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Formation of Equipment Disposal System in the Agro-Industrial Complex of Russia as a Part of a Unified Production and Consumption Wastes Handling System

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Abstract: Now a days, Russia is lagging behind other countries in solving the problem of production and consumption wastes disposal (here in after referred to as the wastes) in general and especially in the field of disposal of the machinery withdrawn from serviceas well. As a result, the country loses vast material resources due to improperly organized system of disposal of various wastes and a significant damage is casued to nature. One can judge the importance of this issue even from the fact that V.V. Putin, the president of Russia, voiced the need for creating a 'garbage' problem decision-making mechanism thrice this year (during Putin 2016 Q and A marathon on 04/14/2016, meeting of presidential council for strategic development and priority projects on 11/25/2016, state council meeting on 12/26/2016). So far, all the actions of the Russian government in this regard are mainly reduced to improvement of Solid Household Waste (SHW) disposal system. However, in addition to SHW, there are other types of wastes which are also material-intensive and hazardous when improperly placed. For the time being, the Unified Waste Handling System (UWHS) is only beginning to be created in Russia and this process is slowing down to a great extent due to inconsistencies in the regulatory and legislative framework and lack of a unified ideology of creating the system it self. A hypothesis for the necessity of structuring UWHS activities is put forward in the study. It is proposed to consider the system as a set of three interconnected and interdependent phases of activities for waste handling and develop each of these stages as a separate UWHS subsystem. At the same time, a major part in solving a waste disposal problem should be assigned to branch (specific) wastes disposal systems. The feasibility of creating such systems is proved by the example of Decommissioned Agricultural Machinery (DAM) disposal system. In this regard, all the methodological provisions of forming the decommissioned agricultural machinery disposal system (here in after referred to as the system) can be used for developingdisposal systems of other types of waste.

Key words: Disposal, waste handling system structuring, agricultural machinery, resource conservation, ecology

INTRODUCTION

"Approximately 100 billion tons of domestic and industrial wastes which occupy about four million hectares are accumulated in Russia by today" said Vladimir Putin at the meeting of Strategic Development Council on November 25, 2016 and set the task of creating decision-making mechanism for "garbage" problem.

If the importance of 'garbage' problems 'has grown' to the nationwide level, then the problem of decommissioned machinery disposal is faded into insignificancefor now.

Since, the uniform understanding of the term is not available yet we shall assume in this study that the machinery is the machines, equipment, appliances and other products that provide satisfaction ofthe society identified needs. In this business segment, Russia lags behind the leading countries that have established recycling industry for >20 years ago. In the USA, this industry which occupies the 16th place among the largest industry branches in the country where in up to 95% of used cars (14-15 million PCs.) are recycled at >7 thousands of disposal enterprises with the numbers employed of about 46,000 people. Revenues of these enterprises make up >25 billion US dollars per year (Mitrokhin and Pavlov, 2015). Branch annual turnover exceeded 5 billion US dollars as early as in 2004 (Vorontsov, 2006) according to the Arizona Association of Auto Recyclers. Other technically developed countries show much the same rates in this industry. Despite this

experience, the problem of equipment disposal in Russia is not among the priorities. Disposal fee which is spent strictly for creation of decommissioned machinery disposal system in other countries in Russia, even before its (fee) legal registration was being considered by the government as subsidiary earnings for the budget. A. Siluanov being the head of the ministry of finance at that time, explained to the representatives of the press that "the serevenues in the form of subsidies would be directed for supporting single-industry towns, civil industries and employment support. Neither equipment disposal system was being mentioned.

Nevertheless, Russian government declared the need for creation of decommissioned machinery disposal system as early as in 2009 (RFGR, 2000, 2009). The enforcement of disposal (environmental) fee for the wheeled and self-propelled machinery (NESR, 2014) via the law as well as the liability of machinery manufacturers for disposal of the machinery produced by them, established in the law (FLR, 1988) has not altered the situation over the past year.

At the moment, judging by the statements of the Russian president (RFGR, 2016) and experts in the field of natural resource management, "waste disposal industry with sufficient capacity for waste disposalis absent now" (emphasis added). It was noted by N.R. Sokolova, head of the state environmental oversight of the federal service for supervision of natural resource usage (Rosprirodnadzor) at the "New Ecological Strategy of Russia Forum on October 15, 2014" (RFGP, 2012a, b).

In Russia, there are no documents and standards defining the formation ideology, methodology and strategy, that would ensure the unified formation principles recommended by the state of not only decommissioned machinery disposal system but also the unified production and consumption wastes management system as a whole. All this refers to the fact that there is a problem with disposal of wastes including those from decommissioned machinery within the country and it needs to be resolvedin the near future.

This research is aimed at creating a mechanism for solving the problem ofdisposal of various wastes and substantiating top priority and feasibility of establishing the branch (specific) decommissioned machinery disposal systems, development and implementation of which will create conditions for formation of the management system for unified production and consumption wastes.

MATERIALS AND METHODS

Development of the problem: Handling of wastes during recent decades turned into a global problem which implies a threat to the whole mankind. And there are multiple researchs devoted to the solution of this problem. During the last 15-20 years in Russia, increased interest in wastes recycling is observed. The main part of the publications on this problem consists of the researchs on SHW handling. There should be noted the following scientists among those who paid attention to this problem: V.B Abramov, V.A. Arakelova, B.Ts. Bebchuk, O.S. Varlamova, A.S Gur'nev, A.A. Gusev, A.A. Golub, V.Ye. Lotosh, A.F. Mudretsov, N.V. Pakhomov, K.K. Richter, Ye.B. Strukova and other researchers. The attention of these scientists was focused in general on solution of technical and process and economic issues related to SHW recycling problem exceptionally.

The researchs on the DE recycling problem were actively conducted in Russia only in early 2000s. Wide range of legislative organizational and administrative, financial and economic issues of development problem of wheeled vehicle disposal system in the RF as well as proposals for their solution were considered in the researchs of Yu.V. Trofimenko, Yu.M. Vorontsov, K.Yu. Trofimenko, R.L. Petrov, R.L. D'yachenko, M.A. Vaslyaev, B.B. Bobovich and others. The main ("leading") organization conducting the researchs in this direction is Moscow Automobile and Road Construction State Technical University (MADI). NP NSRO RUSLOM.com and several other organization actively participated in solving different issues of the DE disposal problem.

In agroindustrial complex, the researches in this area have been conducted for 15 years. The main organizations engaged in agricultural machinery disposal are Russian State Agrarian University Moscow Timiryazev Agricultural Academy, Federal Research Agroengineering Centre All-Russian Research Institute of Agricultural Engineering etc. By the researchs of the employees of these and other organizations, a certain theoretical and practical base for development of a number of tasks related to DAM disposal. Many issues related to technology at the different stages of disposal were solved in the researchs of N.V. Aldoshin, V.K. Astanin, V.S. Gerasimov, I.G. Golubev, L.M. Dzhabrailov, A.N. Zhurilin, M.Yu. Konkin, V.V. Kuldoshina, N.A. Lylin, Ye.V. Pukhov, Ye.A. Puchin, S.A. Solov'ov, V.I. Chernoivanov and others. The significant contribution to popularization of the problem of wastes disposal and DE in particular was made by G.I. Tsukaryova and her "Wastes recycling" journal.

The peculiarity of almost all researchs, performed during this period is highly specialized orientation of researches of the branch machinery disposal problem, wheeled and agricultural ones in particular. At that, each kind of machinery was considered as an object for creation of "parallel" disposal system which is not interacting with others. The main objects of researches in those researchs were local issues of technology and organization of certain DE disposal.

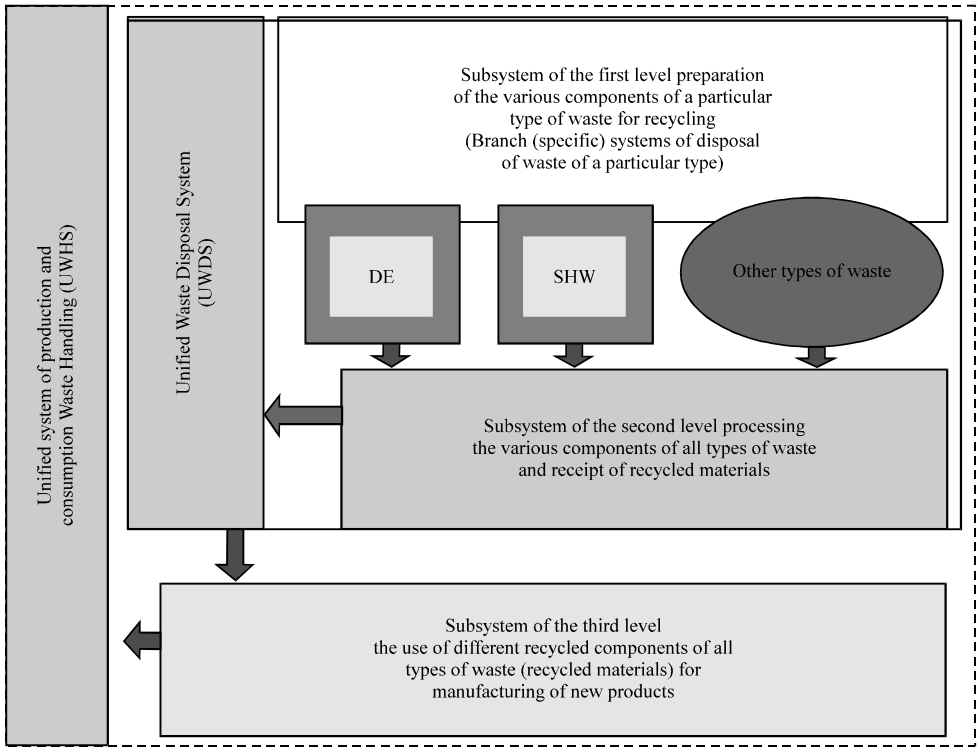

Fig. 1: Structure of unified waste handeling system

Some other orientation is observed in the researchs on disposal of agricultural machinery which were conducted at All-Russian Research Institute of Agricultural Engineering in recent years with direct involvement of this study researcher. These researchs are characterized by comprehensive approach to the problem of the system formation which is considered in general as the main component of the unified waste disposal system and are focused on solution of number of tasks related to improvement of DAM disposal organization and technology as well as on regulatory, legislative and economic support of this system.

The presented research is oriented to the development of mechanism for solution of various wastes disposal problem and to substantiation of top priority and feasibility establishing of branch (specific) decommissioned machinery disposal systems, development and implementation of which will create conditions for formation of the management system for unified production and consumption wastes in general.

Approaches to solving the problem: The DE disposal is a new research area in Russia which grown briskly only in early 2000s. Domestic and foreign practice states that each type of waste (solid household wastes, wastesof vehicles or aircrafts withdrawn from service, etc.) require their own specific technologies and organizing their scrappage processand thus creating specific systems of disposal of various wastes, including different types of decommissioned machinery disposal systems. In this case, the industry classification of various equipment can act as an identifying characteristic and such systems are proposed to be called asbranch (specific) decommissioned machinery disposal systems.

A hypothesis for the necessity of structuring the activity with regard to waste and considering UWHS as a set of three interconnected and interdependent phases of such activity is put forward in the study. In this case, each of these stages shall be considered as a separatesubsystem. An option of such a structuring is proposed in the study (Fig. 1).

One of the components of the fourth subsystem is “Integrated State information System for Calculation of Wastes from products usage” which creation is declared by article 24.3 of the RF Federal Law “On wastes”. The second important component of this subsystem is legislative support of activities on wastes handling. The third important component of the fourth subsystem is economic support of activities on wastes handling. There is a lot of attention paid to this issue in this research.

Branch (specific) disposal systems of various wastes, including those from decommissioned machinery are

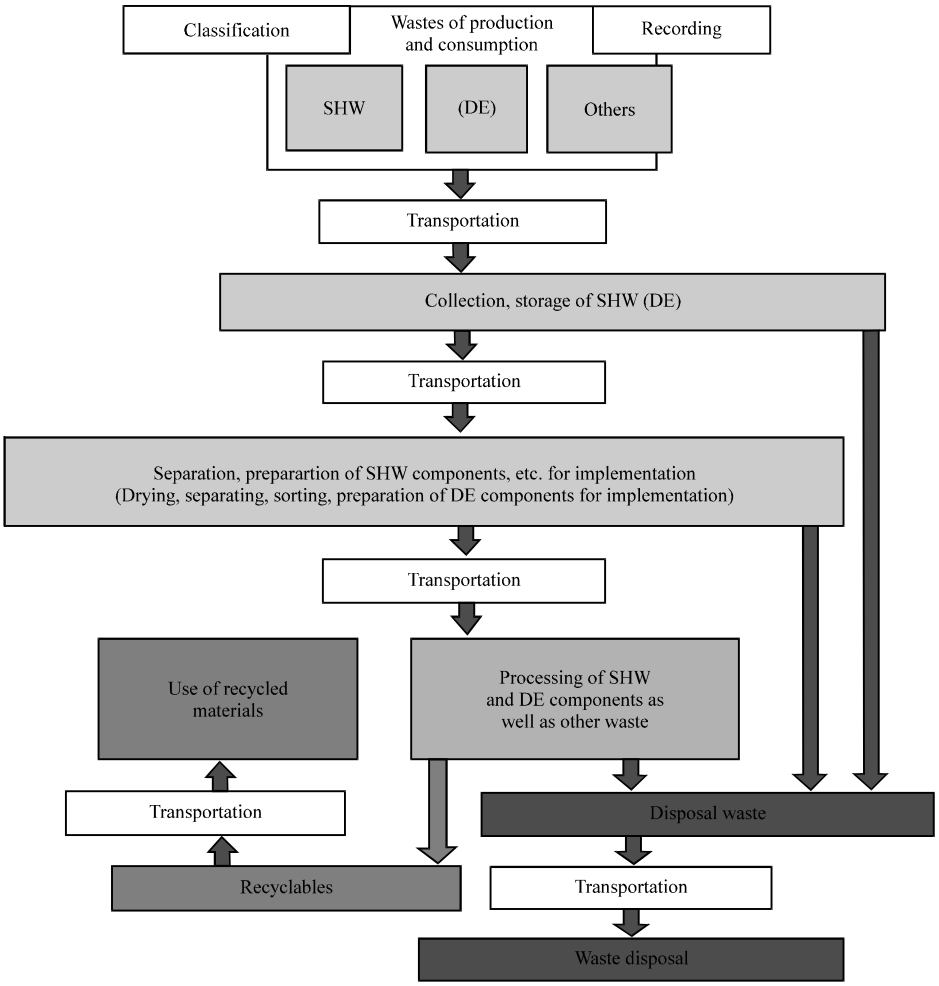

Fig. 2: Waste handeling general scheme

considered as a subsystem of the first level which enterprises perform preparation of waste components for recycling. Processing companies form the subsystem of the second level and fulfill processing of prepared components. Joint operation of these systems will ensure creation of the Unified Waste Disposal System (UWDS) in Russia, beingcapable of solving the problems of resource conservation and environment in accordance with international requirements.

We will consider the enterprises using secondary resources as feedstockas a subsystem of the third level. The interaction of allthe three subsystems will ensure creation of effective UWHS.

As it has been repeatedly noted in a series of studies (Solovyov *et al*., 2015; Ignatov, 2016), the general waste handling scheme can be represented as the one composed of six main stages (Fig. 2) waste collection; reversed waste collection and separation as well as preparation ofwaste components to be shipped for processing; transportation; processing of prepared waste components with a view to obtain secondary raw materials; use of secondary raw materials for production of new products; placement of unused waste.

The first two stages of waste handling (1 and 2) are the key ones and the most labor-intensive processes requiring sufficiently high qualification from doers. At the same time, at these stages, machine manufacturers can ensure compliance with the requirements established by law for the rates of equipment disposal as well as meeting the generally accepted requirements for resource conservation and environment.

Here the researcher again lays emphasis on the fact that all types of waste (including SHW, decommissioned machinery waste and others) require performance of specific researchs at the first two considered stages of disposal operations. The idea of UWHS structuring and

Fig. 3: Types of machinery requiring disposal

allocating branch (specific) disposal systems of equipment of various kinds into separate subsystems was suggested to the researcher by the waste handling policy being pursued by the Russian government in recent years.

Thus, SHWs are allocated into a separate type in the law and branch (specific) system of disposal of this wastes type is developed for handling with the mentioned above which needs to be improvedas shown above.

The regulatory legislative and economic basis for creation of other branch (specific) disposal systems engaged in disposal of a certain type of equipment used in a particular industry began to form in Russia at the beginning of the 21st century.

Works regarding disposal of aviation equipment were regulated as early as in 2000. The introduction of disposal fee for the wheeled vehicles gave an impulse to activate the researchs concerning formation of automotive equipment disposal system elements in 2012. Researchs regarding disposal of military equipment were regulated in the same year by the RF Government Regulation dated June 13, 2012 No. 581. In 2016, the disposal fee for self-propelled machinery was introduced which gave a handle and motivation for development of the disposal system of agricultural, road-building, municipal, forestry and other machines being among self-propelled equipment. However, apart from those mentioned above, there are other types of equipment (Fig. 3) which also become waste and require disposal after withdrawal from service.

The first level subsystem structure was developed by the researcher with a view to structure UWHS. The structure of the branch decommissioned machinery disposal system is shown in Fig. 4. Complexes of the enterprises performing the researchs of the first and second stages of decommissioned machinery disposal, technologies and equipment applied by the above mentioned enterprises as well as relationship between the participants of researchs which form the subsystems of the first level will be called by us as the branch (specific) systems of disposal of various wastes.

Branch (specific) system of decommissioned agricultural machinery and equipment disposal (here in after referred to as the System) will be consideredas an example hereinafter. Let's emphasize the fact that all the methodological provisions of formation of this system can be applied almost completely while creating branch systems of disposal of waste of different kinds.

The ultimate objective of the system is to prepare waste components for processing. It should be noted that equipment manufacturer (which is burdened with the responsibility for performance of disposal in accordance with the law has the possibility of exercising control over the technologies of disposal operations fulfillment and compliance with the requirements of resource conservation and environment. Equipment manufacturer can provide control over the observance of the wastes recycling targets established by Russian legislation at the enterprises of the first level subsystem. Besides, the equipment manufacturers can uniquely identify the need for financial assets required for performance of these types of disposal operations and recover the costs for performance of the above mentioned operations due to disposal fee.

The owners of the equipment, machinery manufacturers (dealers), contractors of recycling researchs and government agencies are the participants of this system. Each of the system's participants performs certain functions which list is described in the study (Ignatov, 2016). Branch (specific) systems of disposal of

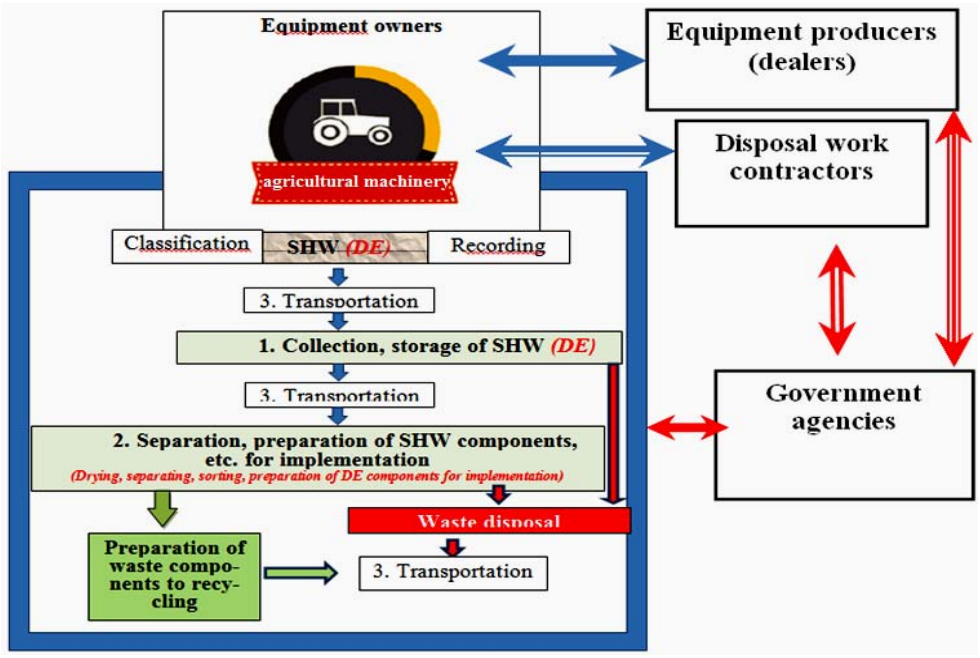

Fig. 4: Decommissioned agricultural equipment disposal system structure

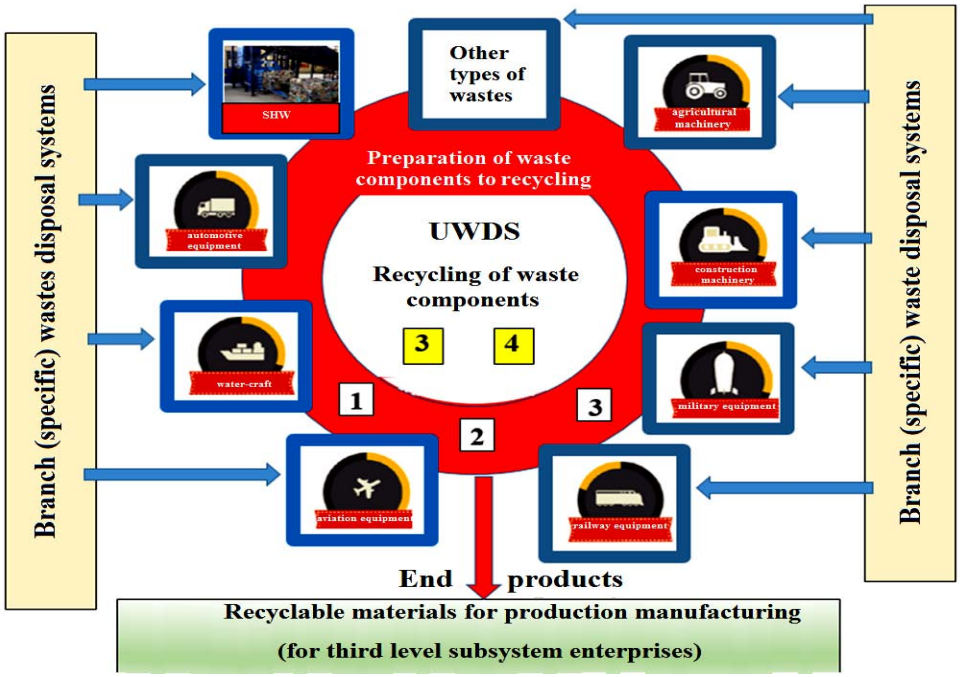

Fig. 5: Unified wastes disposal system structure

various wastes provide the feedstock (waste components prepared for recycling). The complex of these processing enterprises forms the second level subsystem. All branch (specific) systems of disposal of various wastes, interacting with the second level companies form UWDS (Fig. 5). UWDS enterprises provide processing the components of the entire types of waste and secondary raw materials for production of products or energy are the

end products of this system. So, for example metal from all types of decommissioned machinery SHW, etc., comes to shredder enterprises where it is processed and then sent to steel plants where different products are made of it.

At this stage of wastes handling, the equipment manufacturer has virtually no possibilities to influence on the technologies and organization of components processing because the components received by the second level subsystem enterprises isolated from the various wastes (including from various types of vehicles, SHW, equipment of other types) are depersonalized. Therefore, to determine the share of participation of specific manufacturer equipment (the share of the ith component typefrom the equipment produced by it in the total amount of the components of the same type being processed) at the second level subsystem enterprises does not seem possible. And, therefore the tasksregarding definition of the manufacturer equipment "contribution" in the total amount of recyclable components are virtually unsolvable.

The fifth stage of wastes handling (Fig. 2) is performed via the third level subsystem enterprises, using wastes processed components of various kinds as feedstock for manufacturing of new products. Manufacturing of new products is not associated with a certain kind of wastes of which raw material is prepared and it can not be regarded as a disposal stage. Elements of the 3rd and 6th stages (Fig. 2) are inherent in virtually all other stages and are most commonly performed by specialized transport enterprises.

The interaction of all three subsystems ensure the creation of an effective UWHS and solves the problem of production and consumption wastes management. But the industry disposal systems that provide preparation of the components of all types of wastes and supply UWDS with feedstock are the basic elements of UWHS.

If one ranks UWHS subsystems based on the level of fulfilling the legislative requirements on disposal of decommissioned equipment then the manufacturer's possibilities to influence on the quantitative and qualitative characteristics of these requirements at the first level disposal enterprises can be estimated within the limits of 90-97%. The remaining 3-10% are related to deficiencies in the field of machine adaptation for disposal or immaturity of disposal technologies. Equipment manufacturer is connected with the second and third level subsystem enterprises indirectly only as their activity does not require the participation of equipment manufacturer.

As far as the use of utilization of wastes for production of goods (products), performance of researchs, provision of services including the re-use of waste, comprising the reuse of wastes for the intended purpose (recycling), their return to the production cycle after appropriate treatment (regeneration) as well as extraction of valuable components for their repeated use (recovery) is meant by wastes disposal* according to the law and equipment manufacturer is burdened with the responsibility for disposal of decommissioned equipment waste then in accordance with this law, an equipment manufacturer must participate in all UWHS subsystems. But as it has been shown above, it is not in compliance with the capabilities of equipment manufacturer and is inconsistent with the world practice of wastes disposal, including wastes from decommissioned equipment.

A different interpretation of the term is suggested by the researcher. Wastes disposal** is an activity comprising preparation and further processing of the components being a part of the wastes to a condition that makes it possible to perform the reutilization of the products resultant of this activity. This interpretation was substantiated in a variety of publications and is used in this study.

While working on the problem of decommissioned equipment disposal, a number of significant inconsistencies in the regulatory and legislative framework concerning disposal of decommissioned equipment (Ignatov, 2016a) that prevent the creation of industry based equipment disposal systems in Russia was identified by the researcher. These inconsistencies were brought to the attention of law developers.

For the foregoing reasons and based on the new interpretation of the term (**), the researcher suggests (Ignatov, 2016b) to make amendments in the law concerning equipment manufacturer's responsibility for disposal of equipment and limit this liability to preparation of decommissioned equipment components for processing only as well as include disposal amongwarranty liabilities of equipment manufacturers.

Works associated with the development (Solovyov *et al*., 2015; Ignatov, 2015) were being performed in federal research agroengineering centre all-russian research institute of agricultural engineering in the field of operation, maintenance and repair of agricultural machinery, new power systems and nanotechnologies (GOSNITI) over the last few years. The methodology and the strategy of its creation were developed with the researcher's direct involvement.

The methodology determined the system of principles and methods of organization and construction of theoretical and practical activity of the system. It is expected that the system will use the infrastructure of Repair and Technical Enterprises (RTE) of Agro-Industrial Complex (AIC). Performance of disposal works of the first

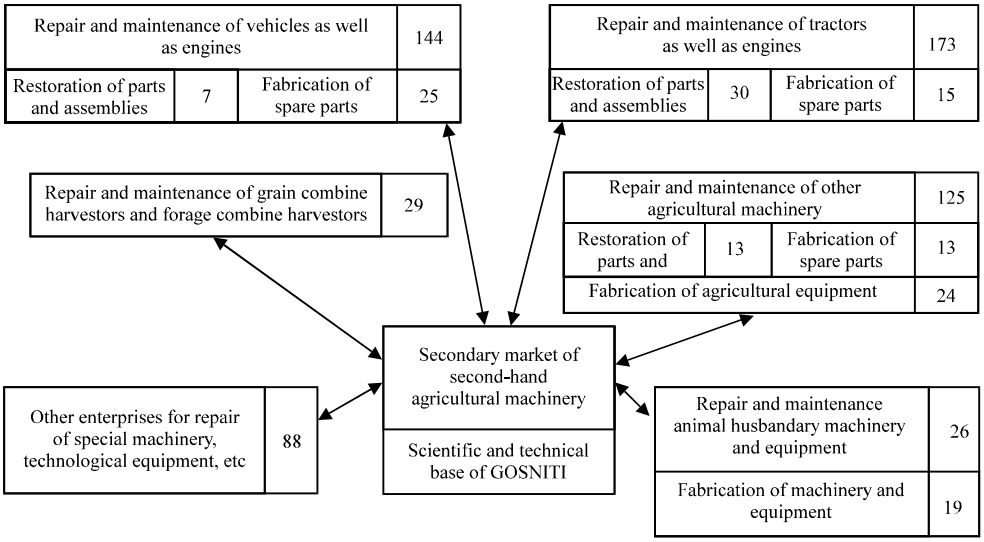

Fig. 6: Structure of the Russian

and second stages will be organized at the above mentioned enterprises. This will make it possible to use technical, process and intellectual potential of already existing enterprises which will be able to perform these researches after a certain modernization and organization of workshops (sites) for disposal of agricultural machinery on their basis.

The feasibility of such organization of disposal works is determined by the fact that manufacturers of self-propelled machinery including Agricultural Machinery (ACM) and other types of machinery, using the world's experience of technically developed countries have moved towards a closed-proprietary system of production and maintenance of the equipment being produced by them. This system requires the creation of branded service by brand-name manufacturers which among other things, solve the issues of warranty, post-warranty maintenance and repair of the equipment being produced by them.

Currently, the AIC of Russia has a wide range of RTE (Fig. 6). The above mentioned RTE are connected with geographical location convenient for ACM consumers and have long-term economic ties with them.

Application of AIC RTE will significantly reduce the costs associated withthe system's infrastructure development, laying the groundwork for performance of disposal operations.

The skill of planning any activity based on accurate forecasts is meant by the strategy in the dictionary of T.F. Efremova. The strategy defines the interaction of the system's participants, taking into account the possibilities, prospects, means of entity activity, problems, difficulties and conflicts that hinder the implementation of interactions. Despite, the fact that the experience of other countries suggests the need and feasibility of establishing decommissioned equipment disposal systems which show high economic indices, the government agencies are in no hurry with the deployment of works concerning creation of such systems in Russia. Direct transplantation of European, American or any other disposal model onto Russian realities is impossible due to certain national specificity.

This is especially due to the fact that Russia has chosen not really effective model of economic support for the development and implementation of equipment disposal system via disposal fee (Fig. 7) which goes into the state budget and is under government control (Ignatov, 2016a, b; Kunze, 2013).

Only four small European countries where imported equipment is mainly applied have chosen the model of economic support based on disposal fee, from which disposal fund is formed. The government takes system management upon itself in these countries. The use of the experience existing in these countries is irrelevant for Russia.

In most countries, equipment manufacturers and importers independently create the system of disposal of equipment produced by them in accordance with national legal requirements. Thus, equipment manufacturers solve an important problem of decommissioning the old equipment and increase in sales of their new equipment and are interested in the fact of disposal performance in accordance with the applicable EU Directives on disposal of decommissioned equipment.

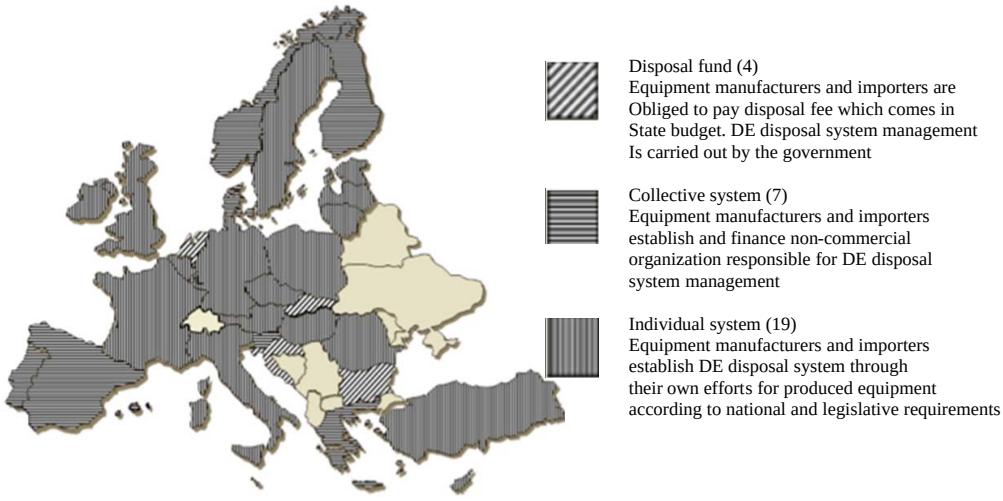

Fig. 7: Models of economic support for national equipment disposal system in European countries

In this case, allocations for performance of decommissioned equipment disposal meet the needs for them and are fully spent only for development and maintenance of equipment disposal systems in serviceable condition. This provides for manufacturers not only the implementation of disposal rates which are the highest ones in the EU and are up to 95% or more regarding vehicles but also the resolution of other issues, including social, resource conservation, environment onesand so on.

This is largely due to the fact that the production of domestically made vehicles has decreased by several times over the last years in Russia and is about 10% of the total scope of equipment being commissioned. It is not of economic benefit to Russian equipment manufacturers, being in difficult economic conditions, to create a national system of disposal of equipment of own manufacturing (third option) and the infrastructure providing for the implementation of disposal operations up to the world standards. Based on this, the second and third options of development economical support and the system implementation (Fig. 6) are irrelevant for Russia at the moment.

It is necessary to create an original disposal model with the use of the chosen option of economical support of branch decommissioned equipment disposal systems for Russia. The feasibility of establishing such system must be proven as well.

Hereafter, the issue of feasibility and possibility of establishing a Russian branch decommissioned equipment disposal system will be considered bythe example of the system. In this case, we shall note that while developing branch disposal systems of virtually all types of equipment, a unified methodology of creation which is the same as while establishing the system, must be applied. And this greatly increases the relevance of work regarding establishing the system.

In general, the resolution of the issue regarding feasibility of establishing any object (including the System) depends, on the one hand on the volume of resources invested in the creation of this object and on the other hand on the positive effect obtained as a result of its (object) operation (Fig. 8).

The resources can be different in volume and scope material (economical) costs, intellectual resources (intellectual assets) of the companies involved in the process of creation and operation of equipment disposal system, etc. The Amount of Financial Resources (AFR) needed for investing the range of works on creation of the system is a target value in this case.

The effect obtained after completion of total works on creation of the system is determined by the results of the operation of this system. Since, the system solves the problem on a complex basis, the positive effect is manifested in a variety of spheres: economical, social, environmental, political, etc. and has a different importance beginning with a particular individual and ending with the world community as a whole (line 9 of Table 1).

If the resources invested in the system exceed the resulting positive effect then there is no point to solve the problem facing the developers. If a positive effect from operation of the system being created will be more than the resources invested in the system, it is necessary to look for ways of pursuing the stated objective. Precisely this approach was used in this study in order to prove the feasibility of establishing this system.

Fig. 8: Regarding the feasibility of establishing a disposal system of decommisioned agricultural equipment

Table 1: The complex of issues being solved via disposal systems of decommissioned agricultural equipment which provide for obtainment of a positive effect at different levels*

Issues	Importance level
Preservation of remaining lifetime of decomisioned equipment wastes	1, 2, 3, 4, 5, 6
Reducing the negative impact of wastes on the environment	1, 2
The slowdown in rates of mineral production	1, 2
Economical support of equipment manufacturers	2, 3
Renewal of vehicle fleet and equipping domestic customers with more productive machines	2, 3, 4
New job formation	2, 3, 4, 5
Improving the quality and volumes of recycled materials	2, 3, 4, 5, 6
Ensuring control over the movement of secondary resources	2, 3, 6

*World community as a whole; the country which produces wastes (equipment); equipment manufacturers; equipment consumers; recyclers; wastes processers

RESULTS AND DISCUSSION

Based on these assumptions and postulate of the preponderance of income activity over the expenses in any form, the hypothesis and formation stages of the system has been formed (Fig. 9). This strategy implies the performance of a number of works and activities, providing the creation of required infrastructure for operation of the system in the Russian environment.

System's infrastructure was formed as well as cost items for its formation, methodology, algorithm and programs of determining these values were developed and the process of establishing the system was simulated over a period of three stages presented in Fig. 8 (Solovyov *et al*., 2015) based on the system's formation accepted hypothesis.

While determining the Amount of Annual Financial Resources ($AAFR^j$) necessary and sufficient for creation of the system per each jth year of the system establishment, the following basic cost items were being taken into account, i.e.:

$$AAFR = Q^j = Q^j + Q_2^j + Q_3^j + Q_4^j \text{ Д}_5^j \quad (1)$$

where, $Q^j_1 = Q^j_{1a}+Q^j_{1a}$ costs for formation of the system infrastructure (Q^j_{1a}) and legislative framework development ($Q^j_{1б}$) in the jth year; $Q^j_2 = Q_{2a}+Q_{2a}$ costs of machine manufacturer for the development of regulatory and technological documents and technologies ($Q_{2б}$) based on which the performers should fulfill safe and controlled utilization in the jth year at the cost of $Q_{2б}$; Q^j_3 expenses for logistic in the jth year; Q^j_4 the costs for landfilling the nonutilizable wastes in the j-th year; D^j_5income from the sale of prepared and processed wastes components from decommissioned agricultural equipment in the jth year.

AAFR generally depends on the amounts of equipment being annually withdrawn from service and dynamics of work performance regarding creation of the system, i.e., the duration of the system "formation period" from the beginning of work package performance regarding formation of the system and up to reaching the design capacity by it.

The design capacity of the Fleet of Machines to be Disposed (FMD) N_{FMD} was determined based on the amount of agricultural equipment being annually taken out of service. The statistics of the Ministry of industry

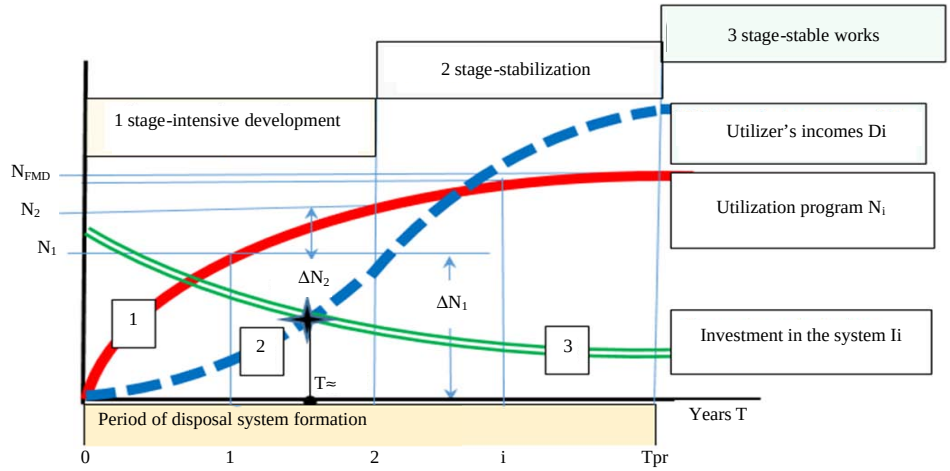

Fig. 9: Accepted hypothesis and stages of strategy formation

Table 2: System power change parameters

Type of technological machines	System power N^{j}, thous. pcs. by year ($N^{j} = \alpha_j \times NFMD$)				System annual power increase $\Delta n^{j}i$			
	First N^1	Second N^2	Third $N^3 = N_{FMD}$	The fourth and so on $N^{3+} = N_{FMD}$	ΔN_1	ΔN_2	ΔN_3	ΔN_{3+}
Tractors	20	37.5	50	50	20	17.5	12.5	0
Combine harvesters								
Combined harvester-threshers	4.6	8.625	11.5	11.5	4.6	4.0	2.9	0
Fodder harvesting	0.56	1.05	1.4	1.4	0.56	0.49	0.35	0
For root crops harvesting	0.2	0.375	0.5	0.5	0.2	0.18	0.13	0
Total	27.36	47.55	63.4	63.4	27.4	22.2	15.9	0

and trade of the Russian federation, the data of the RF ministry of agriculture departmental records 6 mechanized (as of 01/01/2014), Russian statistics committee (Rosstat) reports 10 mechanized (in terms of decommissioning) and 1 REPAIR 01/01/2013 (Ministry of Agriculture of the Russian Federation) and other sources was used to determine this parameter. N_{FMD} = 63.4 thousand pieces of equipment was determined on this basis. In general, the determination of the system optimal period of development and commissioning is a separate and quite time consuming work. There can be no doubt that there are many options of the system formation strategy in theory and ideally all possible strategy options should be estimated and the best option shall be chosen.

But in this case, all other things being equal, an option wherein the system will be dynamically developing and will start to function effectively in a relatively short period is of outstanding interest at this stage of the system development.

Using a strategy in which the system will be developing with a low-intensity expansion will result in a "long-delayed construction" and such an option is economically inadvisable. Additionally while choosing the Strategy option, consideration should be given to the fact that the Disposal Fee Value (DFV) which should provide the system economic component will also depend on the period of formation. Certainly, the shorter the formation period of the system, the greater the DFV will be. However, reducing this period will require the introduction of high rates of disposal fee which willhurt the abilityof agricultural machinery tocompete.

Two research works, aimed at identifying DFV for agricultural equipment and specialized production equipment, the results of which were applied when developing regulation have been fulfilled in GOSNITI with direct involvement of the researcher in the instruction of the Ministry of Industry and Trade of the Russian Federation.

While developing the above mentioned research works, the research developers, considering the employer's recommendations, proceeded from the fact that the resources derived from disposal (environmental) fee should meet thefinancial needs for creation of the System "from the ground up" as long as disposal enterprises that meet the requirements of resource conservationand environmentare not established yet. Taking into account all the factors,the system formation strategy was developed over a three-year period with the fastest growing capacity of disposal enterprises which parameters are presented in Table 2. AAFR^{j} has been determined for these parameters in accordance with.

Table 3: The value of financial resources in the first year of the system operation (mln.)

Designation	Types of costs for	Cost values
Q1a	Infrastructure for the UWDS of decommissioned agricultural equipmentin general	4058.8
Q11a	Infrastructure for preparation of decommissioned agricultural equipment components	1527.5
Q1b	Legal basis for the UWDS of decommissioned agricultural equipmentin general	405.88
Q2a	Technological documentation for decommissioned agricultural equipment disposal system	405.88
Q2b	For preparatory and main works for decommissioned agricultural equipment disposal system	548.50
Q3	Logistics for the system in general	999.60
Q4	Wastes disposal for the whole system	19.830
AAFR	Per the entire system Q1+Q2+Q3+Q4	6438.5

Table 4: Costs and profits of enterprises performing the workson preparation of components for implementation (mln. rub.)

Type of cost	Values
The costs of 1st level subsystem creation	2977.86
Incomes of the enterprises in the first option	3359.2
The balance in the first option of the utilization of waste components	381.34
Incomes of the enterprises in the second option	7189.36
The balance in the second option of the utilization of waste components	4211.5

To calculate AAFR and DFV, due to which the disposal fund must accumulate, the calculation algorithm and software has been established (Solovyov *et al*., 2015; Ignatov, 2015). Similar researches have also been performed in respect of specialized production equipment. The algorithm for calculation of these values is shown in Fig. 10.

The amount of Annual Financial Resources (AAFR) required for creating the decommissioned agricultural equipment disposal system has been identified for each year of its formation period using the algorithm and calculation program developed by the researcher. The investments for establishment of processing enterprises are provided for in these costs because it isnecessary to create additional capacities for their processing, develop regulatory and legislative framework and so on for processing the decommissioned agricultural equipment components prepared at disposal enterprises.The results of calculations of this value are presented in Table 3 for the first year of the system operation. As can be seen from this table, the costsfor infrastructure of the enterprises forming part of decommissioned agricultural equipment disposal system are about 15% of the total AAFR.

While determining DFV,AAFR analytical data and data of the ministry of industry and trade of the Russian Federation on the cost agricultural machinery C_{MF} being commissioned within the territory of Russia was used. In this case, the average interest rate P_{rate} per the machinery being commissioned was determined via dividing C_{MF} by AAFR. The value P_{rate} for various years of the system operation ranged from 7.3-8.16% of the cost of a new machine.This information was presented to the Ministry of industry and trade of the russian federation. However, this rate is >10% for new machines and comes >100% of the cost of used machine in the resolution (Ignatov, 2015). In case of such rates, the disposal fund would be quite enough for creation of the system “from the ground up”. Given that while establishing the system the technological capacity of AIC RTE will be applied, the funds for creation of the system will be more than enough. However as previously stated, researches on establishing the system are not performed at the national level yet.

The values of revenues derived from the system operation that can be raised by the enterprises engaged in the preparation of decommissioned agricultural machinerycomponents for further processing have been defined by the researcher. In this case, two options of the use of wastes components were considered; implementation of waste components at market prices of raw materials recyclable without part selection and the same but with the selection of accepted parts and implementing the above-mentioned at the prices of after market parts and implementing the other components at the prices ofraw materials.

When using the first option, the revenues from the sale of prepared decommissioned agricultural machinery components (scrap metal, batteries, rubber, hydraulic fluids, etc.) at the prices of raw materials were less than the costs forwork performance regarding preparation of decommissioned agricultural machinery components for processing (line 4, Table 3). In this case, these enterprises should obtain subsidies from the disposal fund.

Disposal technologies which are based on the selection of parts and implementation of accepted parts at the after-market are applied abroad. The calculations conducted by the researcher have shown that when using this technology and conducting the selection of parts, the revenues of disposal facilities are significantly increasing (line 6, Table 4). Besides, the companies will become self-sufficient.

Thus, the value of a resulting positive effect from the system operation (in case of properly organized process of decommissioned equipment disposal) from the first item (Line 1 Table 1) only proves the feasibility of its creation.

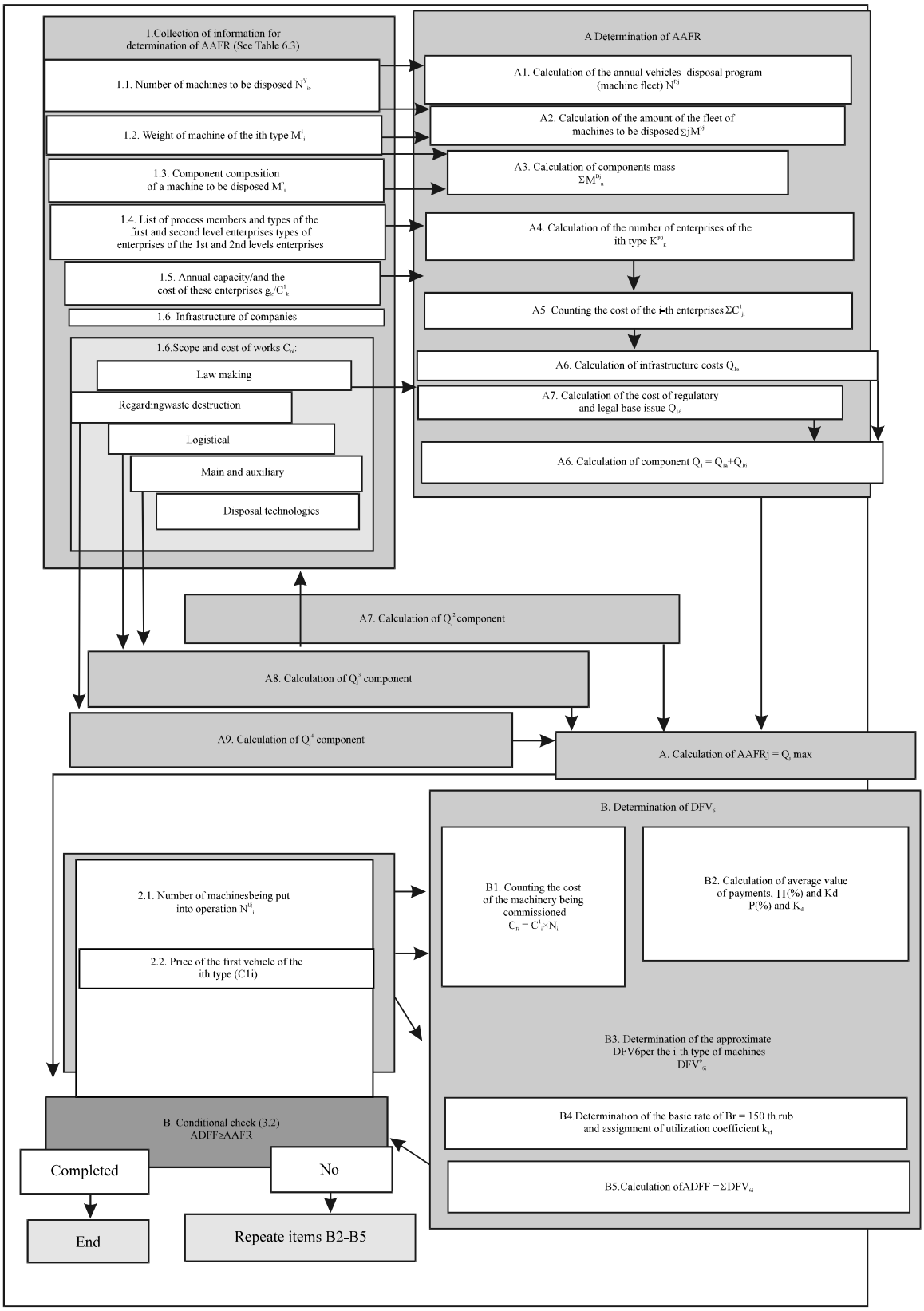

Fig. 10: AAFR and DFV calculation program algorithm

Besides, processors of decommissioned agricultural equipment components also raise the revenues commensurate with the voiced incomes of producers. Determination of the processors income valuewas not included in the program of research sincethe components of all types of wastes come onto the processing plants at the same time and it isimpossible to determine the fraction of revenue from processing of decommissioned agricultural equipment components. However, according to experts, the revenues of processors exceed the revenues of producers.

It was also shown in a number of studies (Solovyov *et al*., 2015; Trofimenko *et al*., 2011) that the total amount of pollution damage caused by vehicle wastes is >1.6 bln rubles in the Moscow Region only. However, in case of properly organized process of disposing this waste, the amount of this damage value is reduced by 4 times, i.e., the state will save about 1.2 bln. rubles to eliminate the effects of wastes pollution from decommissioned equipment in a particular region only. If we extrapolate the results of these calculations to other regions, the amount willsettle for dozens of billions of rubles.

Quantitative values of positive effects regarding the other items of Table 1 have not been determined by us. To determine the above mentioned items, additional researchesare needed but a priori, it is safe to say the establishment of the system will lead to origin of multiplier effects due to addition of the positive effects that will be undoubtedly obtained regarding the items 3-8, Table 1. Similar positive effects will be provided via disposal systems of the other types of decommissioned equipment. The above calculations make it possible to draw conclusion on the proof of feasibility of establishing both decommissioned agricultural equipment disposal systems and disposal systems of the other types of equipment. Besides, it can be assumed that it is the creation of the effective disposal systems of all types of wastes (including the decommissioned equipment of different types) that will provide the maximum economic benefit and ensure the establishment of the effective UWHS in Russia. This hypothesis is confirmed via the similar calculations regarding creating disposal systems of specialized production equipment conducted by us. The obtained numerical values of expenses and revenues for this disposal system are of the same order as for the system.

However such optimistic findings brought to the attention of the Ministry of Industry and Trade of the Russian Federation and the RF Ministry of Agriculture employees have not produced a positive result and have not led to the intensification of works on creation of the system. Furthermore, the actions on establishing this system taken by our country's high officials are inconsistent with the need for creating decommissioned equipment disposal systems in Russia declared by the Russian Government in.

However, given that the system effectiveness has been proved by us and the effect expected from the system is much more than the resources invested in its creation, it is necessary to look for ways to achieve the stated objective.

A mechanism of resolving the wastes issue in question at the various levels of governance is proposed in the study. The proposed UWHS structuring makes it possible to divide the overall problem into its component parts and solve each of them in parallel in accordance with the particular tasks that have an effect on the decision of that part of the problem.

The feasibility and self-sustainability of the system creation has been proven based on the simulation of the system development process and its economical efficiency has been determined as well. It is noted that the basic conditions for the system creation are currently formed in Russia and the issues of the engineering and economical plan can be resolved

When the system reaches the designed capacity, the disposal facilities performing preparation of decommissioned agricultural equipment waste components will obtain approximately 3% of invested assets.

The system operation can provide a high multiplier effect which can exceed the costs for establishing the system by several times because the problems of political, social and environmental plans will also be solved during its operation apart from economical problems.

The research revealed the possibilities of application of offered methodology for decommissioned agricultural equipment disposal systems to create branch (specific) wastes disposal system. The outcomes of this research are also used in the researches on creation of decommissioned agricultural equipment disposal system in the Republic of Belarus.

The results of the researches conducted by the researcher have shown that the creation of the branch wastes disposal systems including from the decommissioned equipment will ensure the efficient operation of UWDS and UWHS in general.

The reasons for reducing the possibility of practical implementation of the proposed theoretical insights have been researched, the recommendations regarding their elimination have been given and the incompliances in the legal framework hindering the creation of the system have been specified by the researcher.

CONCLUSION

The results of the conducted research may represent a theoretical basis for implementation of the formation process of resource-saving, environmentally-oriented decommissioned equipment disposal systems of various kinds in the very near future.

To do this, it is necessary to provide agricultural equipment producers with motivations and conditions for involvement them in the process of creating the system and developing the activities by them concerning ensuringdisposal suitability (similar to maintainability) at all stages of complete machine life cycle at the national level and create the conditions for AIC engineering service enterprises for the implementation of decommissioned agricultural equipment disposal works at the above-mentioned enterprises at the same time.

The Government of the Russian Federation should include the "Program of development of the unified wastes disposal system as well as branch disposal systems of various types of decommissioned machinery forming part of UWDS" in this list while forming the list of publicly funded researches. It is proposed to develop and implement the branch system for agricultural equipment disposal intoAICin the first turn because there are all the pre-requisites and a theoretical justification for this.

The results of the research showed up the necessity and feasibility of establishing decommissioned agricultural equipment disposal systems in the RF AIC. At the same time, continuation of the policy of ignoring the need for creation of effective resource-oriented and environmentally-oriented equipment disposal systems and other types of wastes will lead not only to big economic losses but also to increase of both environmental and social negative developments.

REFERENCES

FLR., 1998. On production and consumption waste. Federal Law of the Russian, Russian.

Ignatov, V.I., 2016a. Disposal fee: Is it a path to the development of industry in Russia or to its further degradation?. Kuban State Agrarian University, Krasnodar, Russia.

Ignatov, V.I., 2016b. New concept of equipment disposal system formation. Multidiscip. Network Electron. Sci. J. Kuban State Agrar. Univ., 7: 1065-1080.

Kunze, P., 2013. Experiences with the recycling of end-of-life vehicles in Europe. Proceedings of the International Conference on Disposal of Vehicles in Russia, September 6, 2013, National Research Technological University, Moscow, Russia, pp: 1-12.

Mitrokhin, N.N. and A.P. Pavlov, 2015. Disposal and recycling of vehicles: Education guidance. Moscow Automobile and Road Construction University, Moscow, Russia. http://lib. madi. ru/fel/fel1 /fel15E279.pdf.

NESR., 2014. National forum. New Environmental Strategy of Russia, Russia. http: //www.vernadsky. ru/news/news/?ELEMENT_ID=330

RFGR., 2000. On the procedure of disposal and implementation of decommissioned aircraft. Russian Federation Government Resolution, Russian.

RFGR., 2009. On the performance of experiment regarding stimulation of the purchase of new vehicles instead of the vehicles taken out of service and being delivered to disposal as well as concerning creation of collection and disposal system of the vehicles taken out of service in the Russian Federation. Russian Federation Government Resolution, Russian.

RFGR., 2012a. On disposal fee in respect of wheeled vehicles. Russian Federation Government Resolution, Russian.

RFGR., 2012b. On licensing, development, production, testing, installation assembly, maintenance, repair, recycling and implementation of arms and military machinery. Russian Federation Government Resolution, Russian.

RFGR., 2016. On disposal fee regarding self-propelled machines and their towed vehicles and amending some acts of the Russian Federation. Russian Federation Government Resolution, Russian.

Solovyov., S.A., V.F. Fedorenko, V.I. Ignatov, V.S. Gerasimov and V.A. Maku *et al.*, 2015. Disposal of Agricultural Equipment. Publisher Rosin formagrotekh, Novokubansk, Russia, Pages: 172.

Trofimenko, Y.V., Y.M. Vorontsov and K.Y. Trofimenko, 2011. Disposal of Vehicles: Monograph. AK Press Publishing Company, Oakland, California, Pages: 336.

Vorontsov, Y.M., 2006. Is vehicle recycling a new Russian industry. Waste Recycl., 1: 4-7.