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DIMINUTION IN ENVIRONMENT POLLUTION BY REVALUATING WASTES AND CROP RESIDUES

Ch. POPESCU[1], D. BUCUR[*2], Livija MAKSIMOVIC[3]
[1]*Gh. Asachi Technical University of Iaşi*
[2]*University of Agricultural Sciences and Veterinary Medicine of Iaşi*
[3]*Institute of Field and Vegetable Crops, Novi Sad, Serbia*

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ABSTRACT - *The paper assesses the amount of by-products from crops obtained every year in Romania (about 20,637,000 t), pointing out the opportunity of a more economic revaluation of these produces and of pollution diminution. Cereals straw (about 5 million t each year) could be used as raw material in the industry of celluloses. Straw residues, maize stalks, marc, domestic wastes, etc. could be changed into compost, which is used as crop fertilizer. Sunflower heads (774,000 t each year) and husks (227,000 t each year) represent a source for producing food vegetable jelly and furfural. Grain legumes stalks (130,000 t), together with 218,000 t leaves and necks, resulted from sugar beet processing, could be used for animal feeding. Oil is extracted from apricot, sweet cherry, peach, plum, and grape stones (about 87,000 t each year), as well as from tomato seeds.*

Key Words: crop wastes, crop residues, revaluation, environment protection

REZUMAT - Diminuarea poluării mediului prin valorificarea unor deşeuri şi reziduuri agricole*. In lucrare se estimează cantitatea de produse secundare ale recoltelor obținute anual în România (circa 20.637.000 tone), evidențiind posibilitățile de valorificare mai economică a acestor produse şi reducerea poluării. Paiele cerealelor (circa 5 mil. t anual) se pot folosi ca materie primă în industria celulozei. Resturile de paie, tulpinile de porumb, tescovina, reziduurile menajere etc. se pot transforma în compost, îngrăşământ pentru diferite culturi. Capitulele (774.000 t anual) şi cojile de floarea-soarelui (227.000 t anual) pot fi sursă pentru producerea pectinei alimentare şi a furfurolului. Vrejii de la leguminoasele boabe (130.000 t), împreună cu cca 218.000 t frunze şi colete, rezultate la prelucrarea sfeclei de zahăr, pot fi folosiți în hrana animalelor. Din sâmburii de caise, cireşe, piersici, prune (cca 87.000 t anual) , ca şi din semințele de tomate şi struguri se poate extrage ulei.*

Cuvinte cheie: deşeuri agricole, residuuri agricole, valorificare, protecția mediului

[*] E-mail: dbucur@univagro-iasi.ro

In the process of farming, great amounts of by-products are obtained, used as animal food, raw materials for industry, fertilizers, and fuel. Great parts of them form wastes, contributing to environment pollution.

At the world level, there are different ecologist groups concerned for the revaluation of by- products and diminution in wastes. For beer making, only 8% is extracted from the nutritive substances of barley grains; palm tree oil weighs only 4% of the biomass; coffee grains represent only 3.7% of bushes. One of these ecologist groups, ZERI (Zero Emissions Research and Initiatives), founded in USA, at the beginning of 1990, has in charge the ecologist groups of the units, so that the wastes from one unit could serve as raw material for another, as in case of ecosystems from nature (Capra, 2004). The activity of the ZERI organization has extended to USA, Japan, China, and other countries of the world, being supported by 3000 scientists.

The present paper estimates the amount of by-products from crops obtained each year in Romania, in order to point out the opportunity of revaluating these products more economically, and of diminishing the pollution process. The amount of by-products obtained every year in Romania from different crops, during 2001-2003, as well as the average value on the three years was assessed by using data from the Statistical Yearbook and coefficients of changing by-product production, which were established by Zaharia (1983) and Radu (1985). Recommendations on the economic revaluation of different by-products were established according to authors' own investigations and data from specialty literature.

At crop harvesting (wheat, rhy, barley, and oats), five t of straw is obtained every year, and from maize, 9.8 million t of stalks and leaves, and 2.4 million t of cobs are obtained (*Table 1*). These products are used in households as animal food, fuel, etc. A higher part of these products should form the raw matter in celluloses enterprises, for diminishing the utilization of wood necessary for other fields. Husk, the by-product resulted from cereals threshing, legumes stalks (138,000 t each year) (*Table 2*), sugar beet leaves and necks (218,000 t each year), cabbage leaves (156,000 t each year) (*Tables 1 and 2*), and other by-products contain great amounts of nutritive substances for animal feeding (*Table 3*). High amounts of bran and grist rich in proteins, valuable as fodder, are obtained when grinding wheat and rhy grains or extracting oil from soybean seeds (*Table 3*).

Table 1

By-products obtained from field crops in Romania (thousands t, 2001 - 2003)

Crop	Year			Average 2001 - 2003
	2001	2002	2003	
Wheat, rhy (straw)	5590	3464	1947	3667.0
Barley, two-row barley (straw)	1375	1010	470	951.7
Oats (straw)	422	344	339	368.3
Rice (straw)	1	0.4	0.2	0.5
Maize (stalk)	9922	9139	10420	9827.0
Maize (cob)	2426	2234	2548	2402.7
Grain peas (stalk)	14	15	17	15.3
Grain beans (stalk)	25	25	27	25.7
Soybean (stalk)	47	98	146	97.0
Sunflower (heads)	626	680	1015	773.7
Sunflower (stems)	793	917	1377	1029.0
Sunflower (husks)	233	283	426	314.0
Oilseed flax (stems)	3	3	2	2.7
Grain sorghum (stems)	7	3	6	5.3
Sugar beet (leaves, neck)	221	241	193	218.3

Table 2

By-products obtained from vegetables and fruits in Romania (thousands t, 2001 - 2003)

Crop	Year			Average 2001-2003
	2001	2002	2003	
Apricots	2.9	1.9	7.3	3.0
Strawberries	0.8	0.7	0.6	0.7
Sweet cherries Sour cherries	9.3	6.8	10.0	8.7
Apples	46.2	44.7	73.8	54.9
Pears	10.2	9.7	14.7	11.5
Nuts	17.4	19.2	26.0	20.9
Peaches	2.1	1.7	2.3	2.0
Plums	69.7	27.6	113.7	70.3
Grapes	159.3	152.9	153.1	155.1
Sweet pepper	33.8	36.1	45.6	38.5
Water melon Yellow melon	281.9	333.5	391.5	335.6
Tomato	56.7	57.3	71.2	61.7
Onion	37.3	32.0	32.9	34.1
Garlic	8.8	7.7	8.1	8.2
Cabbage	144.2	144.6	179.4	156.1
Roots	97.8	98.3	107.8	101.3

Table 3

Main chemical components of some vegetable produces for animal food (Popescu, 1996)

Produce	Percentage of fresh produce				
	glucide	celluloses	protein	lipide	ashes
Bran	50.7	8.9	14.9	4.0	6.0
Barley straw	31.9	38.6	2.9	1.4	4.4
Oats straw	35.9	38.7	3.8	1.6	4.4
Rhy straw	33.2	44.0	3.1	1.3	7.5
Millet straw	36.4	3.5	4.8	2.3	-
Buckweat stems	35.1	43.2	5.2	1.3	5.5
Maize green mass	9.1	4.4	2.4	0.2	1.3
Sorghum green mass	17.6	7.2	1.9	0.5	2.9
Horse bean stalks	31.8	33.6	9.9	1.5	5.8
Bean stalks	31.0	36.0	8.1	1.1	-
Lentil stalks	34.5	32.1	8.7	2.3	-
Peas stalks	36.5	38.2	7.0	1.2	6.5
Soybean stalks	36.2	26.0	11.3	2.7	12.7
Soybean grists	33.0	8.4	41.5	1.2	7.0
Rape green mass	5.7	2.5	2.8	0.8	1.3
Potato stalks	10.2	6.2	2.5	1.0	3.9
Sugar beet leaves and neck	7.4	1.6	2.3	0.4	4.8
Topinambour stems	9.8	3.5	2.6	0.5	2.4

The vegetal produces, which remain from animal feeding, may be used as fertilizers for different crops. These vegetal wastes, applied together with chemical fertilizers on irrigated crops from Fundulea, Ilfov County, has doubled wheat, potato, and sugar beet yield (*Table 4*). Wheat and maize, grown on different soil types, fertilized with the compost obtained from straws, maize stalks or sunflower stems, had a higher content of nitrogen and other chemical elements. When processing flax and hemp stems, for separating textile fibres, parts of stems and fibres remain, which are used as fertilizing agents (after composting) together with chemical fertilizers, and enrich the protein production in wheat and maize, and oil and sugar production in sunflower, respectively, sugar beet (*Table 5*). After grape processing and wine making, 155,000 t of residues remain every year, and can be changed into compost (*Table 2*). It proved to be a good fertilizer as manure for vine plantations (*Table 6*).

Households, restaurants, etc. produce great amounts of domestic residues made of fruits and vegetable seeds, peduncles, and husks. Each year, 80,653 t residues are obtained from tomato processing, 38,509 t from peppers, 335,546 t from water and yellow melons, 101,282 t from root plants, 95,000 t from apples, etc. (*Table 2*). Some of these produces may serve as raw matter for oil extraction, because seeds from stones contain 51% oil in apricots, 46% in peaches, and 37%

in plums. Tomato seeds contain 20-37% oil, pepper seeds have 25-30% oil, and grape stones contain 12% oil (Popescu, 1996).

From domestic wastes without any other utilization, compost (having many nutritive elements for plants) can be obtained (*Table 7*). This compost, used as fertilizer in France, has increased yield in potatoes by 3.7-4.3 t/ha, in sugar beet by 5.1 t/ha, and in chicory by 6.5 t/ha (Flon, 1972).

The investigations conducted in vegetation pots at the University of Agricultural Sciences from Bucharest, showed that the compost obtained from domestic wastes has increased oats yield by 12-57%, and tomato yield by 30-35% (Vîjială et al., 1992).

Table 4

Influence of organic residue (straw, cobs, and stalks) and chemical fertilization on yield in irrigated crops at Fundulea, Ilfov County (1972 - 1977) (Sipoş et al.,1978)

Fertilization		Wheat		Barley		Maize		Sugar beet	
organic	chemical	q/ha	%	q/ha	%	q/ha	%	q/ha	%
0	0	27.2	100	42.7	100	65.2	100	367	100
Crop residues	0	35.6	131	43.6	102	76.0	117	577	157
	N	45.7	168	58.6	137	90.9	139	495	135
	NP	54.8	201	56.2	132	99.5	153	729	199
	NPK	55.8	205	62.0	145	105.4	162	742	202
-	-	Potato		Sunflower		Soybean		Clover	
0	0	234.0	100	29.3	100	30.0	100	618	100
Crop residues	0	289.0	124	27.4	94	30.6	101	704	114
	N	419.0	179	31.4	107	29.2	96	614	101
	NP	482.0	206	32.6	111	28.9	95	805	130
	NPK	484.0	207	32.6	111	29.3	97	677	110

Table 5

Influence of hemp chaff on components from wheat, maize, sunflower and sugar beet crops (Popescu, 1965[1])

Rate (t/ha)	Protein from wheat grains		Protein from maize grains		Oil from sunflower seeds		Sugar from beet roots	
	kg/ha	%	kg/ha	%	q/ha	%	q/ha	%
-	450.1	100.0	396.1	100.0	9.8	100.0	45.3	100.0
5	518.5	115.2	428.2	108.1	10.4	106.2	48.1	106.2
10	517.4	114.9	443.8	112.0	10.8	110.5	51.7	114.1
20	512.7	113.9	438.7	110.7	10.9	111.3	51.7	114.1
Average	516.2	114.7	436.9	110.3	10.7	109.2	50.5	111.1

[1]**Popescu Ionela, 1965** – *Investigation on the content in fertilizing elements of some industrial wastes and their behaviour as fertilizers.* PhD Thesis, Polytechnic Institute of Iaşi

Table 6

Influence of marc on grape yield and quality in Muscat Ottonel variety at Valea Călugărească (Cătănescu et al., 1987)

Fertilizer	Rate (t/ha)	Grapes harvest (t/ha)	Quality	
			Sugar (g/l)	Acidity (g/l)
Unfertilized	-	7.66	153.6	3.59
Manure	20	9.06	138.8	3.53
	40	9.81	143.7	3.64
	60	10.21	196.3	3.74
Marc	20	10.03	145.7	3.27
	40	10.78	146.3	3.50
	60	10.63	146.3	3.54

Each year, from sunflower, 1 million t of stems and 774,000 t of heads are obtained as by-products, which are used as fuel. From sunflower heads, food vegetable jelly is extracted, and from fruit skins, furfural can be obtained.

Table 7

Average composition of compost samples from domestic wastes (Flon, 1981)

Name	Average composition (%)	
	at composting	after composting
Water	34.01	28.16
pH	7.50	7.65
Dry matter		
- organic matter	39.38	26.50
- carbon	17.22	4.40
- nitrogen	0.77	0.45
- carbon / nitrogen	18.78	9.47
Main elements		
- phosphoric acid (P_2O_5)	0.65	0.35
- potassium (K_2O)	0.38	0.44
- sodium (Na_2O)	0.49	-
- chalk (CaO)	6.26	8.60
- magnesium (MgO)	0.64	0.62
- iron (Fe)	2.14	1.09
- sulphur (S)	0.65	0.70
- chloride	0.46	-
Oligoelements		
- manganese (Mn)	0.0453	0.0690
-copper (Cu)	0.0270	0.930
-zinc (Zn)	0.0804	0.1520
-boron (Bo)	0.0018	0.0018

Ashes resulted from burning straw, cobs, sunflower stems and other vegetal produces used as fuel, can be used as fertilizer. Ashes obtained from burning sunflower and buckwheat stems contain until 46.0% K_2O, being a valuable

potassium fertilizer (Table 8). Ashes from coniferous wood and potato stalks are rich in calcium and good as amendments on acid soils. Ashes from sunflower pericarp have a high zinc, boron, and copper content, and ashes obtained when burning flax and hemp stems are rich in manganese, copper and zinc, and can be used as fertilizers with microelements (Table 9).

Table 8

Chemical composition of ashes in different plants (Davidescu et al., 1981)

Origin	K_2O	P_2O_5	CaO	Na_2O	MgO	F_2O_3	SiO_2
Coniferae	6.0 - 6.9	2.5	35.0	-	-	-	-
Leaf-bearing trees	10.0	3.5	30.0	-	-	-	-
Wheat straw	9.4 - 17.8	3.4 - 8.8	5.8	1.4	2.5	0.6	67.4
Rhy straw	9.7 - 22.0	3.3 - 6.3	8.5	-	-	-	-
Potato stalks	21.4	7.8	32.6	-	-	-	-
Maize stems	27.2	9.1	5.7	0.8	11.4	0.8	40.2
Clover hay	27.0	10.7	29.3	0.8	8.3	4.6	6.2
Sunflower stems	26 - 36	2.5	18.5	-	-	-	-
Flax stems	34.0	6.2	24.8	4.4	15.0	3.7	6.7
Buckwheat stems	35.0 - 46.6	11.2	18.4	2.2	3.6	-	5.5

Table 9

Chemical composition of ashes (Popescu et al., 1968, 1971)

Components	Ashes	
	flax and hemp stems	sunflower pericarp
P_2O_5 (%)	3.76	-
K_2O (%)	2.76	-
CaO (%)	31.81	23.60
MgO (%)	2.65	-
S (%)	14.47	-
Mn (ppm)	608.39	traces
Cu (ppm)	454.26	179.15
Zn (ppm)	390.38	305.38
Mo (ppm)	7.85	7.10
Co (ppm)	14.30	14.63
B (ppm)	93.75	191.49

CONCLUSIONS

On the average, 20,637,000 t of by-products, wastes and residues result every year, in Romania, from crop processing. All these produces can be economically revaluated.

Stalks obtained from grain legumes (138,000 t), together with 218,000 t of leaves and necks resulted from sugar beet processing can be used for animal breeding.

Five million t/year of cereals straw and other produces can be used as raw material in celluloses industry.

Oil can be extracted from apricot, sweet cherry, peach, plum and grape stones (about 87,000 t each year) and from tomato seeds.

Sunflower heads and husks (774,000 t, respectively, 227,000 t) represent the source for producing vegetable jelly and furfural.

Straw residues, maize stems, marc, domestic wastes, etc. can be changed into compost, which is a valuable fertilizer for different crops.

Ashes resulted from the use of crop residues as fuel contain potassium, calcium or microelements. They are used as fertilizers or amendments.

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