THE DEVELOPMENT OF THE AUTOMOBILE TRANSPORT IN AGRICULTURE

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Abstract

One among the factors for the increase of competitiveness and profitability of producers within the agricultural production is the stimulation of researches and the development of progressive technologies within transport processes as transport is an important component of agro - industrial complex and as for agriculture itself, it is one of the most transport-capacious branches within the national economy. The article is being devoted to the directions and the perspectives for the increase of efficiency of transport appliance due to the improvement of machine-park structure, the design and the organization of operation of vehicles.

Key words: automobile transport, machine-park structure, mobile electrical units, gas-balloon cars, systems of satellite navigation.

INTRODUCTION

The transport is the important component of the agro-industrial complex; its main purpose is to provide the movement of freights at the production stage for the plant farming and animal husbandry. The annual transport turnover for the goods within agricultural enterprises constitutes from 20 to 40 tons per hectare of the cultivated land and as for the overall volume of transport labour – 80 – 200 tons/km per hectare of the cultivated land. About 40 - 60% of all energy expenses within the agricultural enterprises are being regarded as those being spent on transportation: at seeding and planting phases – supplying grains, seeds and fertilizers; at harvesting phase – collecting and picking up of the crops; at the phases of preparation and application of fertilizers – transporting them to the storage points and then to the fields. The labour expenses within the transportation, taking into account the total sum of workforce applied for the cultivation and harvesting procedures, constitute for – 30%, for potatoes – 40%; corn on a silo – 70%. A quarter of all workers within the agricultural enterprise are being engaged in transportation (DIDMANIDZE, 2005).

The transportation process ensures the rhythmical functioning of the general technological process of the enterprises. Especially it belongs to the enterprises with the continuous processes of production, in which the strictly regulated movement of objects of the labour is required.

At the organization stage of transportation and the definition of carrying capacities of transport enterprise for a certain economic region the goods` turnover is initial. The characteristic and important features of the transport processes in agro-industrial complex are the wide range in accordance with the purpose and high unevenness of goods` turnover within a year (Fig. 1) (EVTJUSHENKOV, 2004).

The factors of no small importance, making the transport performance more complicated are the following: the exploitation of the rolling stock on the roads of low categories of pavement (III, IV, V), even often in cross-country conditions; the urgency caused by transportation of perishable production; the complexity of mechanization of loading and unloading works.

Depending on the distance and technology of the freights` movement, one can distinguish inner-farm, inner-economy and outer-economy types of transportation.

Inner-farm ones provide the movement of freights, for example, forages from warehouses on farmyards to the barnyards, the removal of manure from barnyards to the storage units etc. They are characterized by a big variety of freights and recurrence of transportations of the same freights in a day. The inner-farm means of transportation are presented by low-power tractors with special trailers or bodies, transport cranes, screws, pneumatic devices. It has to work all the year round irrespective of climatic and other conditions.

The inner-economy types of transportation (the removal of manure from the farm to the fields, the transportation of seed material, fertilizers, grains from combines, etc.) are being characterized by short distances (1-20 km). For this purpose cars and trailers on the tractor pull are being applied.

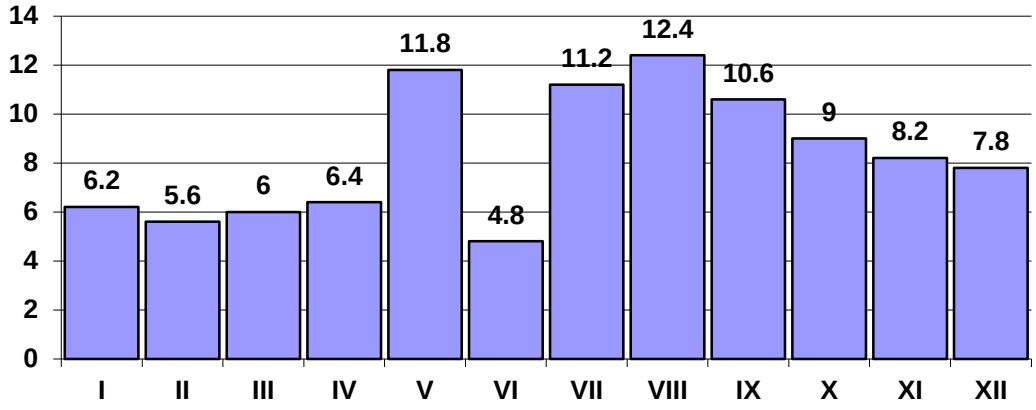


Fig. 1. – The share of the overall annual volume within the transportation works in Central part of RF in months – percentage

The outer-economy types of transportation are connected with the carrying of freights into the economy or from the economy: the movement of goods from the threshing floors, fields and warehouses to the places of further processing; the delivery of mineral fertilizers, oil products, construction materials, cars, the equipment to the economy. The distances for such transportations can be 40 – 60 km and more. For this the means of the big loading capacity and high technical speeds are being applied.

The work of transport becomes complicated because of high degree of wear of a rolling stock and means of loading at the simultaneous annual increase in load for them.

According to the Avtostat agency, the total number of trucks (a middle and big class) reaching in our country 3, 7 million copies, a share of cars with the age over 15 years reaches 2, 4 million. The share of the cars assembled in Russia makes 88% (Fig. 2) (WWW.AUTOSTAT.RU/INFOGRAPHICS/22363).

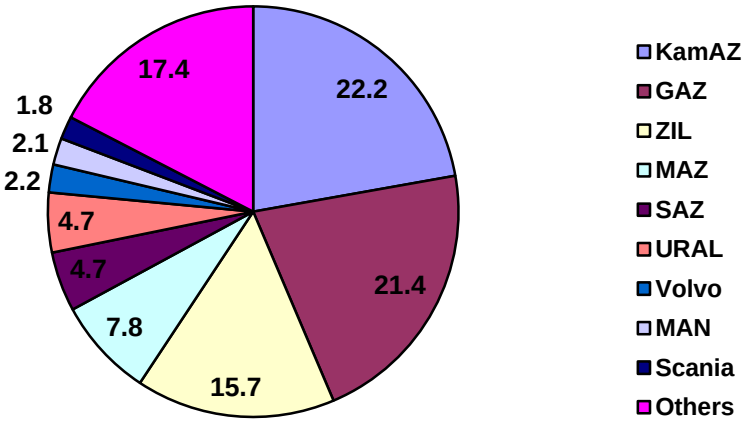
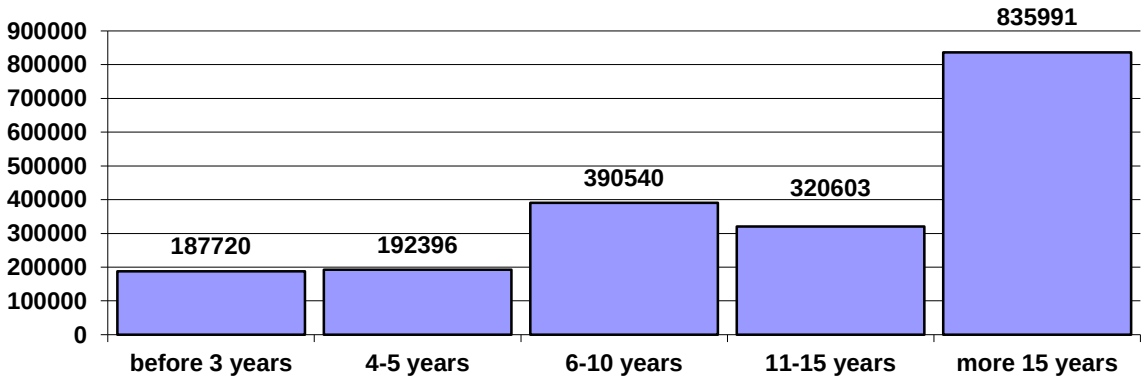


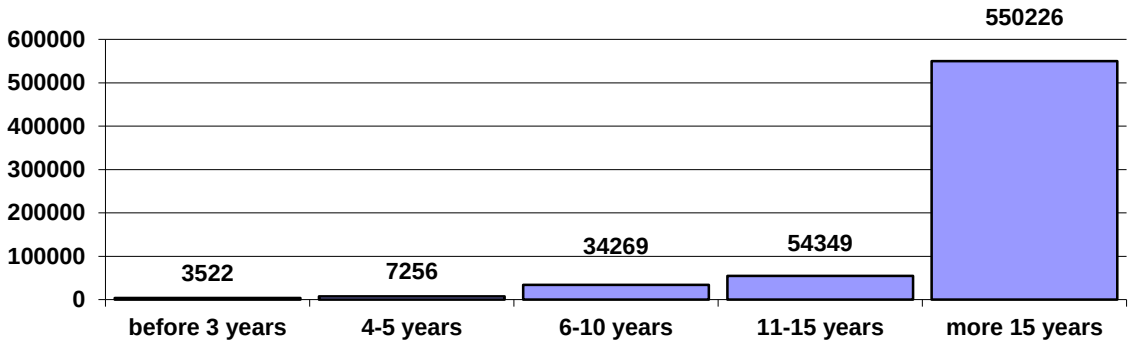
Fig. 2. – The park of trucks in Russia in accordance with the first of July, 2015: – KamAZ; – GAZ; – ZIL; – MAZ; –SAZ; – URAL; – Volvo; – MAN; – Scania; – Others

In 2015, KamAZ (22.2%) has come out on top, having moved on the second place GAS brand cars which share has decreased to 21,4% (from 22.2%). On the third place holds an essential share of ZIL park (15.7%) though actually several years these cars aren't made. Other marks have entered "five" of leading brands: MAZ (7.8%) and SAZ (4.7%). Among brands from more than 2% shares are the Ural (4.7%), Volvo (2.2%) and MAN (2.1%). In the long term rather intensive redistribution of shares of producers, first of all, because of reduction of a share of the brands which aren't letting out or not importing cars to Russia is expected. It is possible to carry cars of brands to them ZIL, SAZ, KRAZ.

As for the brands` distribution according to the age structure, it doesn't differ essentially from each other, the difference is only in number of rather new cars, speaking about success of work of car makers in the last decade (Fig. 3) (POLJAKOVA, 2013).



a



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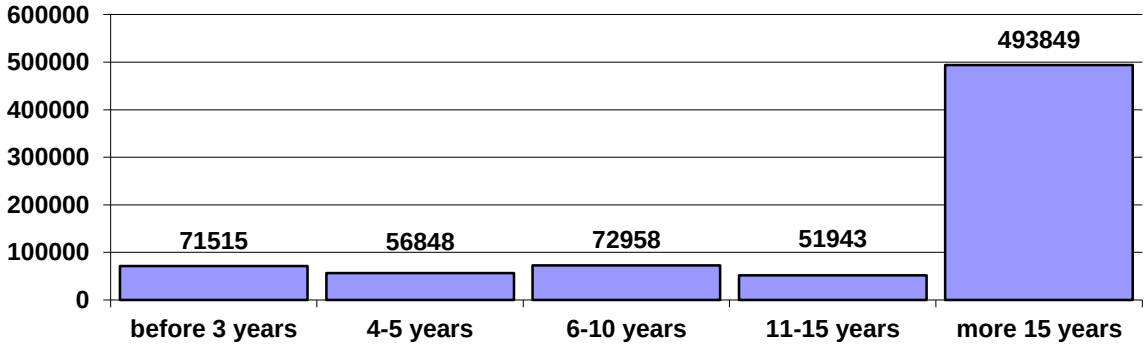

c

Fig. 3. – The age structure of trucks` brands: a – GAZ; b – ZIL; c – KamAZ

Nowadays it is possible to observe the sharping contrasts in the appliance of the equipment: on an equal footing machine operators receive absolutely different results of operation of machines. It is caused by the fact that on places modern means of the organization of transportations aren't used, work of separate services of the enterprises isn't sufficiently coordinated, the fleet of vehicles isn't fully adapted for transportation of agricultural freights, and the service regulations of equipment, its storage, maintenance and repair aren't followed.

In the conditions of the modern economy, the role of improvement of transport service of agro-industrial complex also raises. This is caused by the fact that in the spheres of agricultural production, the further processing and realization of goods, the large number of specialized branches and productions which are connected among them-selves, are being engaged both economically and quite often technologically.

In this regard, the importance of effective use of vehicles and loading- unloading equipment increases even more considerably. At the same time, the further improvement of the organization of transportation of goods in agriculture and branches serving it, the improvement of usage of transport and loading- unloading means, the reduction of expenses of work and funds for the transportation of goods is required.

The solution for these questions especially is important in the connection with the existence of small-scale country (farmer) enterprises and the overworking enterprises and the saturation of farms by new vehicles. The implementation in the country of necessary organizational and technical measures allows using rationally available material and technical resources of transport of agro- industrial complex, to improve the transport service of farms and the overworking enterprises.

The tasks connected with the increase of the efficiency of the automobile transport of agro-industrial complex needed to be solved in the complex are presented by several levels:

1. The determination of necessary productivity (decrease in prime cost) in connection with the planned growth of volume of transportations.
2. The definition of the sources for the gain coverage in volume of transportations (decrease in cost of transportations).
3. The definition of elements for the gain coverage in volume of transportations (depreciation of transport work) as a result of improvement of indicators of work.
4. The definition of necessary indicators (coefficients of release and technical readiness, etc.).

It is clear from the above that automobile transport in relatively small-scale farm level is important part of farm management and needs some improvement for future. That is why the main aim of this article is to highlight the ways for possible improvement of this sector.

MATERIALS AND METHODS

The activity for the improvement of work of park and in general work of transport in agro- industrial complex can be conducted with the usage of several indicators. At the first stage - they are set or the target indicators allowing to achieve the desirable objectives pay off (on the example of the region this is an increase in gross collecting production, respectively, growth of a cargo transportation, on the example of the enterprise – it can be the increase in load capacity or the decrease in the current costs (Fig. 4)).

At the second stage – the definition for the ways of growth of productivity, as a rule, it is the increase in park of cars (an extensive way), or change of indicators of work (an intensive way) that is more preferable. In the analysis of cost of transportations the decisive key - the change of structure of the park.

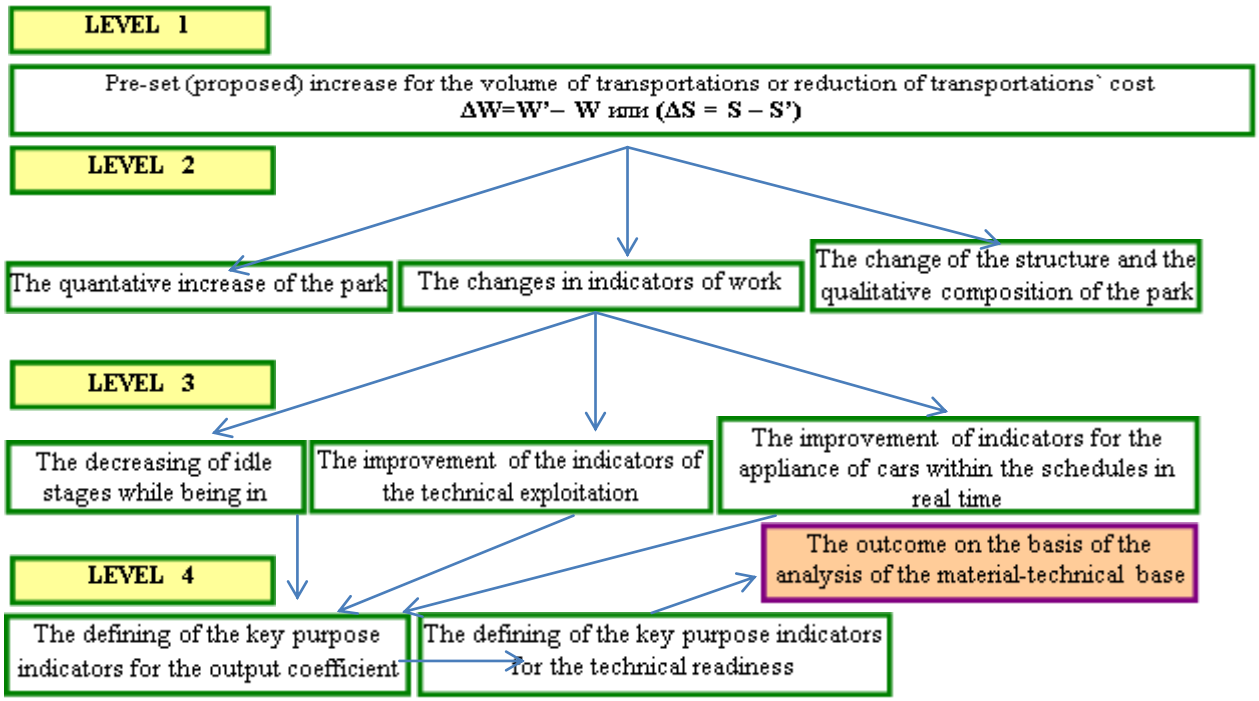

Fig. 4. – The stages for the improvement of work of the transport means` park

At the third stage the directions of improvement of indicators of work assuming the reduction of idle times, improvement of technical operation and improvement of indicators of the usage are being considered. All factors listed above at the fourth stage allow the reaching of the target values of coefficients of release and technical readiness.

RESULTS AND DISCUSSION

The majority of freights in agro-industrial complex require the appliance of specialized vehicles. Depending on the type of transport, the structure to be transported has its distinctive features, but at the same time the obvious domination of bulk cargoes (Fig. 5 and 6) is observed (DIDMANIDZE, 2005).

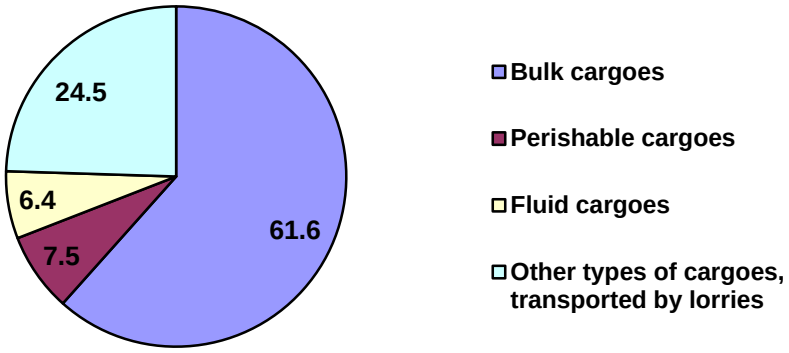

Fig. 5. – The structure of the cargoes, being transported in the outer-economy types of transportation, percentage – bulk cargoes; perishable cargoes; fluid cargoes and other types of cargoes, being transported by lorries

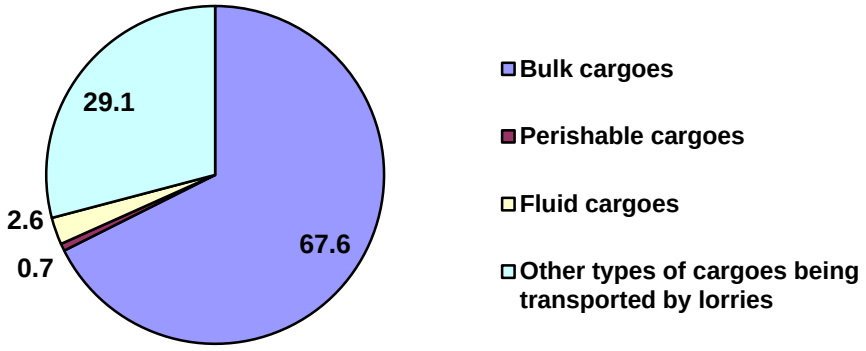

Fig. 6. – The structure of the cargoes, being transported in the inner-economy types of transportation, percentage – bulk cargoes; perishable cargoes; fluid cargoes and other types of cargoes, being transported by lorries

If to speak in general, the park of lorries or trucks in the country and the goal orientation of the native industry for the production of the basic resources have led to the fact that in the park the average weight in transportation is occupied by the dump trucks (Tab. 1, Fig. 7) (POLJAKOVA, 2011). The fact that it is necessary to carry cargoes along the long distances and their irrational organization, and also the low degree of their containerization may be referred to the distinctive features of the Russian road haulage. So such a big average weight is present in the park of lorries with sides.

Nearly 75% of freights in agro-industrial complex (AIC) require the presence of lorries with the specialized or dump bodies, however the real structure of the park within the AIC is far from the rational for both types of bodies, and as for the loading capacity of lorries see (Tab. 2) (EVTJUSHENKOV, 2004). Within the concrete enterprises this ratio can be another.

Tab. 1. – The Structure of the park of lorries with the full weight more than 3,5 tons in accordance with types of a body, %

Body type	All brands	GAZ	KamAZ	MAN	ISUZU
Dump trucks	21,5	5,2	32,1	5,2	7,7
Lorries with sides	18,5	29,6	17,6	6,5	33,1
Articulated lorries	12,3	–	17,5	57,3	1,7
Vans	10,5	19,2	4,4	15,2	27,4
Special vehicles	6,6	7,7	5,7	1,6	6,2
Tank-lorries (trucks)	3,3	6,4	1,9	0,4	0,7
Mobile or truck-based cranes	2,1	0,1	1,6	–	0,8
Others	25,1	31,8	19,3	13,9	22,4

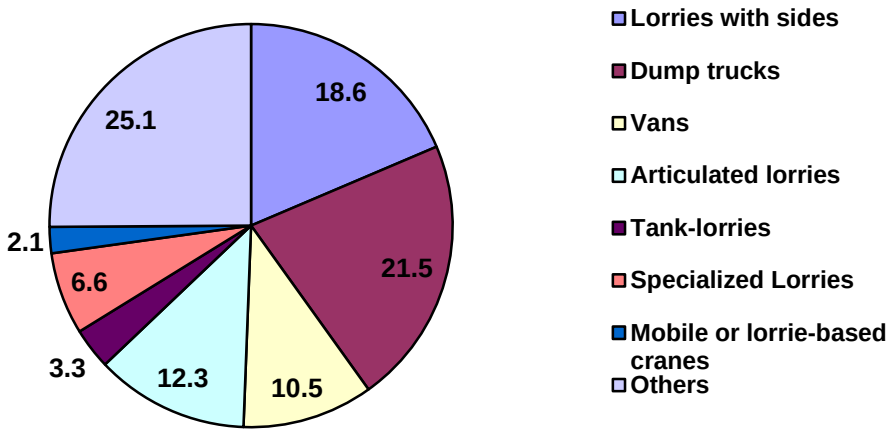

Fig. 7. – The distribution of lorries in the park according to the body type – percentage

Nowadays one can mention the certain movements in the field of the rationalization of the lorries` park structure, which can be easily seen on the example of the registration processes of new lorries and trucks in different regions; the specifics of their activity began to set up a distinctive imprint on the supply of the necessary body types. For example, let`s take Moscow oblast and the distinctive features of cargo freight – the prevailing of the already finished and packed production which has been received after final stages of processing (POLJAKOVA, 2012).

Tab. 2. – The lorries` park structure in accordance with the body types and the load capacities within the AIC (according to the data, provided by VIM)

Body type	Share, %	Load capacity	Share, %
Dump truck	39	to 2 т	5.9
Lorry with sides	42	from 2.1 to 5 т	65.6
Vans (of all types)	4	from 5.1 to 8 т	20.7
Tank-trucks	12.9	from 8 т	7.8
Others	2.1		

The other distinctive feature of the replenishment of modern park of a rolling stock is the obvious shift towards lorries of a big class that allow to improve the inter-economic external transportations, but doesn't improve the situation with the inner-economic as the purchased lorries are first of all prepared for the roads with the rigid improved coating (POLJAKOVA, 2012). According to the number of the researches which has been being carried out, during the previous 5 to 10 years, the creation of specialized transport techno-

logical machines can be a solution of the problem of transport service (IPATOV, 2008; DZOCENIDZE, 2011). However, the development and the deployment of new vehicles has seemed to the car-makers as the irrational and the Silant project has been developed at the level of the small-scale assembly, serving the needs of generally Novgorod region, and the multipurpose transport-technological machine has been developed on the modular base of lorry "Ural" has remained at the level of experimental cars as the factory has considered that this segment of equipment has bad market potential, having switched resources to the creation of a line of cars under the Urals-Next brand (CHERNJAVSKIJ, 2015).

The real perspectives for the nearest future – the creation of specialized cars on serial chassis as the recession consequences in the market of vehicles first of all have struck at perspective developments. On the new chassis "Gazon-Next" and "Ural-Next", the creation of scale of cars of middle class and a big class is possible. The scale of bodies like "Multilift" at present is very limited and serves as the municipal rather, than agriculture (CHERNJAVSKIJ, 2007).

As the option which is the most really embodied in practice, it is possible to consider the further development of hook-on equipment for the ordinary or modified bodies of articulated lorries for work with the hydro-fixated equipment, which in its turn is widespread in all regions of the country, and a large number of the equipment will be released from large infrastructure projects, especially after 2018. The perspectives of such a scheme still should be defined, as well as load capacities of modern serial cars in the conditions of agro-industrial complex.

Here it is necessary to allocate the two directions, the work on which has been being conducted for a long time, and the leading role belongs to the experts working at our university.

The first direction, of course, is the development of various schemes of mobile electrical units whose types are presented by hybrid schemes (DIDMANIDZE, 2015). As for the remote perspective – after 2030 one can be able to predict the intensive growth of number of cars equipped with fuel elements and working on the hydrogen (Fig. 8).

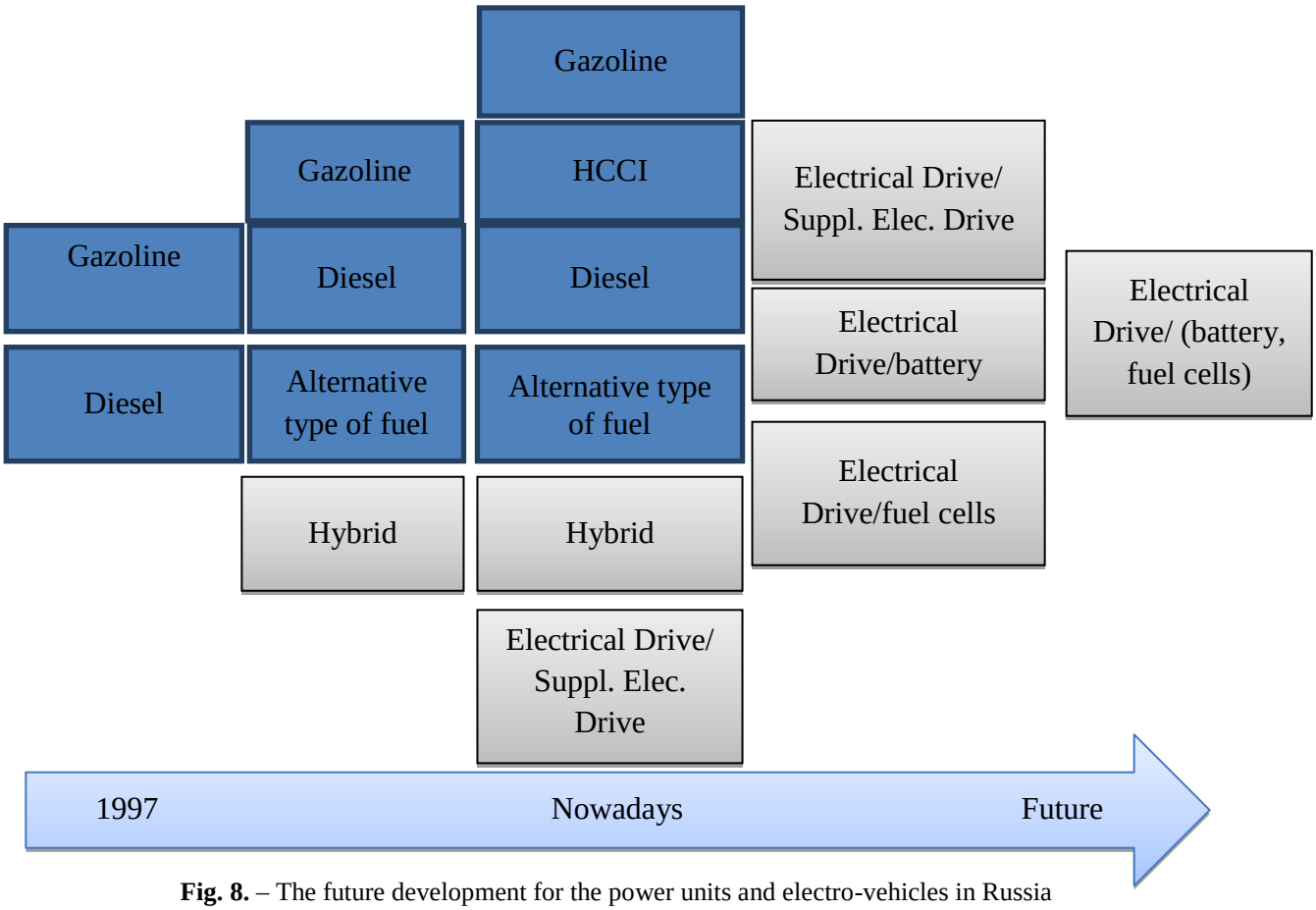

Fig. 8. – The future development for the power units and electro-vehicles in Russia

Nowadays there are four types of mobile electrical units with autonomous power supply, two of which – with the traction rechargeable batteries (TRB) and a combination of the internal combustion engine (ICE) and TRB – are the most widespread. Mobile electrical units with TRB have found mass application as inland transport of the enterprises of various types. Inter-economic transportations are rather complicated because of a small stock for the movement and lack of an opportunity for intermediate TRB charging on a route, i.e. due to the lack of a service network. Mobile electrical units with ICE and TRB are deprived of the main lack of electrical units of the first type, however their mass application, first of all, as vehicles, is restrained by the complexity of a design, and, respectively, unavailability of the existing enterprises of technical service for their maintenance and repair.

The research works which has been being carried out until recently in scientific divisions of higher education institutions and branch scientific research institutes, in the connection with that fact that they are not required by automobile construction enterprises, are rooting extremely slowly because of this, the lag in this area from foreign countries becomes more notable. On the practical level a lot of work in this direction has been performed in MSAU named after V. P. Goryachkin and some other higher education institutions (Fig. 9). In MSAU the concept of creation of the combined power stations has been developed for application in traction vehicles.

Fig. 9. – The mobile electric-powered units, having been developed in MSAU named after V.P. Goryachkin

The development of mobile electrical units for transportation purposes is being conducted worldwide. Foreign producers have created a line of vehicles of loading capacity on the basis of the serial and specially designed chassis, the Russian developers have planned the main characteristics of perspective electrical units for transportation purposes only on the basis of serial chassis (DIDMANIDZE, 2015).

The design of similar vehicles began with category M1 vehicles on classification of UNECE worldwide, having gradually extended to the categories M2 and M3. The work with the category N1, i.e. with trucks, has begun after receiving a certain effect (more often ecological in operation, but not in full life cycle) from operation of small-scale examples of category M.

The creation of equipment for inner-economic transportations on the basis of the Belarus-920 tractor and the recharged passenger vehicle of a small class (Tab. 3) (DIDMANIDZE, 2015) became the newest developments in a scope of mobile electrical units.

Tab. 3. – The technical features of the mobile electric units for the transportation purposes having been developed in Russia

Basic model	VW Caddy Maxi	Ford Transit	KamAZ-65115-Electro	Tractor Belarus
Electric motor	Siemens	Azure Dynamics	Trolleybus	Azure Dynamics
Power of electric motor, kWT	61	57	189	60
The capacity of one cell, A·h	160	300	300	160
The mass of one cell, kg.	5,6	9,6	9,6	5,6
The amount of cells, piec.	86	100	144	100
The overall mass of the batteries, kg.	481,6	960	1382,4	560
Maximum speed, km/h	130	75	75	Not available

Besides the application of hybrid transport technological machines, the perspective direction is the usage of gas fuel as one of the most really applicable amongst alternative ones. The problems, ecological orientation and an economic orientation are at his expense solved.

In recent years a number of important documents have come into force. First of all, It should be noted the Federal law "About energy saving..." and the order of the Prime Minister to the executive authorities and organizations about the preparation and providing the comprehensive program of the stimulation of application of the natural and liquefied hydro-carbonic gas as motor fuel. The law would become the basis for the formation of the state order for acquisition of the cars completed with the gas-balloon equipment (GBE) and transfer to the propane for the departmental transport of the organizations financed from the state budget that can give economy to 1 billion rubbles a year (VASIL'EV, 2015).

The transition of automobiles to the alternative types of fuel is, in fact, actual and essential. Domestic car makers began to release more willingly gas-balloon automobiles (GBA), but not all and not in the volumes demanded really. In leaders is KAMAZ with the RARITEK subsidiary which has mastered the release of several models of trucks and city buses NEFAZ, and also "GAZ Group" with "Gazelles" and LiAZ buses. In 2010 GAZ issued about 1, 2 thousand gas-balloon "Gazelles", and approximate output in 2016 – about 4 thousand cars have been let out. Many cars will be also turned on gas-balloon equipment by small firms, which are specializing on this. At the same time the total of gas-balloon cars will only grow, having reached half a million units only on trucks and buses without automobile transport (Fig. 10) (VASIL'EV, 2015; MORDOVCEV, 2011; PROHOROV, 2011).

The exploitation of gas-balloon cars is impossible without the creation of system of supply with fuel. The system of supply with the compressed natural gas (CNG) for GBA gas station is based on the available network of automobile gas-filling compressor stations (ACNG filling station) of various power or mobile refueling units (PAGZ - MRU).

Nowadays in Russia there are 211 ACNG filling stations making from 220 to 500 gas stations a day. ACNG filling station capacities are used for 25% so far.

Gas stations with the usage of the mobile refuellers located directly at the enterprise, on platforms near highways and on the highway on the platforms adjoining gas stations and also in field conditions, turns out to be economically for the consumer who is situated from the station on the distance 10 to 70 km (RYBAKOV, 2004).

The application of mobile gas-filling means in comparison with gas station of transport directly from the ACNG filling station increases the prime cost of CNG, but cuts transportation costs of consumers due to the elimination of single run of GBA that can be useful at the organization of work of agricultural machinery separated from the central estate.

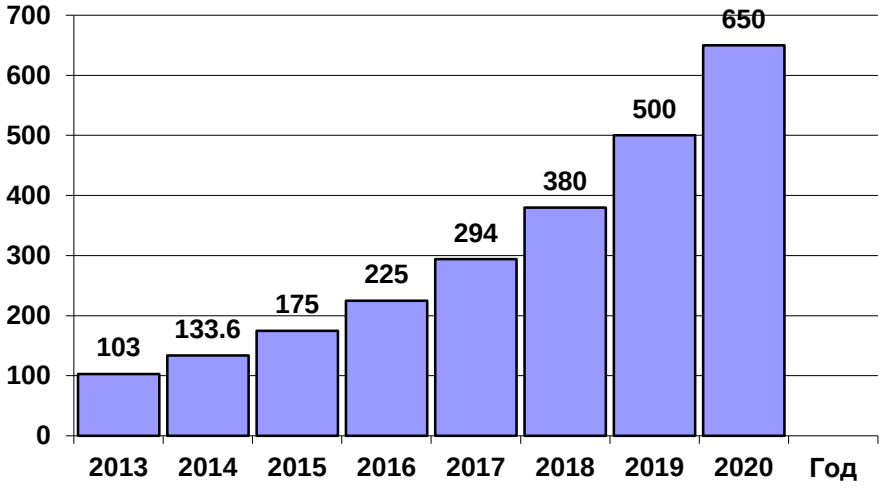

Fig. 10. – The total amount of automobile park using the gas as fuel, units

PAGZ or MRU can be applied as the transported gas-accumulators. At the same time on the platform of gas station the stationary gas-filling station (GFS) for 4 to 6 posts (as well as on the ACNG filling station) is equipped to which CNG is delivered by MRU, filled on powerful CNG filling stations. In this case the equipment of MRU considerably becomes simpler as the equipment for gas station of cars, the commercial accounting of the filled gas, difficult fittings of switching of sections (DIDMANIDZE, 2012) isn't required.

Thus, this technology of the MRU appliance gives the chance to solve the problem of mass gas station of cars at the enterprise, even taking into account the peak loadings on gas consumption, at an exit of cars to works. 18 technological schemes of supply with the usage of mobile and stationary gas-re-fuelling stations have been developed for providing machine and Tractor Park with natural gas in the GNU "VIM" still in the late nineties – the beginning of the 2000-th year. The garage gas-refuelling station, working from household gas networks has been developed for agricultural and transport enterprises in VNIIGAZ. At the beginning of the 2000th years more than five enterprises let out sets and separate units of the filling equipment, now their production is forced out by foreign producers, as a rule, the Italian. Domestic producers began to offer the container modules of storage and the CNG filling station (LLC RARITEK).

Having considered the features of the formation of park of vehicles, improvement and prospects of a transport design and transport technological machines on the basis of application of new power sources and new fuels, it is necessary to pass to the organizational stage of work of the automobile transport.

The comprehensive control and the effective usage of park of transport technological machines – an important condition in order that agricultural and transport enterprises to remain competitive in the Russian and foreign markets in the conditions of integration of the Russian Federation into the World Trade Organization.

The major factors defining an organizational technological level and efficiency of performance of these transport productions are:

- the reduction of duration of a cycle of process in connection with combination of operation of basic and transport cycles;
- the continuity and the threading of process;
- the rhythm of course of process;
- the reliability of the cars which are carrying out separate operations.

To give an essential impulse towards the improvement and optimization of transport productions can give the more active usage of modern hi-tech achievements to which the means of global satellite network belong (BOROVICKIJ, 2014). However, even taking into account that the appliance of means of satellite communication became recently considerably more available to the ordinary consumer, their application, especially in agro-industrial complex, is insufficiently active. The main reasons for the insufficient use of opportunities of system are:

- The lack of sufficient regulatory base for use of satellite technologies in agriculture;
- The lack of mechanisms of promoting and stimulation of use of satellite systems in agriculture;

- The absence of necessary number of the qualified users satellite systems;
- The lack of high-precision hardware elements of satellite system, available at cost (it is actual for systems of exact agriculture).

The usage of means of satellite communication can give synergetic effect in case of application in transport productions.

1 During the application of freight processes for the transportation of agricultural and food production the following tasks are being realized:

- The finding out the possible location of the car;
- The tracking of loading of the car with collecting and data transmission about the potential deliveries of freight to the consumer for the purpose of optimization of processes of reception and unloading, management of freight traffics;
- The tracking of a condition of freight, for example, temperatures in transit the cooled or frozen freights, providing the IFS and HACCP standards;
- The tracking of actions of the operator, in particular opening and closing of a body, raising of a body of the dump truck, etc.
- The control of technical condition of the car and the trailer with collection of data on fuel consumption, pressure in tires, a condition of brake system allowing to lower operational expenses.

2 The usage of means of satellite communication in production and technological processes of cultivation of agricultural and commercial crops allows the passing to the exact agriculture, using geo-information technologies and providing the adoption of optimal solutions on management of activity of the agricultural enterprise.

When using satellite technologies at cultivation of crops the following problems are solved:

- The automation of processes of management of equipment (parallel driving, auto-piloting) on the basis of systems of navigation when carrying out the technological operations providing high precision of crops, uniformity of rows etc.
- The drawing up soil cards of farms with use of automatic samplers;
- The monitoring of a condition of fields and crops;
- The differentiated application of fertilizers;
- The automatic monitoring of productivity and drawing up cards of productivity, and in the long term cards of profitability of sites of fields;
- The monitoring of technical condition of harvest and landing equipment, other power saturated cars;
- The planning of statement of cars on maintenance on loading;
- The accumulation and data storage, the processes and to carry out the multiple-factor analysis for the long period allowing to trace dynamics.

Finishing the consideration of prospects of development of the automobile transport, it is necessary to stop on the important direction without which the solution of those tasks and problems which have been designated above is impossible. This direction is training, and it is not only training of graduates with the high education, but also the preparation of the scientific personnel capable to realize and develop the designated directions.

CONCLUSIONS

The scientific work is being conducted in several directions reflecting all aspects of operation of transport technological machines.

The first direction considered the development of energy saving traction vehicles, meaning the development of designs and technologies of ensuring operability of new types of cars.

The second direction considered the improvement of methods of usage and management of work of transport technological machines. Here the mutual and beneficial work with VIM and other researching institutions is possible too for example the assessment of technological capabilities of the transport technological machines used in agro- industrial complex for the purpose of determination of the operational properties which are most adapted for transfer to gas without loss. The definition for the list of technological operations and transport works, where the usage of the installed gas-balloon equipment on cars is the most effective. The future perspectives of the appliance of serial cars in agro-industrial complex are being taken into consideration too.

The third direction considered the researches in the field of improvement of technical service of transport technological machines at all stages of their usage – from the delivery to the enterprise to the utilization upon the coming to the point of the destination. From the perspective researches it is possible to present, for example, an assessment of a condition of technological base of the enterprises and the choice of the preparatory activities which are most adapted for carrying out the ensuring filling and technical operation of TTM working at gas. Such difficult work can also be conducted together with VIM and STATE PLANTS. Consideration of technological processes of technical

service of new types of transport technological machines can be conducted together with GOSNITI.

As authors considered, the fourth direction regards the researches in the field of improvement of quality of traditional types of fuel and the appliance of alternative fuels. From the perspective researches it is possible to allocate, for example, the creation of inter-economic associations' operators for the management of park of mobile funds of TTM gas station from GBO, the development of onboard and stationary means of improvement of quality of the fuels intended for the equipment used in the conditions of agro-industrial complex.

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