Interdependencies regarding the evolution of greenhouse gas emissions and agricultural activities of Romania

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ABSTRACT

This work aims to analyse the interdependence of the activities that lead to the increase of gas emissions afferent to agriculture lands, and as well to identify some characteristics regarding the years within the analysed period. It has been noticed that the biggest quantities of greenhouse gas generated by the main analysed agricultural food groups (cereals, leguminous plants, oleaginous plants) were produced in 2007. In order to develop the agro-food sector in Romania, measures to reduce the greenhouse gas emissions should be taken.

Keywords: *agriculture, GHG, interdependent, sustainable development.*

INTRODUCTION

Agriculture is, traditionally, an important branch of the Romanian economy, being supported both by the population number working in the sector and the contribution to the gross domestic product.

At the same time, within the National Development Plan for 2007-2013 it is shown that the analysis of the rural area offers a clear image of the investment level from the following sectors: agriculture, forestry and piscatorial one, all characterized by poor technical equipment for farmers, mainly because of the low level income and difficulties encountered in accessing bank loans.'

From the 23.8 million ha which represents the Romanian territory, the agricultural area of the country is 14.7mil. Ha (61.7 %), of which 9.38 mil. Ha represents arable land.

Romania finds itself on the 6th position in Europe in terms of used agriculture area (after France, Spain, Germany, Great Britain and Poland) and on the 5th position in terms of arable area (after France, Spain, Germany and Poland).

The agriculture real estate's repairs done according to the way it is used indicates that the arable land covers circa 64% of the agriculture area, a third part of the area, 4.8 mil Ha, is covered by pasture and hayfield, whereas the vineyards and orchards represents circa 3%.

The rapport between the arable area of the country and the inhabitants number indicates that each inhabitant shares circa 0.42 Ha arable land, whose value is superior to most European countries and almost double with regard to European average, which is only 0.236 Ha/inhabitant.[1]

The cereals represent the main food group, grown on almost two thirds of the cultivated area. Although within the last years the cereal production in Romania was highly reduced because

[1] http://www.maap.ro/pages/raport/agricultura-romaniei-feb2010.pdf

of the unfavorable climate conditions (excessive drought), Romania is, in general, a big cereal producer.

***Table no. 1.* Area and total production on agricultural culture categories**

Specification	Area –thousands ha					Total Production – thousands tones				
	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
Total Cereal	5129.2	5210.7	5282.4	5066.4	5224.7	7814.8	16826.4	14873	16946	20842
Wheat, rye	1987.1	2123.3	2164.3	2060.5	1959.4	3065.0	7212.4	5235.5	5727.4	7145.1
Barley, two-row barley	363.8	394.0	517.5	506.1	419.5	531.4	1209.4	1182.1	1262.7	1329.0
Oat	208.7	200.4	202.7	194.3	185.3	251.6	382.0	295.8	331.1	375.9
Corn kernel	2524.7	2441.5	2338.8	2289.9	2589.7	3853.9	7849.1	7973.3	9085.2	11717.6
Rice	8.4	9.9	12.9	13.1	12.7	27.5	48.9	72.5	89.6	65.3
Sun Flower	835.9	813.9	766.1	823.6	995.0	546.9	1170.0	1098	1454.8	1789.3
Rape oil	364.9	365	419.9	579.5	392.7	631.5	673.0	559.6	920.6	739.0
Soya	133.2	49.9	48.8	64.1	72.1	136.1	90.6	84.3	143.3	142.6
Sugar Beet	28.7	20.4	21.3	24.4	18.8	748.8	706.7	816.8	792.5	660.5
Potatoes	268.1	255.3	255.2	243.9	242.6	3712.4	3649.0	4004	3333.8	4076.0

Source: processing MARD data and Annual Statistics Report 2009 - 2012.

By analyzing the table no.1 it can be seen that in the period 2007 – 2011, both the area cultivated with the main food groups and the obtained production have been growing. The report will analyze the interdependences between the food groups with the heaviest weight within the value of agricultural production in Romania and greenhouse gas emissions.

MINING DATA ANALYSIS

With the view to establish the interdependences between the GHG emissions and the agricultural activities, the following things were included: Culture production –Peas, -Beans, -Other leguminous plants, -Soya; Sugar Beet, Fodder Roots; Industrial cultures for fibers (linen, hemp); Sun flower; Rape; Other oleaginous plants; Other industrial cultures; Tomatoes; Onion; Garlic; Cabbage; Pepper; Watermelons; Melons; Other vegetables; yearly Green Fodder; perennial green fodder (alfalfa-trefoil). All of them are expressed in thousands tones/year (ASE –represents - agricultural sector emissions).

In order to identify the interdependences between the activities, Weka programme will be applied – software dedicated to analyze the type of data mining for data. This can be found at [w-WEKA11] and consists of a platform which has used more algorithms while maintaining an intuitive interface.

The analysis has two stages:

1. Identifying the most important activities and grouping the years accordingly (the components of a group (years) will have similar data).
2. Identifying a set of existing rules within the data.

a) Identifying the most important activities and grouping the years accordingly (the components of a group (years) will have similar data).

The algorithm used to identify the most important attributions is Infi Gain, which gives a score to each attribute which has a class role. This one, together with the Ranker method (method that gives a score to each attribute relying on individual assessment) offers a list of attributions in the order of the given scores. The results are (Figure 6.13) (the higher the value, the bigger the information inflow within the analysis for a specific attribute):

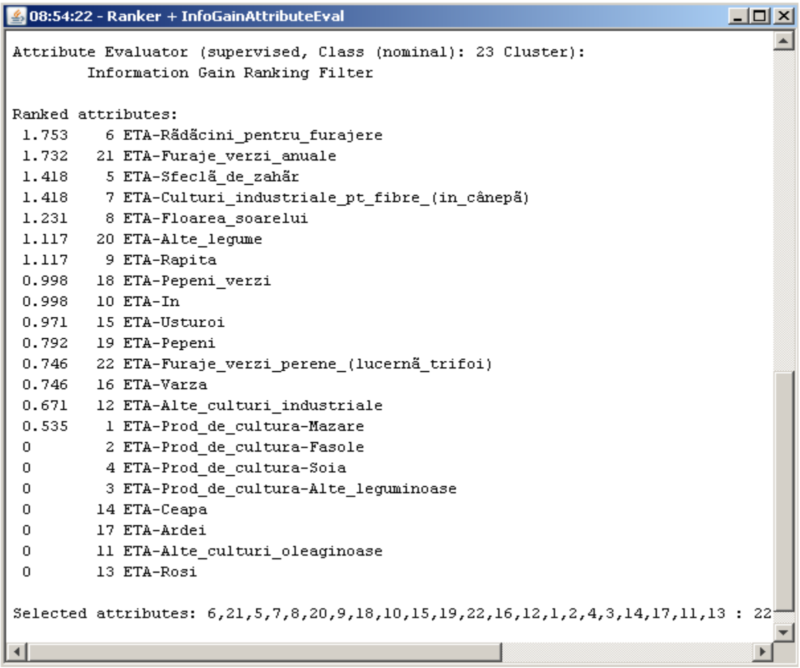

Figure no. 1. Given scores to the agricultural activities

Table:

Ranked attributes:
6 ASE - Fodder_Roots
21 ASE – Yearly_Green_Fodder
5 ASE – Sugar_Beet
7 ASE – Industrial_cultures_ for_ fibres_(linen_hemp)
8 ASE – Sun_flower
20 ASE – Other_leguminous_ plants
9 ASE – Rape
18 ASE – Watermelons
10 ASE – Linen
15 ASE – Garlic
19 ASE – Melons
22 ASE – Perennial_green_fodder (alfalfa_trefoil)
16 ASE – Cabbage
12 ASE – Other_industrial_cultures
1 ASE – culture_production_Peas
2 ASE – culture_production_Beens
4 ASE – culture_production_Soya
3 ASE – culture_production_Other_leguminous_plants
14 ASE – Onion
17 ASE – Pepper
11 ASE – Oher_oleaginous_plants
13 ASE – Tomatoes

The years in which the activities took place can be grouped in four categories, each of them with certain characteristics regarding the values of the most representative instances. The algorithm used to identify the categories is k-Means. The principal of the algorithm is the following [W-MEAN08]:

- it is initiated the centers (centroids) $z_1,...z_k \in R^d$ and the cluster number C_1, ... C_k;

- it is calculated the distance from the centroids to all the instances from the data set;
- an instance is allocated to a cluster C_i if the distance from it up to the centroid z_i is smaller than those to the other centroids;
- the algorithm is closed when, from one period to another, the instances do not change the cluster to which they were allocated.

The results are presented within the Table no.2.

Table no. 2. Results after applying the algorithm

Attribute denomination	**Cluster 0**	**Cluster 1**	**Cluster 2**	**Cluster 3**
An	**2007**	**1989**	**1991**	**2003**
ASE-Cultivated_production-Peas	17.7	98	49	23.5
ASE-Cultivated_production-Beens	18	143	57	36.7
ASE-Cultivated_production-Oher_leguminous_plants	0.5	13	5	0.4
ASE- Cultivated_production -Soya	136.1	303	141	224.9
ASE-Sugar_beet	748.8	6771	3277	764.5
ASE-Roots_for_fodders	595	4094	2575	985.6
ASE-Industrial_cultures _for_fibres_(linen_hemp)	0.6	241	125	3.9
ASE-Sun_flower	546.9	655	556	1506.4
ASE-Rape	361.5	18	10	8.1
ASE-Linen	0.4	48	28	1.5
ASE-Other_oleaginous_plants_cultures	1.7	7	3	19.5
ASE-Other_industrial _cultures	9.6	90	42	20.4
ASE-Tomatoes	640.8	1011	813	818.9
ASE-Onions	325	412	225	350.4
ASE-Garlic	49.9	46	30	76.5
ASE-Cabbage	893.2	877	551	1019.2
ASE-Peppers	184.9	253	182	249.1
ASE-Watermelons	408	0	0	706.3
ASE-Melons	0	0	0	58.3
ASE-Other_vegetables	615	1594	1247	1405.8
ASE- Yearly_green_ fodders	2222.5	15801	14403	4725.3
ASE-Perennial_green_fodders_(alfafa_trefoil)	7330.2	18057	12963	12613.9

Source: processing data of WEKA programme

On the basis of the table above, it can be seen that the years can be separated into four categories within the analyzed period. Most emissions are generated as a result of perennial green fodders. All the activities within this cluster have high values of CO_2 emissions and 1989 is the most representative year. At the other end, there is cluster 0 which has the lowest values beside the gas emissions, the representative year being 2007. The distribution of the instances in the cluster is the following:

Clustered Instances

0 5 (24%)

1 1 (5%)

2 9 (43%)

3 6 (29%)

b) Identifying a set of existing rules within the data.

In order to obtain a set of rules, algorithm Part is used, which works based on the 'divide and rule' principle, and builds a decision rule on the basis of each leaf (from a decision tree). By running the algorithm, the following rules were obtained:
PART decision list

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1) ASE-Melons <= 41.9 AND
ASE-Watermelons <= 2 AND
Year > 1991: cluster0 (7.0)
2) ASE-Melons <= 41.9 AND
ASE-Culture_production-Other_leguminous_plants <= 0.9: cluster3 (6.0)
3) ASE-Watermelons> 0: cluster2 (5.0)
Number of Rules: 3

Commentary: first rule: If the gas emission resulted from the melon activity is smaller or equal to 41.9 and the gas emission as a result of the watermelon activity is smaller or equal to 2 in any year after 1991, then, the instance (year) is allocated to cluster 0, the one with the lowest values regarding the CO_2 gas emissions. Seven instances follow this rule.
*Commentary: second rule***:** If the gas emissions resulted from the melon activity is smaller or equal to 41.9 and the gas emission resulted from leguminous plants activity is smaller or equal to 0.9, the instance is distributed to cluster 3. There are 6 instances that follow this rule.

CONCLUSIONS AND PROPOSALS

Current environmental risks generated by the degradation of the quality of the environmental factors led, in time, to the necessity to integrate the objectives of the environmental policy within the sectoral policies; as the relation between agriculture and environment is interdependent, assuring the compatibility between the agricultural and the environmental policies is one of the main concern at the international level in the present.
Romania's adherence to European Union has brought new challenges for agriculture, such as managing compatibility differences with regard to the EU. The objectives related to environment tend to become difficult to meet. Even if the financial support systems created within the agricultural policy in order to assure the increase of profitability impose environmental conditions and objectives, most of the time these are not efficient, due to informing gaps, a decreased level of interest for environment protection, or as a result of the administrative barriers, problems already met in the case of the other member states. For example, even if there is pressure to include more requirements regarding the environment protection within the agricultural policy applied by the international organisms and civil societies, eco-conditioning is regarded as a more laborious measure from the administrative point of view. Some member states ask for simplification of the process and specific management requirements. More than that, at the EU level, studies referring to implementation of the agro-ecologic systems suggests that the effectiveness of these could be improved.
Data mining analysis of interdependences of the activities which lead to the increase of the emissions constitute a new approach to the necessary forcasts and scenarios regarding the climate change, consiting also support for the policymaker factors. The development of ulterior research in the field could included the influence of the policy measures on the changes occured in the emissions evolution.
Within the analyzed period (1989-2007), it is seen that GHG emissions from agriculture (from the main analyzed food groups) decreased considerably (with circa 70%). For the future period, innovative technologies which can maintain the decreasing trend of GHG emissions from the agricultural activities should be introduced. Awareness-raising actions for farmers

regarding the potentials risks generated by the GHG emissions for the environment are also necessary.

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