression for monitoring the soil composition**

| Name of the explanatory variables | Monitoring the soil composition (coef./SE) |
|---|---|
| Age head (years) | 0.04(0.03) |
| Gender head (1-male, 0- female) | 0.16(0.71) |
| Education head (1-5, 1 lowest, 5 highest) | 0.30(0.34) |
| Agricultural education (1-yes,0-no) | 1.19(0.64)* |
| Own cultivated land (ha) | 0.28(0.08)*** |
| % of land cultivated with wheat, maize, potato and sunflower | 2.78(1.24)** |
| Share of land with ownership title from total owned land with ownership, user title, sales-purchase, inheritage contract and leased land (%) | 1.19(1.05) |
| Per capita agricultural income (Euro) | 0.0002(0.00) |
| Per capita non-agricultural income (Euro) | 0.002(0.00)* |
| Access | -0.55(0.36) |
| Constant | -10.75(3.00)*** |
| LR $chi^2$ | 40.56 |
| Pseudo $R^2$ | 0.26 |
| Prob>$chi^2$ | 0 |
| No. of observations | 292 |

Legend: *** Significance at the 1% level, ** Significance at the 5% level,* Significance at the 10% level.
Coef. coefficient, SE Standard Error

A next variable already mentioned before to be important in applying the right amount of fertilizer is the regular monitoring of the soil composition. The independent variable takes the value of 1 if the soil composition is regularly monitored and 0 otherwise. Table 12 presents the results of the logit regression on the determinants of monitoring the soil composition. Since there are very few households who have monitored the soil

composition, for a more realistic model the number of explanatory variables has been reduced, therefore excluding regional dummies. Given that monitoring the soil composition is an investment decision, because it is a very expensive activity, it is not likely to be influenced by the agroecological zones, more by the education or the income of the household.

There are some differences in the land and income variables as compared to the analysis before. For monitoring the land composition only own cultivated land is considered, not total cultivated land which would include also leased land. This is because it is assumed that the household would invest in monitoring the soil composition in first place in own land and mostly on those parts which are cultivated, or in use. Another variable referring to ownership is the percentage of land with final title from total own land[13] and leased land. Income, due to its importance in the investment decision is differentiated in per capita agricultural income and per capita non-agricultural income.

The results show that agricultural education is important in taking the decision of monitoring the soil composition, just like the size of own cultivated land. The higher the percentage of land cultivated with maize, wheat, potato and sunflower from total land the more the household will engage into monitoring the soil composition. This result is understandable, since other important crops in the household are grapes and hayfield, especially hay not bringing enough benefits to motivate the household to monitor the soil composition. Per capita non-agricultural income is significant in influencing the monitoring of the soil composition while per capita agricultural income is close to significance (with 0.11 probability). The relative importance of the non-agricultural income as compared to the agricultural income is surprising, however it may suggest that even if the agricultural income is high it does not offer so much net gains to compensate for the costs involved in monitoring the soil composition, this being more easily supported from non-agricultural sources.

The last two variables to be analyzed are the conversion in the last 5 years or the plan to convert in the following 5 years agricultural land into hayfield, pasture, orchards, vineyards and forest, as well as the conversion in the last 5 years or the intension of conversion in the following 5 years of hayfield, pasture, orchards, vineyards and forest into agricultural land. Table 13 shows the explanatory variables used to explain the two types of conversion decisions. The land variables concern own cultivated land only, since the leased cultivated land is not likely to be the subject of the conversion decision of the household. The share of land cultivated with maize, wheat, potatoes and sunflower is included. In the case of conversion of other land into arable land South Romanian plain and South Romanian mountainous regions are joined into one variable –South Romania, because South Romanian mountainous region predicts failure – no conversion perfectly.

[13]Total owned land includes land with final title, land with temporary title like user certificate, purchase contract or heritage documents. With purchase or heritage contracts the household still needs to go through some administrative procedures to transform the ownership into final legal title.

The younger the head of the household the more likely he is going to convert some land from one use to the other. If the household head is a female she is more likely to convert other types of land into arable land, which is a surprising result since one would expect that female household heads choose less intensive agricultural activities and not convert more land into arable land. Agricultural education influences conversion of arable land into other uses. The availability of family labor influences positively both types of land conversion decisions, explainable by the need for labor when converting one land use into the other. The larger the size of own cultivated land the more likely conversion of arable land into other uses and the larger the area cultivated with wheat, maize, potatoes and sunflower, the less likely the occurrence of conversion of arable land into other uses. Both in the Transylvanian inner and outer region inhabitants are more likely to convert one type of land into another.

**Table 13. Logit regression of conversion of arable land into other land and of other land into arable land.**

| Name of the explanatory variables | Conversion of arable land into other land[1] (coef./SE) | Conversion of other land into arable land[1] (coef./SE) |
|---|---|---|
| Age head (years) | -0.05(0.02)*** | -0.05(0.02)** |
| Gender head (1-male, 0- female) | -0.71(0.50) | -1.17(0.66)* |
| Education head (1-5, 1 lowest, 5 highest) | -0.01(0.24) | -0.11(0.31) |
| Agricultural education (1-yes,0-no) | 0.99(0.51)** | 0.30(0.68) |
| Own cultivated land (ha) | 0.13(0.06)** | -0.04(0.09) |
| % of land cultivated with wheat, maize, potato and sunflower | -1.35(0.74)* | -1.02(0.95) |
| Per capita income (Euro) | 0.0003(0.00) | 0.00(0.00) |
| Family labor (mandays/month) | 0.01(0.01)** | 0.03(0.01)*** |
| Hired labor (mandays/month) | 0.004(0.01) | 0.04(0.03) |
| Family labor outside the household (mandays/month) | 0.004(0.01) | 0.02(0.02) |
| Transylvania inner | 1.03(0.53)** | 1.46(0.85)* |
| Transylvania outer | 1.38(0.61)** | 3.00(0.94)** |
| Transylvania | | |
| South Romania plain | -0.21(0.68) | |
| South Romania mountainous | -1.27(1.13) | |
| South Romania | | 0.20(0.95) |
| Access (0-low, 1-medium, 2-high) | -0.19(0.26) | 0.23(0.34) |
| Constant | 1.24(1.70) | -0.07(2.14) |
| | | |
| LR $chi^2$ | 59.46 | 49.36 |
| Pseudo $R^2$ | 0.22 | 0.26 |
| Prob>$chi^2$ | 0 | 0 |
| No. of observations | 292 | 292 |

[1]Other land concerns hayfield, pasture, orchards, vineyards and forest.

Legend: *** Significance at the 1% level, ** Significance at the 5% level,* Significance at the 10% level.
Coef. coefficient, SE Standard Error

## 6. Linkage between transition and ecological sustainability

The linkage between the macroeconomic changes and land quality changes is realized through the interaction between land management potential respectively land management practices, underlined by the regressions. The results are summarized in Table 14. The aging of the agricultural producers, a first attribute, influences negatively crop rotation, the use of only chemical fertilizers and the conversion of land into different uses, while it positively influences temporary fallow. These results are based on the land management regressions before: the variable of age had a negative sign for example at crop rotation and was significant, meaning that the older the household head, the less likely crop rotation. Given that one of the current characteristics of the agricultural households is their high age, it suggests that the changes in the transition have brought about lower crop rotation, because of the aging agricultural producers.

**Table 14. Relation between the land management potential attributes –result of the changes in transition- and the land management practices.**

| Variables of land management potential | Attributes of land management potential variables as an impact of the changes in transition | Sign of impact of the attributes of land management potential var. on land management practices | Land management practices |
|---|---|---|---|
| Age | High | - | Crop rotation |
| | | + | Temporary fallow |
| | | - | Chemical fertilizer choice |
| | | - | Conversion of land in different uses |
| Agricultural education | Low | - | Crop rotation |
| | | - | Monitoring the soil composition |
| | | - | Integrated fertilizer choice |
| | | - | Conversion of arable land into other land |
| Income | Low | - | Crop rotation |
| | | - | Chemical fertilizer choice |
| | | - | Monitoring the soil composition |
| Land size | Small | - | Crop rotation |
| | | - | Monitoring the soil composition |
| | | - | Conversion of arable land into other land |
| | | - | Temporary fallow |
| | | - | Permanent fallow |
| Land plots | Small, fragmented | + | Crop rotation |
| Labor force | Not available | - | Conversion of land in different uses |
| Commercial orientation | Low | - | Crop rotation |

The rest of the factors are similarly included in the table. The table shows that attributes like the low level of agricultural education, low income, small land size, low amount of labor force in the household (especially where there are old members) and low commercial orientation all influence some land management practices negatively. They have a negative impact on crop rotation, temporary, permanent fallow, chemical and integrated fertilizer use as compared to no fertilizer, monitoring the soil composition, conversion of land into different uses and especially conversion of arable land into other type of land.

The only two positive impacts of the changes in the transition are on temporary fallow and on crop rotation. The first positive impact on temporary fallow is due to age, since older household heads are more likely to leave land fallow. However, the likelihood of fallow in case of old farmers may not be related to land management considerations but to the fact that older farmers do not have the necessary labor force to cultivate all their land. The other impact on crop rotation is very surprising, the smaller the size of the individual land plots the more likely crop rotation, a result contradictory to economic rationale.

Based on the table it can be concluded that the transition did not bring about ecological benefits to agriculture. The structural changes during the transition have created such conditions which are not beneficial for the practicing of most land management practices considered positive for soil improvement and conservation.

Table 14 summarizes just some of the land management practices; anti-erosion measures, irrigation, drainage or liming for example are not included. However these measures were already emphasized earlier in the analysis to be influenced by different household and land characteristics and they could be easily added to the above table. For example, small and dispersed plots make many anti-erosion measures impossible. Moreover irrigation, drainage and the treatment of land with lime has as a precondition that the households have the necessary financial resources and also the labor force, therefore poverty and old labor force having a negative impact on these land management practices.

The analyzed land management practices all contribute in some extent to soil conservation and improvement, addressing ecological problems like erosion, low level of nitrogen, phosphorus, acidity, dryness or water-logging. Therefore since the present characteristics influence the use of land management practices negatively, they have an indirect negative impact on ecological characteristics of agriculture and therefore ecological sustainability.

## 7. Conclusion

The paper has described the ecological characteristics of agriculture during the communism and the emerging situation during the transition on both national and village level. The study has presented how the structural changes in agriculture have brought about old, rarely agriculturally educated, poor, subsistence farmers with small and fragmented lands. Furthermore the characteristics of the new agricultural actors were

linked to the different land management practices which themselves are influential on the ecological parameters of agriculture, therefore on sustainability. The characteristics of the agricultural producers and their land turned to be significant in hindering most of the land management practices like crop rotation, leaving the land periodically fallow, monitoring the soil composition for applying the right amount of fertilizer, using chemical and integrated fertilizers, the conversion of land to different uses, liming, anti-erosion measures, irrigation and drainage. Since all these land management measures are beneficial for land conservation and improvement, it can be concluded that the changes in transition did not bring about ecological sustainability in agriculture.

In order to promote ecological sustainability in first place the current characteristics of the agricultural producers and their land characteristics should be addressed. Besides offering possibilities for agricultural education, encouraging land transactions is important, which would help the producers to adjust their land size to the efficient level. A larger farm could provide a decent income to the farmer and move him out of the subsistence trap, while the possibility of profitability, due to increased land size could make agriculture attractive to the young generation. Addressing and relaxing the constraints of agricultural production would contribute to ecological improvement, through the interaction between the characteristics of agricultural actors, their land management practices and the ecological aspects of agriculture.

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