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# Analysis of Technical Parameters of Volume Transport Trailers – Towards a Sustainable Product

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This study analyses the technical parameters of volume transport trailers used in agriculture. Its fundamental goal is to present their key technical properties with specific specifications (adapted to work on medium-sized and large farms), as well as to determine the choice of manufacturers that offer sustainable products. It is assumed that the technical parameters are closely related to the pro-environmental dimension (optimization according to needs). In order to achieving the main aim, partial objectives were formulated and implemented, such as: (a) to reconstruct and interpret relevant literature and selected documents (technology sheets, production and commercial specifications, directives, standards, etc.) and to select the technical parameters which are important from the perspective of customers and suppliers; (b) to compile a list of technical parameters constituting the foundation for the analysis. These specifications became the basis for defining the appropriate direction of further research work (comparison of the technical parameters of agricultural trailers from selected manufacturers), the results of which are presented in the work. The following hypothesis was adopted prior to the research procedures: Due to market requirements and the need to adapt products to regulations, the technical parameters of agricultural trailers with similar characteristics are comparable, regardless of the manufacturer. Therefore, based on the selected parameters, it is difficult to indicate a product that best meets the key requirements of a sustainable product. It is postulated that non-technological parameters, such as brand awareness and consumer experiences resulting from the pro-environmental and social positioning of the manufacturer, should constitute features of a competitive advantage.

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## 1. Introduction

The efficiency of the flow of goods on farms depends mainly on their access to technical means of production, such as means of transport and other devices that constitute a part of an agricultural logistic infrastructure. Operations, such as loading, unloading,

storage, or packaging, performed both inside and outside the farm, also play an important role [1].

Modern production technologies, the increase in the weight of transported agricultural produce and extensive logistic chains make it necessary to constantly

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improve the organization of transportation processes [2]. The efficiency of agricultural transportation can be improved mainly by ensuring appropriate work organization as well as by increasing its potency, capacity and velocity [3].

Agricultural transport is meant to move means of production, products and materials that are directly and indirectly related to farm production [4]. Therefore, farming activities require proper transportation solutions [5]. Transport is an important element of the technology for harvesting and preserving agricultural resources as it requires the use of various types of expensive high-performance technical means [6-7], with a high load capacity (volume) and speed [8] (it should be emphasized that the production of trailers with increasingly larger load capacities is directly related to the increasing demand for tractors with higher power).

As one of the basic activities connecting the entire technological cycle of production in agriculture, transport has a significant share in farming expenditure. It differs depending on the distances covered and the type of transported material [1-2], including specialized trailers with individualized parameters [9-10].

Trailer users increasingly expect solutions that meet their individual needs, as well as those that do not have a negative impact on the environment. Taking customer needs and environmental requirements (including carbon footprint reduction) into account, agricultural trailer manufacturers are working on the most optimal solutions toward decarbonization and improved safety, comfort, efficiency and ergonomics.

Providing these values (throughout the entire cycle, from production, processing, transport, storage to purchase and recycling) constitutes a premise which defines sustainable products [11-13]. It also implies the users' focus on various requirements, who increasingly take the latest design, construction, production and operation achievements into account. Agricultural trailers are "relationship-based" products, as users are also involved in the process of their creation. In the course of the research, it was found that it is users who, in a sense, define the values of highly individualized products, customized to their own needs and expectations. This is why increasingly efficient and modern production technologies that are not harmful to the environment are so important in the production process of agricultural trailers. New methods of organizing production

(aimed primarily at eliminating losses resulting from production processes) significantly define agricultural trailers as sustainable products that comply with EU directives. The compliance with technical specifications and environmental standards is crucial [14].

The above characteristics constitute objective opinions, views and judgments which provide a basis for formulating the parameters for the assessment of agricultural trailers important from the perspective of sustainability.

The study is meant to present the key technical properties that are characteristic of volume transport trailers with a specific (similar) load capacity range (adapted to work on medium-sized and large farms), as well as to determine the choice of a specific manufacturer, fitting into the idea of product sustainability. It is assumed that technical parameters are closely related to the pro-environmental dimension.

In order to arrive at the main aim of the study, it was crucial to formulate and implement partial objectives, which included: (a) using the method of reconstruction and interpretation of specialized literature and selected documents (technology sheets, directives, standards, etc.), selecting the technical parameters of trailers that are important from both the customer's and supplier's perspective; (b) compiling a list of technical parameters that constitute the foundation for the analysis (the sustainable product perspective).

Specific explanations became the foundation to define the appropriate direction of further research work (comparison of the technical parameters of roll-off trailers from selected producers and their analysis from the perspective of sustainability), the results of which are presented further in the study. The following hypothesis was adopted prior to the research procedures: Due to market requirements and the need to adapt products to regulations, the technical parameters of agricultural trailers with similar characteristics are comparable, regardless of the manufacturer. Therefore, based on the selected parameters, it is difficult to indicate a product that best meets the key requirements of a sustainable product. It is postulated that non-technological parameters, such as brand awareness and consumer experiences resulting from the pro-environmental and social positioning of the manufacturer, should constitute features of competitive advantage.

## 2. Agricultural trailers – construction, types and purpose

Agricultural trailers are among the basic machines necessary on every farm. They are mainly used to transport agricultural produce. Their types must be

carefully adapted to the profile of a given farm, i.e. to its size and the type of work performed. The agricultural trailers available on the market differ in

their purpose, properties and parameters. It is possible to choose from universal models (Fig. 1), which can transport various types of loads, as well as from

specialized models, adapted to a specific type of loading (Fig. 2).



**Fig. 1.** Pronar T672/1 universal trailer  
Source: Pronar internal materials



**Fig. 2.** Fortschritt bulk trailer  
Source: authors' own photograph

Agricultural products are characterized by great diversity due to their physical and mechanical properties (liquids, bulk materials, loose substances, portioned goods, people and animals) as well as distance. These properties determine their susceptibility to transport and reloading, and therefore require the use of appropriate means of transport. The appropriate selection of technical parameters reduces the expenditure of working time, as well as lowers transport costs [15]. The load capacity [19], assortment of transported material, diversification of the required efficiency and the buyer's financial potential are all of great importance, and as such, these factors determine the rich offer of agricultural transportation machinery. It can be divided into the following groups [16-17]:

- general-purpose trailers with which additional equipment may function as bulk trailers
- bulk trailers with a large load box capacity
- self-propelled and tractor loaders with various accessories
- universal platform trailers for transporting large cylindrical and cuboid bales
- special transporters for cylindrical or rectangular bales

- specially constructed self-loading and self-unloading trailers intended for loads of specific shapes (large cylindrical bales, small cuboid bales, large cuboid bales)
- self-propelled, self-loading and self-unloading transporters designed for loads of a specific shape (large cylindrical bales, small cuboid bales, large cuboid bales).

Agricultural trailers are generally divided into universal and specialized types. The former include tipper, which, thanks to their three-sided tipping potential, enable quick and efficient unloading. Specialized agricultural trailers are designed to transport a specific type of cargo. Their narrow specialization guarantees safety, but also limits the potential for transporting other loads. Trailers for transporting animals and straw in bales are known as specialized trailers [18].

Trailers may also be divided based on the number and the positioning of their axles. The following types are distinguished: (1) single-axle trailers, small and light, with a relatively low load capacity (up to 5 tonnes), therefore suitable for small farms; (2) two-axle trailers, which have a larger load capacity, are heavier and more difficult to manoeuvre, but are perfect for larger farms; (3) three-axle trailers that are very easy to manoeuvre and load; (4) tandem trailers,

usually equipped with two or three axles, placed in the rear part of the trailer, thanks to which a part of the trailer's weight is placed on the rear axle of the tractor. This solution makes it easier to pull the trailer, but it is more difficult to connect and disconnect it to and from the tractor; (5) shell trailers – designed to transport agricultural produce, such as potatoes, beets, carrots, as well as grain, e.g. corn or rapeseed.

Agricultural trailers are designed to transport bulky materials on farms and on public roads at a maximum speed of 40 km/h. They are metal structures, with a cargo box that tilts sideways and backwards. They are equipped with a pneumatic service brake (with braking force regulators, depending on the load) and a pneumatically controlled parking brake acting on the friction elements of the rear axle service brake. Trailers are equipped with complete signalling and warning systems (electrical installation and reflectors). Their chassis usually consist of a lower frame, a turntable frame, a turntable, a drawbar, wheel sets (front and rear) and suspension elements. The lower frame, the turntable frame and the drawbar are made as a welded structure from sheets and steel sections. The turntable frame, together with the ball turntable and drawbar, create the trailer's pulling and turning system. The drawbar is usually equipped with a drawbar unloading device with the ability to adjust the height of the drawbar eye when connecting the trailer to the tractor. Trailer wheel sets

consist of axles (front and rear), road wheels and road wheel brakes. The axles are made of thick-walled pipes with journals on which the wheel hubs are mounted on tapered bearings. Typically, they are single wheels equipped with drum brakes with shoes activated by mechanical cam spreaders. Trailer axle suspensions are usually made up of 4 steel leaf springs attached to the turntable frame and the lower frame by means of pins and sliders. The wheel sets are attached to the springs with screws.

The cargo space is made up of two frames: the upper frame (load box frame), which is mounted on the lower frame (chassis frame) in articulated sockets secured with pins, which become pivot points when tilting the upper frame (load box). The side walls and side extensions are single segments. Each segment usually has a separate set of locks, which in turn make it possible to close and open individual parts of walls and extensions independently of each other and in any order. This design increases functionality and facilitates operations, hence it is used by most manufacturers. The locks in the walls and extensions, as well as the latch of the chute window in the rear wall are protected against automatic, unwanted opening. The body consists of a frame to which vertical supports are attached, and depending on the purpose, full extensions or lines can be placed on the basic frame to increase the capacity of the load box (Fig. 3).



**Fig. 3.** Fortschritt bulk trailer with extensions  
Source: authors' own photograph

Trailers can be equipped with a hydraulic load box tilting mechanism, which is used to automatically unload them by tilting the load box backwards and sideways. With this solution, the hydraulic system of the tilting mechanism is supplied with oil from the tractor's hydraulic system. The hydraulic system then includes a connecting valve plug, a three-way distributor, flexible and rigid hydraulic lines, a single-acting

hydraulic cylinder, a shut-off valve, a connecting valve socket (for the second trailer) as well as other connecting and fastening components. A distributor in the tractor's hydraulic system is used to control the lifting and lowering of the load box.

A floor-slat conveyor with chains, driven by two hydraulic motors with a side box (Fig. 4) is an example of another unloading system.



**Fig. 4.** Bulk trailer with a floor and slat conveyor  
Source: author's own photograph

In this solution, profiled conveyor strips are arranged alternately, ensuring uniform load distribution. The hydraulic motors which move the floor conveyor have two speeds. The first speed makes it possible to start and gradually accelerate the floor

conveyor, while the second speed ensures quick and even unloading of the box. Trailers of this type can be equipped with two dosing rollers (Fig. 5). The unloading shafts are driven by a gear mechanism.



**Fig. 5.** Fortschritt bulk trailer with dosing rollers  
Source: authors' own photograph

Trailers can also be equipped with a movable front wall (Fig. 2), which, depending on the position, increases the capacity, increases the traction control of the tractor wheels and ensures better and faster unloading. Trailers are sometimes equipped with a foldable upper part of the front wall to allow the operator

to observe the loading of the trailer while collecting the substance, e.g. corn. Manufacturers use a folding cover for the loading channel as additional equipment when the machine operates only as a volume trailer. This prevents the loaded material from entering the loading rotor [1].

### 3. Technical parameters of selected agricultural transport trailers – similarities and differences

When analysing the key technical properties of selected agricultural trailers, attention was paid to the parameters that may determine the choice of a model from a specific manufacturer. Due to limited publishing possibilities, only selected models were analysed, although the research was related to all leading brands available on the Polish market, such as: Wielton, Joskin, Pronar, Bergman, Fortschritt, Fliegl, Stratumann and Krone.

In sustainable agriculture [20], trailers should be used for various technological operations, which the mentioned producers seem to have noticed. Therefore, the machines in their offer are often equipped with raised sides or a tilting rear side, features which adapt them to the transport of various materials. In most designs, the rear wall is raised upwards. It is also possible to install sheet metal mesh extensions or full extensions.

An in-depth analysis of the technological documentation allowed us to conclude that the studied transport trailers meet many requirements in terms of their functionality, ecology, operation, economy and safety [9]. The machines were characterized according to: (1) good quality of operation, (2) high load capacity of the box, (3) optimized tractor power demand, (4) potential for easy and reliable adjustment

of individual units (especially dosing), (5) durability and reliability, (6) versatile use, (7) easy connection with typical agricultural tractors, (8) high efficiency and low operating costs. Attention was also paid to the adaptation of the machines to compost with various physico-mechanical properties.

The environmental criteria [21] are of particular importance, and as such, they are included both at the stage of selecting raw materials and components used in the process of production. The products are designed to be recyclable or reusable, making waste management easier and less expensive. Therefore, manufacturers improve their own processes, as well as influence their suppliers and other market entities they come into contact with at various stages of the life cycle of the manufactured components and parts intended for initial assembly. When analysing the activities of individual producers, thinking in terms of the product life cycle is noticeable. This involves rational minimization of the negative impact of manufacturing processes on the environment, which includes employees, the natural environment as well as the minimization of post-production waste.

In response to the deteriorating state of the natural environment, these issues are becoming crucial. Therefore, a generation of safe, cost-effective and durable

transport trailers that are created during a clean production process should constitute the basis of a sustainable business model. Clean production means eliminating the harmful emissions of gases, liquids, solid substances and radiation from technological processes, limiting the waste of energy, heat, water, raw

materials and other production factors. As the analysis shows, the trailers presented in the study are safe and durable products. They display qualities of balance and are designed to be recyclable or reusable. Detailed data are presented in Table 1.

**Table 1.** Technical data - comparative analysis of agricultural transport trailers from selected manufacturers

Technical specifications	Wielton	Joskin		Pronar	Bergmann	Fliegl		Fortschritt
TYPE / MODEL	PRC-2/V40	SILO-SPACE 480D	SILO-SPACE 480T	T400	HTW 40S	ASW281	ASW381	T-088
Technical load* Administrative capacity** Permissible total weight*** [kg]	17 090* 13 500**	22 000*	26 000*	14 550** 23 000***	20 000- 24 000***	n/a	29 000***	13 000** 20 000*
Empty weight [kg]	7510	n/a	n/a	7450	7440	n/a	n/a	4000
Load capacity [m3]	40	44 (48)	49 (54)	40	39 (42.1)	30-45	30-45	28,6
Length of internal loading area [mm]	8355	7780-8830	8760-9560	8000	7460	8100	8100	5 600
Width of internal loading area. [mm]	2220	2340-2380	2340-2380	Trapeze 2080/2130	2400	2380	2380	2 330
Box height – internal [mm]	2025	2280	2280	2260	2200	2000	2000	2220
Total length [mm]	10 420	n/a	10100/2900/395	10 100	8980	n/a	n/a	6 350
Total width [mm]	2550	n/a	n/a	2900	2550	n/a	n/a	2600
Total height [mm]	3720	n/a	n/a	3950	3860	n/a	n/a	3700
Number of axles	2	2	3	2	2	2	3	2
Wheelbase [mm]	2100	2100	2100	2200	2100			1850
Suspension	Oleo-pneumatic system	Mechanical (shaft)	Oleo-pneumatic system (shaft)	Tandem on parabolic springs with passive steering system	Tandem	Tandem (parabolic springs)	Tridem parabolic (Giant)	Tandem
Tire size	560/60 R22.5	400R22,5 reinforced	400R22.5 reinforced	700/50-26.5	Wheel rim 26.5"	385/65 R 22.5 RE	385/65 R 22.5	550/40/22.5
Transport speed [km/h]	40	40	40	40	40	40	40	40

Source: authors' own compilation

The T400 trailer by Pronar deserves attention. It is a bulk trailer used mainly for transporting biomass. Its body is made of a bolted frame structure stiffening walls made of a galvanized trapezoidal profile. The box floor has a trapezoidal shape, and the rear part of the box is wider than the front part, which guarantees quick and reliable unloading of material, preventing it from getting stuck. The material is unloaded by means of a four-chain floor conveyor. The T400 trailer uses a tandem suspension (with a passively steered rear axle) on 4 parabolic springs, with equalizing wishbones, which ensures lower tire wear and prevents damage to the turf when turning, and at the same time allows coupling with a lower-power tractor. It is designed to be connected to a tractor's lower hitches. It is characterized by a simple, well-conceived and durable design that ensures long, trouble-free use [www1].

Bergmann HTW bulk trailers with a capacity of 34 to 55.5 m<sup>3</sup> were created for users who prioritize a fast working pace and economical solutions [www2]. Their quality and durability is high. They are characterized by a massive construction, driving stability and easy handling. Both its frame and its side profiles are galvanized and then painted or covered with plastic. The HTW series includes models with the following axle arrangements: (1) tandem with Boogie suspension (HTW 35, HTW 40), (2) tandem with hydraulic suspension (HTW 45), (3) tridem equipped with hydraulic suspension (HTW 65).

The HTW 40 model is a two-axle bulk trailer with 2 dosing rollers and a load capacity of 39 m<sup>3</sup>. It is equipped with a generator. A tandem chassis with hydraulic axle alignment is available as an option. The HTW 40 S is standardly equipped with a conical, bolted body, a steel floor, a drive on both sides of the transport floor and a hydraulically foldable forage harvester flap. A hydraulically foldable cargo cover is available as an option. The HTW 35 model has a slightly smaller capacity (34 m<sup>3</sup>). The HTW 45 is a two-axle volume trailer with a load capacity of 45 m<sup>3</sup>. It has a tandem chassis with hydraulic axle alignment for maximum driving comfort. This model is characterized by a high load capacity and long service life thanks to the torsion-resistant chassis and low weight. The HTW 50 is a three-axle trailer with a load capacity of 45 m<sup>3</sup>, while the HTW 65 model is a three-axle trailer with a load capacity of 52.1 m<sup>3</sup>.

To sum up Bergmann trailers, they are characterized by: (1) easy emptying thanks to the conical structure, even in the case of wet and heavy chaff, (2) clear visibility during loading and unloading thanks to a large window in the front wall, (3) easy chopping thanks to the serial 600 mm high chopping flap in the front wall, (4) easy emptying

even with heavy loads thanks to the wide-opening rear flap with high passage.

Fliegl offers ASW trailers with a revolutionary sliding system [www3]. Depending on the model, these trailers are available with a capacity of 20 to 50 m<sup>3</sup> in two- and three-axle versions. The manufacturer used an innovative scraping system that works in every application: from road and field transport to spreading manure (additional option). The material scraping system offers many advantages compared to tilting. It provides better stability thanks to its lower centre of gravity during transportation and unloading. ASW trailers are therefore characterized by: (1) low oil demand (limited telescopic actuators), (2) extremely durable scraping system (60% more loading), (3) 5 times shorter unloading time, (4) larger cargo volume due to compression (depending on the load up to 60%), (5) high stability thanks to the low centre of gravity during transport and unloading, (6) low weight (self-supporting structure), (7) the possibility of retrofitting with additional equipment (reloading auger or spreader).

The Fortschritt T-088 trailer [www4] is an ideal transport solution designed for medium-sized and large farms. Its high quality lies in the design and operation of individual components. The structure of the trailer's load box frame is made according to the principle of a central girder, thanks to which the trailer is adapted to transport loads exceeding even 20 tonnes. The system is based on the chassis, as well as on the tractor. This ensures easy and simple coupling and forward approach. The trailer has a multi-link suspension, thanks to which it copes better with uneven terrain. The chassis can be equipped with a steering axle and a pneumatic braking system (high manoeuvrability and high driving comfort). The scraper belt in the Fortschritt trailer consists of two "endless" chains that run side by side along the loading surface of the trailer. Each chain of the scraper belt consists of two chain strands, between which scraper rails are placed. The trailer can be equipped with a hydraulically movable wall to regulate the unloading throughput.

The PRC-2/V40 model by Wielton Agro with a load capacity of 13.5 tonnes [www5]. It works perfectly with modern self-propelled forage harvesters and agricultural tractors. Its supporting frame is a solid structure known from monocoque versions. The trailer's cargo box has a capacity of 40 m<sup>3</sup>. The trailer is characterized by increased durability, with its strongly profiled sheet metal walls, which compared to smooth steel walls, are not only lighter, but also more stable. Wielton PRC-2/V40 is mounted on two axles, with Boogie suspension. Its drawbar has hydropneumatic suspension. As standard, the trailer

has tires 560/60 R22.5. Thanks to the double slat-chain conveyor and the hydraulically opening tail-gate, its unloading is quick and efficient without wasting valuable time. The specialized version: Wielton PRC-2/V40 is used for transporting chaff and corn. It makes work more efficient, reduces the amount of physical work and reduces fuel expenses, which places the product high in sustainability.

Silo-Space2 by Joskin [www6] is a trailer model with a capacity of 44-59 m<sup>3</sup>. Thanks to its modern running gear, floor conveyor and suspension, it is a product that provides large limits in terms of load capacity and manoeuvrability. Silo-Space2 is offered in a version mounted on a double or triple axle. In the two-axle models, the drawbar suspension is mechanical and consists of a set of spring leaves placed transversely between the drawbar and the frame. In three-axle models, the drawbars are equipped with an oleopneumatic system, i.e. two-way hydraulic actuators and large-capacity nitrogen tanks.

The design of this trailer is based on a conical box with a floor conveyor, which ensures smooth and very quick unloading of green fodder. The self-supporting frame makes it possible to maximize the height of the load box, giving it an exceptional load capacity. To guarantee stability and durability of its floor conveyors over a long period of time, they feature by default 2 chain conveyors driven by 2 hydraulic motors with side gears. Their slats, made of closed profiles, are arranged alternately, ensuring uniform load distribution. The chains are characterized by high tensile strength. Two sets of 4 Ertalon guides, placed on both sides of the galvanized box floor, prevent the steel elements of the conveyor and the box floor from rubbing against each other.

The Silo-Space2 trailer is equipped with a hydraulic running system that makes it stable and drive well on the road as well as in the field. All Silo-Space2 trailers can be easily equipped with unloading rollers, DUO-COVER protective nets, hydraulic extensions and many other solutions.

#### 4. Discussion

The scrutiny of agricultural bulk trailers is justified by the balance of needs in their proper selection. The larger their load capacity, the higher the cost of their purchase, as well as the cost of cooperating machines, such as tractors (an increase in investment expenditure). Although the increase in load capacity significantly raises efficiency, it also increases fuel consumption.

The research clearly shows that the option of using trailers for additional technological operations, such as spreading, constitutes an important factor in

The new Krone GX series multi-purpose trailers [www7] are distinguished by the way they unload and load certain materials. This is made possible by the combination of a sliding front wall and a solid conveyor belt. This double unloading and loading unit is guided by two chains powered by two hydraulic motors. When the chains move backwards, the material is unloaded gently because it moves evenly along the entire length of the load box. It is not compressed, which occurs when only the sliding front wall is used. Krone GX series trailers are ideal for collecting "sensitive" agricultural produce (e.g. carrots, potatoes) from combine harvesters. The trailer's floor can be used when loading materials such as straw bales. They are placed in the rear of the load box and gradually moved toward the front until the trailer is completely full. This type of material is unloaded in a similar way by gradually moving it toward the rear end of the load box.

The horizontal unloading method of Krone GX series trailers makes it possible to use them in low buildings because their load box does not lift. The floor belt conveyor is made of a 2000 mm wide and 3.6 mm thick belt. Its surface is covered with polyvinyl chloride (PVC), which has thermoplastic properties, is characterized by high mechanical strength and is resistant to many solvents. Inside the belt, there are two layers of polyester fabric, thanks to which its breaking strength is 50 tonnes. The two chains leading the double unloading and loading unit are made of flat links. Each chain has a breaking strength of 25 tonnes, i.e. a total of 50 tonnes. Tractor drivers working with the Krone GX series trailer can freely observe the loading and unloading process of the load box. This is made possible by a largely transparent front wall, which is made of durable 1 cm thick polymethyl methacrylate, i.e. acrylic glass (Plexiglas), which is used e.g. in airplane windows [www8]. This material transmits 90-99% of visible light. The above is a premise that positions the Krone GX series trailer as a sustainable product.

minimizing the purchasing cost. It also reveals that as a consequence of market requirements and the need to adapt the machine to regulations, the technical parameters of trailers are very similar regardless of their manufacturer. Therefore, based on the selected parameters, it is difficult to indicate the product that best meets the key requirements of a sustainable product. It is therefore postulated that the non-technological parameters constitute a source of competitive advantage, such as brand or image.



When looking for a specific means of transport on the market, a set of benefits (values) provided by a specific manufacturer may be an important factor. These benefits include selected ergonomic or social functions and features. Buyers also pay attention to economy (maintenance costs), ecology and the manufacturers' pro-environmental activities. This trend includes the concept of sustainable management, which calls for not only passive adaptation to market needs, but also, where possible, for an active impact on the environment and humans.

The need to build a common market for green products and assess their environmental performance will make sustainable products the norm in the EU. The proposed actions are key to achieving the goals of the European Green Deal, the European growth strategy to transform the EU into a fairer and more prosperous society, and to implementing the key objectives of the Circular Economy Action Plan. They will contribute to achieving EU environmental and climate goals by doubling the circular material

consumption rate and achieving energy efficiency targets by 2030.

In the context of the above, each agricultural trailer manufacturer must answer the following questions:

- Where was the product produced (by whom and under what conditions)?
- What materials is it made of?
- Is it recyclable at the end of its life?
- How efficient is the product?

These issues are crucial due to the deteriorating state of the natural environment and regulations regarding sustainable products. Therefore, a generation of safe, economical and durable machines which are manufactured by means of clean production processes should be promoted. Creating goods based on clean production means eliminating the harmful emissions of gases, liquids, solid substances and radiation from technological processes, as well as limiting the waste of energy, heat, water and raw materials.

## Conclusions

The crucial observations from the perspective of the conducted research are as follows:

- The manufacturer's ability to effectively select key technical parameters so that their implementation supports economic, environmental and social goals is a sign of maturity in the area of the effective implementation of agricultural trailers into the product portfolio.
- Sustainable products, such as trailers offered by Wielton, Joskin, Pronar, Bergmann, Fliegl or Fortschritt, are an expression of a commonly held belief that economic efficiency, pro-environmental activity, and human orientation guarantee the effectiveness of a company's operations.
- Wielton, Joskin, Pronar, Bergmann, Fliegl and Fortschritt focus on features that are key to buyers and consistent with the requirements of the socio-economic environment.
- The development of sustainable products, such as trailers offered by Wielton, Joskin, Pronar, Bergmann, Fliegl or Fortschritt, takes place in

a reactive model, i.e. initially, the needs and requirements of the environment are identified, and subsequently a product that takes them into account is developed.

- Profit is important for Wielton, Joskin, Pronar, Bergmann, Fliegl and Fortschritt, but apparently, it is not treated as the only incentive in their developmental strategies. Instead, the offered products are a compilation of profit, environmental dimensions in addition to social needs.
- The users of agricultural trailers demand reliability, durability and ease of use. In order to meet their expectations, Wielton, Joskin, Pronar, Bergmann, Fliegl and Fortschritt produce highly advanced trailers, equipped with systems and technologies that aim to improve comfort, safety, efficiency, fuel consumption and accuracy of agro-technical procedures.
- Increasingly more modern and efficient trailers are made from high-quality materials, parts and components that are produced in highly developed production plants.

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