Influence of technical tools on the ecology of agricultural engineering sphere

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Abstract. Greening the agro-industrial complex became a problem in the last two decades of the 20th century, although some problems in this relatively new direction were raised in the 60s of the 20th century. In this article, the problem of the influence of technical means on the ecology of the agricultural engineering sphere is considered from the point of view of the impact on the human body of substances generated as a result of the technical work of the agro-industrial complex. The problem of greening the agro-industrial complex in modern conditions is of great importance in connection with the observed intensification of the development of agricultural production, which has a direct negative impact on the environment, which is the key to the health of people involved in the labor process. When studying human-machine systems in crop production, the place of ecology in the "external environment" block is determined. The dependences of the conceptual model of transformation of ecosystems under the influence of pollution are presented, which allows us to determine the vector of research in this direction.

1 Introduction

Greening the agro-engineering sector of the agro-industrial complex is a problem of the last two decades of the 20th century. It was formed when agricultural production was quickly replenished with heavy and heavy-duty equipment, a system of technical service in the field was developing on a broad front, and electrophysical methods began to be introduced into the processing of agricultural products [1].

The ecological balance of agricultural production, which has not yet been achieved in the agro-industrial complex, puts forward certain rather stringent requirements for the agricultural engineering field, within which the external environment is considered when studying human-machine systems. Greening the agricultural engineering sector is one of the main blocks of the "External Environment" system, in which the human operator is presented as the main link in the labor process from the point of view of safety, Figure 1 [2,3].

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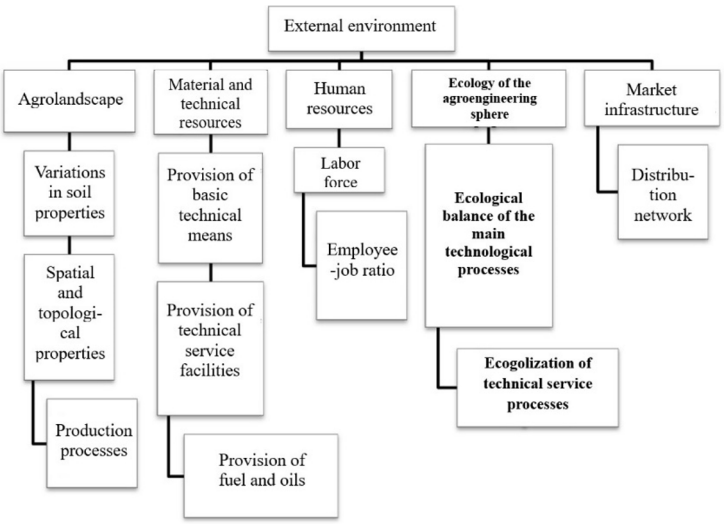

Fig. 1. The structure of the external environment model in the field of agroengineering in relation to mechanized crop production processes.

2 Research methodology

As indicated in the books of Academician V.I. Kiryukhin "Greenization of agriculture and technological policy" "Greenization means not only and not so much the implementation of environmental restoration measures, but the bringing of production processes in accordance with various landscape conditions and the laws of ecology in general, and therefore, eliminating the causes of certain violations, and not the consequences".

If we specify some parameters of the harmful technological impact of the agricultural engineering sphere in relation to the "External Environment" system, it becomes clear that under the influence of pollution the ecosystem undergoes a certain negative transformation. Figure 2 presents conceptual models of possible technogenic transformation of the ecosystem: linear and non-linear [4].

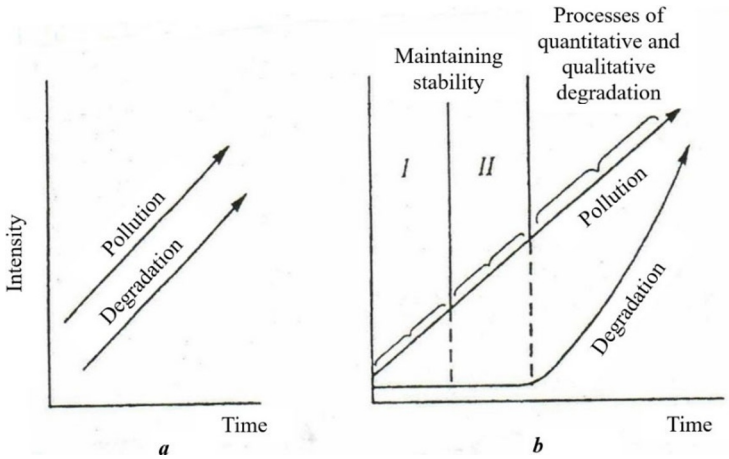

Fig. 2. Conceptual models of transformation of ecosystems under the influence of pollution: a – simple model; b – realistic model; I – constancy of ecosystem processes; II – increasing the intensity of adaptation processes.

Tractors and agricultural machines used in agriculture are environmentally hazardous technical means at all stages of the life cycle, Figure 3 [5].

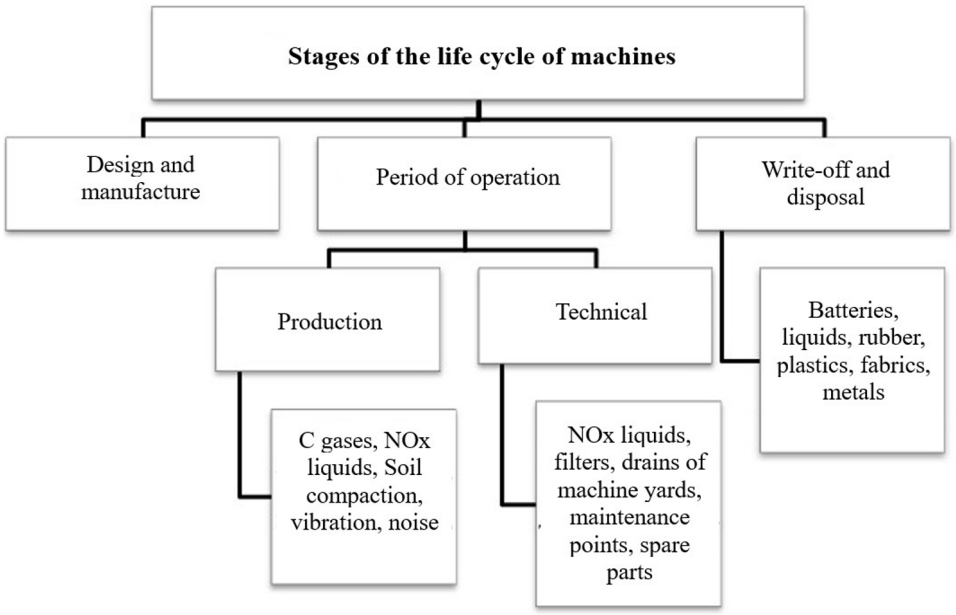

Fig. 3. Scheme of interaction of machines with the environment.

The negative impacts of the propulsion systems of machinery running systems on the soil, emissions of toxic exhaust gases into the atmosphere, and the discharge of wastewater from machine yards and enterprise repair facilities into nearby water bodies significantly affect the ecological balance and human health.

The maximum permissible concentration for emissions of toxic gases into the atmosphere is established by state and industry standards GOST 17.2.205-97 "Nature conservation. Atmosphere. Standards and methods of measurement" and OST 10.0061-97". Diesels, tractors and self-propelled agricultural vehicles. cars. Emissions of harmful substances from exhaust gases. Control procedure during technical operation [5, 6].

A qualitative assessment of the harmful effects of internal combustion engine emissions on human health can be assessed using the data in Table 1. The impact of harmful emissions on human health is given in Table 2.

Table 1. State of human health depending on the level of air and soil pollution (multiplicity of MPC exceedance).

Expected health status	**Multiplicity of exceeding the maximum permissible concentration**	
	Air	**Soils**
No negative changes	1	1
Changes in health status according to some indicators	2-3	Up to 4
Pronounced functional changes	4-7	4-10
Increase in specific and nonspecific morbidity	8-10	20-120
Acute and chronic poisoning	100	120-200
Fatal poisoning	500	200-1000

Table 2. Impact on human health of some components of harmful emissions in the air.

Impact effect	Content of harmful impurities in the air, mg/m^3		
	CO	SO_2	NO_x
Several hours without noticeable impact	115	6	15
Signs of mild poisoning or irritation of mucous membranes after 2-3 hours	115-575	130	20
Poisoning after 30 minutes	2300-3500	210-400	100
Hazardous to life after short term exposure	5700	1600	150

Of significant interest in connection with the content of the above tables is the composition of the exhaust gases of internal combustion engines. Table 3 shows the composition of exhaust gases for internal combustion engines running on gasoline and diesel fuel [7].

Table 3. Composition of internal combustion engine exhaust gases.

Substances (formula)	Volume fraction, %	
	Engine type	
	Petrol	Diesel
O	0.05-8.0	2.0-18.0
CO_2	5.0-12.5	1.0-12.0
H_2O	3.0-13.0	0.5-10.0
N_2	74-77	76-78
NO_X	0.05-0.5	0.1-1.0
CO	0.1-10.0	0.01-0.5
$C_X H_Y$	0.2-2.0	0.01-0.5
Aldehydes	0-0.2	0-0.05
Soot, mg/m^3	>100	< 20000
SO_X , mg/m^3	0.003	0.015

Table 4 shows emissions of harmful substances into the aquatic environment during major repairs of technical equipment.

Table 4. Emissions of harmful substances into the aquatic environment during major repairs of technical equipment.

Substances	Emissions per 1 kg of vehicle weight, g				
	Technological operations				
	Washing and cleaning the surfaces of parts	Welding, cutting, surfacing	Galvanic and thermal treatment, mechanical processing	Assembly, painting	Total
Labomid	899.0	–	0.1	–	899.1
Soda Ash	450.0	–	3.04	–	453.34
Alkyl - sodium sulfate	8.9	–	–	–	8.9
Sintanol	54.2	–	–	–	54.2
Petroleum products	297.2	–	–	–	297.2

Suspend	461.5	–	0.26	34.42	496.18
NaOH	–	–	14.86	0.91	15.77
CrO_3	–	–	26.75	17.2	43.95
$FeCl_3$	–	–	14.1	–	14.1
Trisodium phosphate	–	–	0.1	–	0.1

3 Research results and discussion

Thus, the greening block in the "External Environment" system can be represented as a diagram in Figure 4.

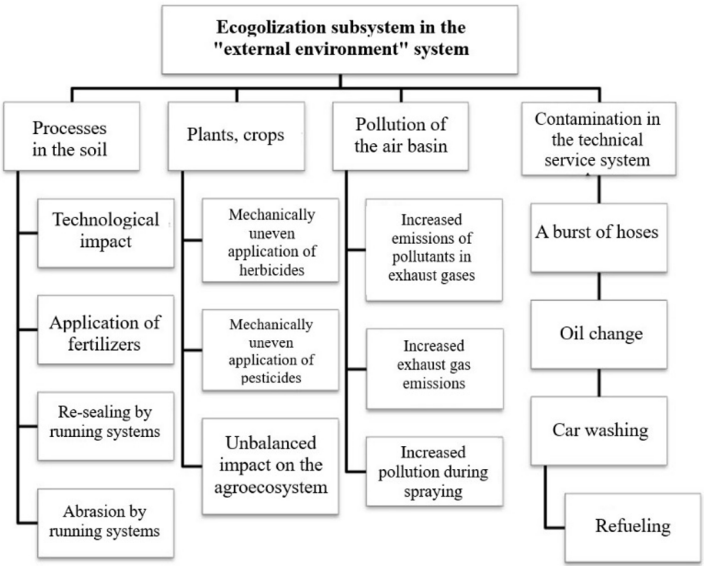

Fig. 4. Block diagram of the greening block in the "external environment" system.

The subsystem consists of several blocks [6, 8]:

- block of processes in soil;
- block of plants and crops;
- air pollution block;
- pollution block in the technical service system.

Significant factors in the adverse impact of machines on the natural environment remain their insufficient technical level and poor operating standards. When designing and manufacturing machines, it is necessary to use materials with a long service life, environmentally friendly and material-saving technologies [9].

According to GOSNITI, oil and fuel losses from the hydraulic systems of tractors and self-propelled agricultural machines alone amount to about 450-500 thousand tons per year throughout the country (on average up to 500 kg per tractor). Losses of fuel materials and their further release into the environment during the production operation of machines are associated with ruptures of hydraulic system hoses, fuel wires, depressurization of seals, losses during refueling, etc.

Research by VIITiN reveals the pattern of release of conservation materials into the environment, shown in Figure 5.

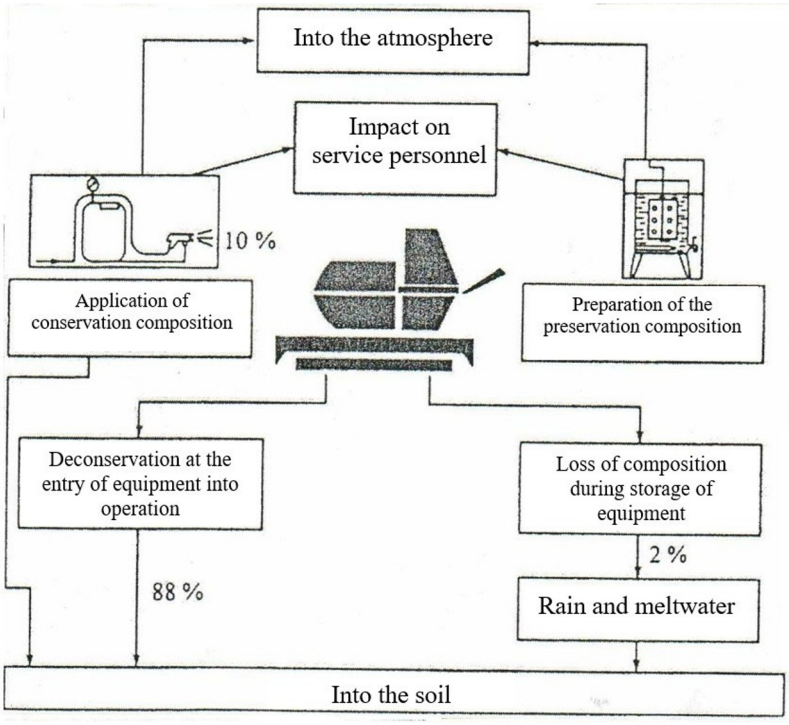

Fig. 5. The impact of anti-corrosion protection of machines on the environment.

In general, the impact of this type of pollutants on the atmosphere and lithosphere is minimal and does not lead to negative changes in the environment, but it has a rather negative impact on the health of personnel involved in the preservation of machines, and requires them to strictly adhere to personal hygiene measures and the use of personal protective equipment.

But the main type of harmful substances that have the most negative effect on human health are exhaust gases from internal combustion engines [7, 10].

Currently, it is possible to reduce the content of toxic substances in exhaust gases using the methods shown in the diagram in Figure 6.

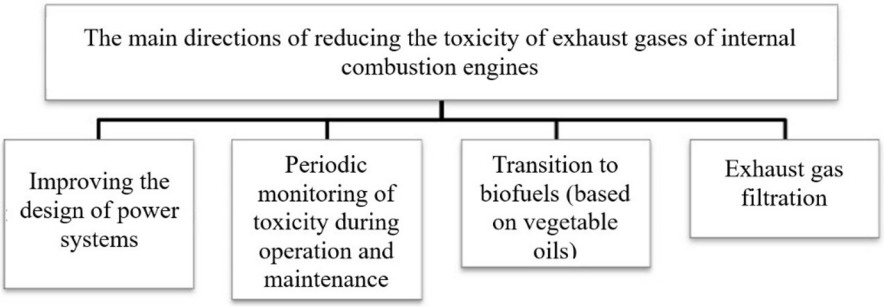

Fig. 6. Measures to reduce the toxicity of internal combustion engine exhaust gases.

In our opinion, "Periodic toxicity monitoring during operation and maintenance" is the most effective, and most importantly acceptable, in agricultural production conditions [11, 12].

The remaining methods will be implemented as a result of scientific research and at enterprises with greater technical and personnel capabilities.

4 Conclusion

Thus, it can be concluded that "Greenization of the agricultural engineering sector" is one of the main blocks of the "External Environment", which includes the entire range of operations in crop production, according to the structural diagram of the greening block in the "external environment" system, and serves as the basis for the development of measures to protect personnel from exposure to harmful substances arising from the interaction of technical means with the atmosphere and lithosphere.

In addition, it should be noted that this area of research, in our opinion, is very promising, since there are strict requirements for the air environment of industrial premises, water resources and soil.

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