Influencing factors on agricultural transports and their effect on energy consumption and average speed

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Abstract: This article deals with the importance of transportation in agriculture, focusing on energy consumption and average speed of different agricultural transport vehicles. Transportation of goods is an important section of both logistics and agricultural production; therefore this article concentrates on the linkage of these two fields of study – agriculture and logistics. Against this background, current trends in logistics and their significance for and impact on agriculture are defined first. The presented data were collected via a road trial comparing agricultural transport vehicles to those commonly deployed in road haulage. The advantages of the well-established tractor lie – of course – in its high cross-country mobility and the many resulting fields of application on agricultural production. The off-road attributes of the tractor combined with the high level of soil protection are characteristics highly in its favor, especially when applying a single phase harvesting system. With multiphase transport chains on the other hand, the deployment of trucks can be the sensible choice because of their higher average speed and lesser fuel consumption compared to the tractor. Furthermore, the motorization of the tractor is a factor to be considered when choosing the right transport system, since a comparison between two forms of motorization showed clear differences in their road performance.

Keywords: agricultural transports, energy consumption, average transport speed, transport vehicle comparison

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1 Introduction

The international trade of goods is one major consequence of the proceeding globalization. Agricultural products, grain, for example, are naturally part of the worldwide distribution of goods, as well. Usually these international transactions are conducted by cooperatives or independent dealers who are able to bundle bigger quantities of grain than a single farmer. Figure 1 shows an overview of the worldwide trade flows in 2008, as they could be reconstructed from data collected by the World Trade Organization (WTO). It becomes obvious that particularly Europe plays a prominent role in the international trade of goods. Especially for Germany external trade is an important economic factor.

In 2012, Germany experienced another record year regarding its foreign trade volume. Exports increased by 3.4% and imports by 0.7% compared to 2011 (Statistisches Bundesamt, 2013). To realize the flow of goods as presented in Figure 1 in practice, a multitude of logistical processes has to be linked seamlessly and efficiently. This challenge starts with the production of all raw materials and ends with the distribution of the final product to the customer.

In this connection, transportation is the crucial link within the flow of materials between the participating stakeholders. In general, three types of transport processes can be found along the supply chain: intra-company transportation, inter-company

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transportation and transports from producer to consumer. Intra-company transportation is linked directly to the production process and is part of its structure and flow. This kind of transportation is characterized by the fact that no exchange of goods between independent production entities is undertaken. Inter-company transportation, on the other hand, takes place when finished (or half-finished) products are relocated to another (external) separated manufacturing plant. The third kind of transportation (from producer to consumer) supplies the end customer with ready-for-use products. Transportation can also be classified by the distance that has to be covered. The distance can even indicate the deployed mode of transport. Intra-company transportation can often be undertaken via stationary materials handling equipment (band-conveyor, roll conveyor, cranes etc.). If needed, also mobile handling devices (industrial trucks) can be used. Conducting local transportation, businesses usually find road vehicles (delivery vans, trucks etc.) to be their best choice. With increasing distance (i.e., supra-regional, national, and continental) and according to freight and given infrastructure, barges and rail might become an alternative to trucks. Dealing with intercontinental transportation, cargo ships and cargo aircrafts are additional options for product distribution (Mührel, 1968).

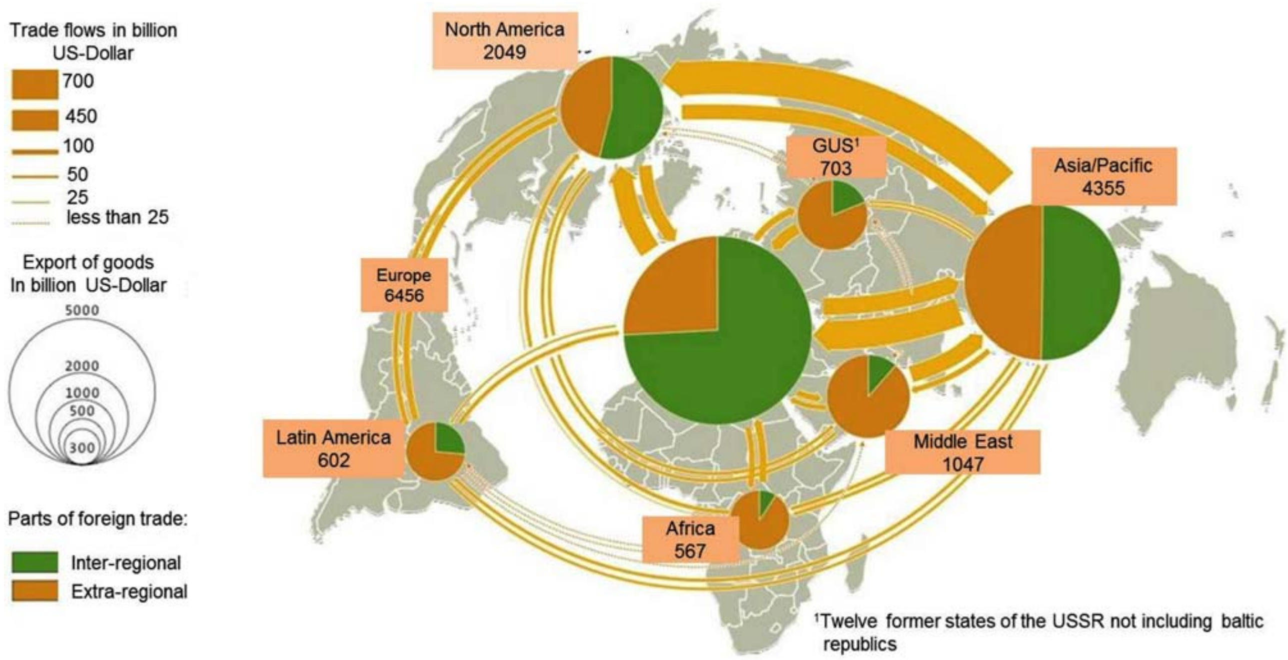

Figure 1 Worldwide trade flows 2008 (Le monde diplomatique, 2009)

Due to increasing internationalization of companies and (international) division of labor (e.g. crosslinking within the supply chain, upstream and downstream outsourcing of sub-processes) the importance of transportation is enforced even more (Ihme, 2008). In combination with the general tendency for product specialization and to individualize them after costumer requirements, the size of the single shipments is actually shrinking even though the flow of goods is massively increasing. This trend cannot only be discovered regarding the industrial production but also within the agricultural environment. Statistics from the Raiffeisen Waren-Zentrale Rhein-Main eG (RWZ, third biggest agrarian cooperative in Germany and service provider for agricultural logistics) show differences in the ordering behavior of businesses in the processing industry (mills, for example) during the last few years. The companies more frequently request smaller lots of grain of a certain quality than bigger amounts that have to be blended during processing. Transport logistics therefore has to adjust to these circumstances and to provide matching modes of transport. Hence, barges (loading capacity above 1,000 t (All used units of measurement within this article are based on the metric system i.e. 1 t = 1,000 kg)) or block trains (also above 1000 t capacity) are often no longer suitable for bulk logistics and trucks (25 t loading capacity, on average) are taking their place (Uhrig, 2013). The described circumstances are only some of the reasons underlying the trend shown in Figure 2. The illustration shows the split of different transport modes in Germany over nearly 60 years. It becomes obvious that road haulage - in past and present - plays the most important role in logistics.

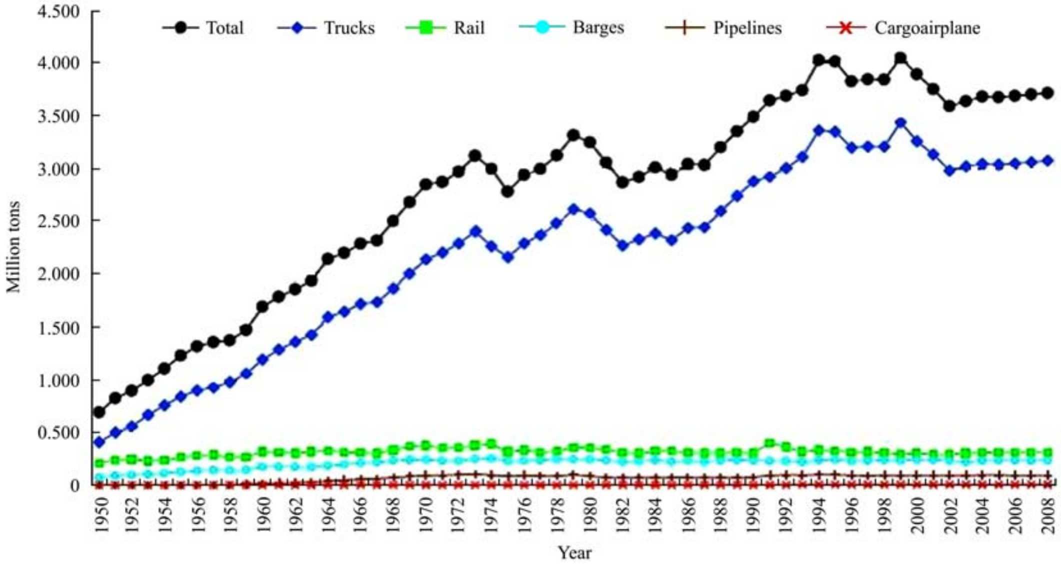

Figure 2 Split of transport modes in relation to amount of transported goods in Germany (Bundesverb and Güterkraftverkehr Logistik und Entsorgung (BGL) e.V., 2013)

In 1950, about 50% of the 750 million tons (t) of transported goods were distributed by truck, 30% by rail and 15% by barge. In 2008 about 75% of 3.8 billion tons (t) of goods were transported via road haulage while barge and rail each amount to 10%. Current data collected by the Federal Statistic Office of Germany show that this trend still continues. Total transports in Germany (that includes inland traffic as well as cross-border traffic) sum up to 4.4 billion t in 2011, of which 77.4% were conducted by road haulage. Accordingly, traffic performance (t multiplied by transported km, tkm) is calculated as 645 billion tkm (Statistisches Bundesamt, 2012). The other modes of transport remain on a comparatively low level.

When choosing the right mode of transport, both the amount of goods to be transported and the existing infrastructure have to be taken into account. Trucks often have the strongest advantages due to their flexible application and the splendidly developing road network systems. Even when selecting ship, rail or cargo airplane as line haulage, pre-carriage and onward-carriage mostly have to be carried out by truck. Hence, a constant use of barges/ships, rail, and cargo airplanes and a decreased employment regarding the growing freight volume, respectively, may be expected. Against this background and because this article focuses on (regional) transport activities in agriculture, its contribution is limited – in terms of content - to vehicles performing road haulage.

When planning transports – especially via road haulage – the serious increase in costs over the last few years has to be considered. Among other things, rising fuel costs, motorway toll for trucks, higher investment costs (for environmentally sound transport equipment, for example), and increasing personnel costs, are responsible for this development. Figure 3 shows the progression of the diesel price in Germany for large consumers.

It is almost impossible to charge the higher diesel costs directly to the costumers by increasing the freight rates because usually – especially with agrarian goods – product prices are low and cannot bear higher logistics costs. To achieve a (slim) margin though, down time (for example loading and unloading periods) has to be reduced to a minimum because the transportation provider is only paid for the movement of goods. Therefore the core challenge for the logistics branch is to adjust all processes to efficiency and to reduce costs.

The previous passages gave an overview on the current trends in logistics. The following sections will show the impact of logistics on the agribusiness and are meant to point out why trends in logistics also concern the agricultural branch.

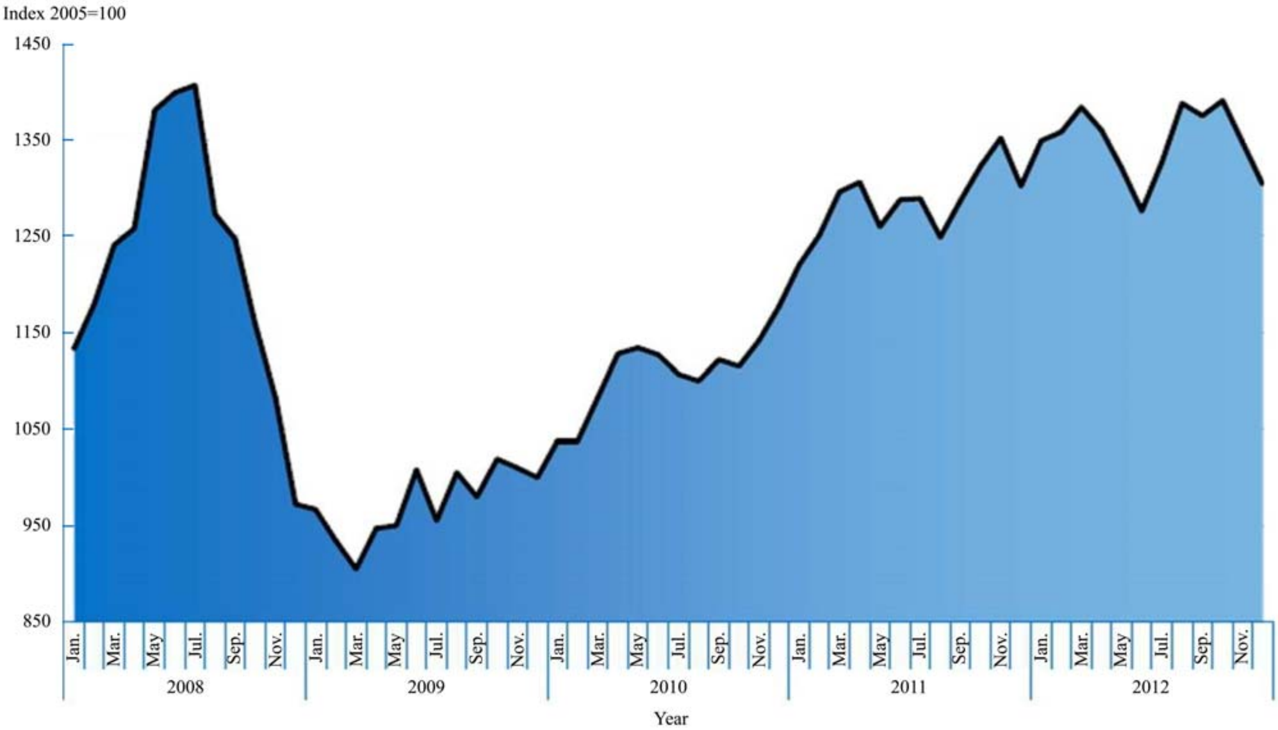

Figure 3 Price development for diesel fuel in Germany (Bundesverband Güterkraftverkehr Logistik und Entsorgung (BGL) e.V., 2013)

2 Historical investigation

First investigations on agricultural transportation and its costs were undertaken in the mid-19th century by J. H. von Thünen (1842). He already described the relationship between value of the grain for the farmer and the transportation costs that increase proportionally to the distance from the market and which therefore lower the value of the goods. In mathematical terms, this economical connection (storage rent, i.e. profit through marketability) can be described as following Equation (1) (Dunn, 1954):

$$L = MF \cdot (PF - KF) - MF \cdot S \cdot KT \qquad (1)$$

where, L: locally achievable storage rent, € ha^{-1}; MF: yield per unit of area, t ha^{-1}; PF: market price of crop, € t^{-1}; S: distance to market, km; KT: transport costs, € km t^{-1}.

Equation (1) shows an existing relationship between the arising transport costs and achievable storage rent. It can be concluded that reduced transport cost will lead to higher profits. Further scientific research and practical implementation of the developed thesis during the following 100 years is mainly conducted on bigger agricultural estates. Reasons for that development seem to be that bigger estates had the possibilities of documentation, knowledge of their costs, bigger field-farm distances than comparable farms, a higher percentage of fresh products (to be sold on the market) and the necessity to improve their processes (Bernhardt 2002). Only after the Second World War, scientific research in East and West Germany developed in very sophisticated but entirely different directions. Due to a different agricultural structure in East Germany (collectivization) and West Germany (private, small-scale), varying strategies for process improvement were designed. Since the agricultural structure of the former Democratic Republic of Germany (GDR) was based on large agricultural holdings, the optimization of all processes concerning transport, goods-handling and storage became the main point of interest (Mührel 1994). The current development in German agriculture, following the trend for (less but bigger farms (see below), brings out the timeliness of the historic GDR research.

The correctness of the observations from 1980s becomes obvious when taking a closer look to the stated problem areas:

a) Increasing the performance of all processes concerning transportation, handling of goods, and storage

b) Transportation of food and feed requires special attention regarding quality control

c) Area-connected production particularly requires efficient logistic processes because raw materials have to be supplied on the fields and the crop needs to be collected after harvesting

d) Locally produced crops have to be distributed to distant processing plants

e) Agriculturally utilized land is as well point of production as roadway

f) Agribusiness has to cope with different driving surfaces (field paths, country roads, federal roads, motorways)

g) Agricultural transport volume is underlying heavy seasonal variations

h) Agricultural traffic depends on many unswayable factors (climate, topography)

i) Different types of business do not allow for standard approaches (Mührel, 1983)

The politically motivated wish for autarky and the resulting pressure for increase in productivity in the former GDR resulted in intensive agrarian production. As a consequence, the transport quantities doubled within only ten years to 70-80 t ha^{-1} in 1990. Next to the increase in quantity, the transport distance that had to be covered also increased, on average about 5.5 km. Therefore, in the same 10 years, traffic performance reached 580 tkm (going out from 80 tkm). Due to active scientific agricultural research and quick implementation of their results through the state-owned industry for agricultural engineering, many vehicles specialized on transport, handling, and storage were invented and employed in the agricultural production cooperatives (LPGs) (Hahn, 1969). For contemporary storage of the increasing crop quantities, standardized and partly automated warehouses (especially for grain and potatoes) with capacities of 5,220 t or 1,885 t were built. Regarding goods, handling, forklifts, mobile cranes, wheel loaders, and front end loaders, were adjusted with special equipment for agricultural use (Helmholz, 1990; Helm, 1990). The first vehicles that were developed for agricultural transportation were combinations of tractors with 2-axle-trailers, usually with a special trailer construction for employment in agriculture (for example the HW 80.11 with heavy cargo chaff cutter for green waste transportation). In the following years the development of high-performance tractors became the focal point, though, when combined with certain types of trailers and a payload above 10 t, these vehicles lacked in road performance (Uhlemann, 1990). The employment of heavy tractors (like the K-700) with hitched trailers was dismissed soon, since these tractors would be needed simultaneously for transport activities and field work. To further increase haul capacity, the use of trucks was intensified, which made the former GDR a pioneer in the field of agricultural logistics. Therefore, four-wheel drive trucks which were technically built for the construction industry or military purposes were given new, agrarian superstructures. Due to higher speed and driving comfort, one truck can - above a transport distance of 5 to 6 km- accomplish the same output as two to three tractor and trailer combinations (Uhlemann, 1990). The substantial advantages of the truck are summarized as follows:

a) Higher performance due to higher speed

b) Less fuel consumption

c) Less dead weight per ton of payload

d) Better working conditions

e) Better running characteristics even with difficult road surfaces

The scientific evaluation results in an extended use of trucks in the former DDR. During the 1970s over 18,000 trucks were employed on agricultural holdings whose performance reached about 40% of all transported agricultural products (Mührel, 1990). These percentages were not only realized to reduce costs in multi-phase harvesting chains but also in single-phased chains, for example, in producing grass-silage (Schwandt, 1969).

3 Current problems

The agricultural structure surveys, conducted by the

German Federal Statistic Office in 2005 and 2007, shown that the utilized agricultural area decreased little over the last few years. The more conspicuous facts are that the over-all number of agricultural holdings is clearly going back but that the utilized area per active farm is constantly increasing (BMELV, 2010). As a consequence, greater distances have to be covered and bigger quantities have to be distributed. To conduct a smooth harvest additional farming and transport equipment have to be employed. Furthermore, the number of employed personnel in agriculture is declining and though 94% of the agricultural holdings are family businesses, seasonal workers have to be hired instead of family members working on the farm (BMELV, 2010).

Most of the developments in the field of harvesting techniques are based on the thought of increased efficiency, which is actually counterproductive regarding the growth of the utilized area per farm. The greater working widths of the combine harvesters are highly time-efficient and the harvest area per unit time can easily be increased by employing machines that are equipped with the latest technologies. For farms with large areas to harvest that sounds absolutely reasonable but the increased efficiency can also slow down the process and become a hindrance for the harvesting activities. Calculations for a common scenario show the mentioned difficulties: when employing four combine harvesters each with a working width of 9 m simultaneously and the harvested grain has to be transported over a distance of 30 km to a storage facility (silo), 28 tractor-trailers have to be provided to assure a smooth logistic process (Bernhardt et. al., 2008). This number of trailers that have to be held available to provide a smooth logistic process for the harvest activities of an entire region, neither the farmer nor a logistics service provider could supply. As a consequence, the farmers have to experience downtime of their harvesting machines and accept the unnecessary costs that are caused, when harvesters are standing on the fields waiting to unload their full tanks. In practice, these are of course not the only difficulties that affect a smooth and efficient harvesting process. A recurring problem is the increasing distances from the farms to the processing industry (or storage facilities). While grain and potato storage locations on average are still "only" about 20-30 km away, especially farmers cultivating sugar beet are suffering from the 80-100 km distances to the nearest sugar refinery (Bernhardt 2002).

All these facts show clearly that logistics - especially during harvesting season - is an important part of the agribusiness and that the processes need to be adjusted for the future for saving time and cost.

As mentioned before, the transport distances increased due to the centralization of storage facilities, the growing size of agricultural holdings, and also the growing number of biogas plants (Voß, 2009). Important parameters for harvesting logistics are therefore: the characteristics of the good, economy, ecology, law and contracts, climate, technical equipment, organization, and quality requirements (Döring, 2009).

Statistical data regarding fuel consumption in Germany show that in 2009, two billion l of diesel fuel were sold to the agricultural sector. Comparing the percentage, the agricultural branch is second in fuel consumption (5%) after the road traffic (Volk et al., 2011). It can be concluded that fuel consumption is one of the main economic influences on the agricultural sector and therefore a straight parallel to the logistics branch can be drawn.

As is shown in Figure 4, in Germany the transported quantities in agriculture come second to road haulage. In 2010, 398.3 million t of goods were distributed within the agricultural branch. Road haulage reached 3.209 million t. The traffic performance though shows the main difference between the two economic sectors. Road haulage usually covers greater transport distances since its purpose is to distribute goods. For the agricultural sector, transportation is a necessary evil to store crops or to supply the processing industry with raw materials. Though transport distances are increasing, compared to the average distances in road haulage, they are still small.

The large amount of transports in agriculture raises the question after the main transported goods. Data from the early years of the current century give a general idea of the product mix and are summarized in Figure 5

(Bernhardt, 2002).

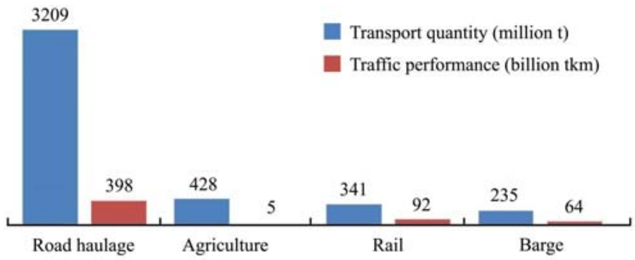

Figure 4 Inland transportation including agricultural sector (Götz et al., 2011)

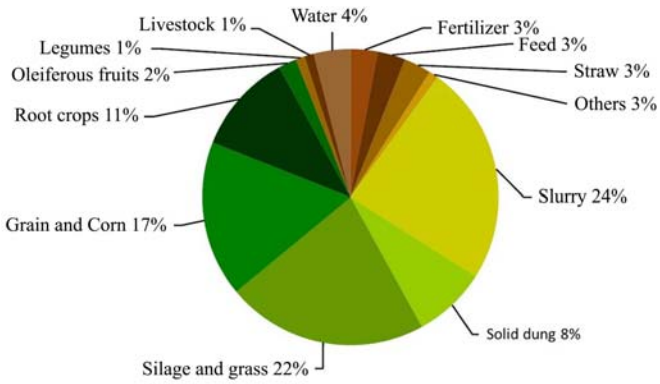

Figure 5 Split of transported agricultural goods at livestock farms after quantity (Bernhardt 2001)

The analysis of data from 92 agricultural holdings in Germany shows that 53% of all agricultural transports at livestock farms consist of solid dung, slurry, silage, and grass (Figure 5). Over a half of all transported quantities of this type of farm are therefore directly related to livestock breeding. At cash crop farms, though, grain, corn, and root crops sum up to one third of all transports. Transportation of water, feed, straw, fertilizer, oleiferous fruits, legumes, cattle, and other goods only account for a small percentage at both types of farm (Bernhardt and Weise, 2001).

For single-phase harvesting processes usually a combination of tractor and trailer is the transport vehicle of choice. But if the distance exceeds 5 to 15 km, these transports are economically critical (Döring and Schleicher, 2010). Multi-phase harvesting processes are characterized by a clear separation of field and road rides since the equipment can be adjusted for each type of surface. When conducting transports within multi-phase harvesting processes, according to the distance, towing vehicles with a maximum designed speed of 80 km h^{-1} can be interesting. Especially for longer distances, trucks (tractor-trailers or articulated trains) may be the right choice. Unimog or Fastrac also come with 80 km h^{-1} maximum designed speed but also contain the option of driving on the fields.

As a consequence of the current situation in agriculture, many farmers are looking for new logistic concepts for the harvesting season. The question is if the standard combination of tractor and trailer(s) is the everlasting best choice. Scientific (historic) research and practical reports show that the truck might be an alternative. The following chapters show practical tests as a first step to evaluate these alternatives economically and to give recommendations for future agricultural logistics.

4 Materials and method

In an experimental series (Engelhardt, 2002; Bernhardt et. al. 2008; Götz et al., 2011) the fuel consumption of different modern agricultural transport systems has been detected. The presented analysis was conducted in Hessen/Germany in 2011. The test track – as in the whole experimental series – includes cross-town routes and country roads in different states of development, which add up to a length of about 17 km. In this particular analysis, highway sections have not been covered.

Two common tractors with different power spectrums, a Unimog and a semi-trailer tractor, have been chosen for the road test. An overview of the towing vehicles technical characteristics is shown in Table 1.

Table 1 Key data of the deployed towing vehicles

	Tractor 121 kW	Tractor 243 kW	Unimog 210 kW	Semi-trailer tractor 310 kW
Nominal output/kW	121	243	210	310
Dead weight/kg	6985	10830	7480	7400
Lenght/m	4.75	5.65	6.11	5.93
Height/m	2.99	3.32	3.49	2.93
Width/m	2.57	2.75	2.50	2.40
Gearing	Infinitely variable transmission	Infinitely variable transmission	Manual transmission	Automatic transmission
Ad Blue reservoir/L	0	0	0	25
Maximum design speed/km h^{-1}	40	50	80	80

The trailer variants have been chosen carefully in order to match the towing vehicles. Two 18 t 2-axle trailers, a 3-axle trailer, and a semi-trailer (with or without dolly-axle) represent the available options (Table 2).

Table 2 Keyfigures of the deployed trailer variants

	18t 2-axle trailer	3-axle trailer	Semi - trailer	Dolly- axle
Dead weight/kg	4420	5900	8130	2180
Gross vehicle weight/kg	18000	24000	34000	13000
Pay load/kg	13580	18100	25870	
Length/m	7.35	8.20	10.10	
Height/m		1.70	2.00	
Width/m	2.55	2.45	2.50	

For every single vehicle combination the fuel consumption and the position and time data have been recorded. Referring to the fuel consumption this was conducted by flowmeter, while position and time data were recorded by a D-GPS receiver. The factors “type of vehicle”, “engine power”, “engine type”, “tyre equipment”, “type of street”, “landform”, and “traffic conditions” have been varied. For the planning of the single tests it was important that the chosen combination is also realistic in practice.

a) Fuel consumption

The analysis of the average fuel consumption shows severe discrepancies between the different vehicle configurations (Table 3). The semi-trailer truck exhibits the lowest fuel consumption, followed by the 121 kW tractor and the Unimog (with nearly similar fuel consumptions). The 243 kW tractor comes last, showing the highest consumption in the road test. Noticeable are the clear differences between the 243 kW tractor and the Unimog. Though the engine output is alike, the 243 kW tractor has a distinct higher fuel consumption.

Table 3 Average fuel consumption (l per 100 km)

	Tractor 121 kw	Tractor 243 kW	Unimog 210 kW	Semi-trailer truck 310 kW
Unloaded	44.47	53.89	39.23	35.87
Fully loaded	67.76	84.67	64.22	55.57

When planning transport-routes in different types of streets, their significant influence on the fuel consumption should be taken into consideration. Therefore, the fuel consumption of the different vehicle variants is analyzed with regard to the type of street (cross-town, urban roads, and country roads). The evaluation is based on a classic tour and therefore, consists of a fully loaded trip and a corresponding unloaded trip. Additionally, different trailer options for the tractor and Unimog variants were examined. These consist in case of the tractors of two agricultural trailers or a dolly-axle hitched with a semi-trailer. The Unimog on the other hand is either combined with a 3-axle-trailer or also with the dolly-axle including the semi-trailer (Figure 6).

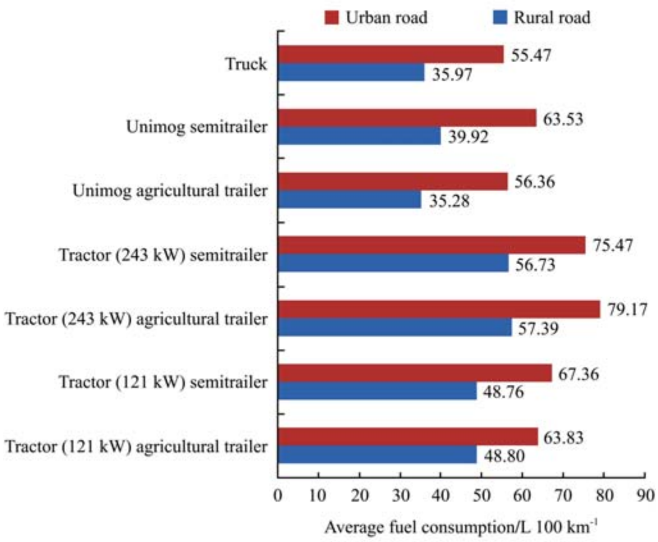

Figure 6 Average fuel consumption in connection to different types of road

All tested variants show clear differences between the types of road. The fuel consumption while driving on cross-town roads is higher, due to more acceleration and deceleration sequences. The Unimog even shows differences between the two trailer variants. The combination with the dolly-axle and semi-trailer responses as an articulated train leads to different handling characteristics. The single 3-axle trailer can be handled very easily and therefore, produces lower fuel consumption. Both tractor variants are articulated trains, so no explicit differences occur in the data.

b) Average speed

Concerning the average speed (Table 4), the truck shows the highest results followed by the Unimog and the 243 kW tractor. However, the unloaded tractor – due to its gearing mechanism – has an advantage in acceleration and therefore maintains a higher average speed. The

121 kW tractor – probably with cause to the low motor power – reaches only the lowest average speed.

Table 4 Average speed (km h^{-1})

	Tractor 121 kw	Tractor 243 kW	Unimog 210 kW	Semi-trailer truck 310 kW
Unloaded	29.33	35.39	33.49	38.42
Fully loaded	26.88	30.01	30.52	33.64

Concerning the average speed, a similar result as in the case of the fuel consumption arises for the different vehicle combinations (Figure 7).

c) Traffic conditions

Earlier road test showed a significant influence of current traffic conditions on the performance of the different vehicle combinations. Therefore, the traffic situation on the cross-town route (Figure 8) and one of the country roads (Figure 9) during the road test has been recorded.

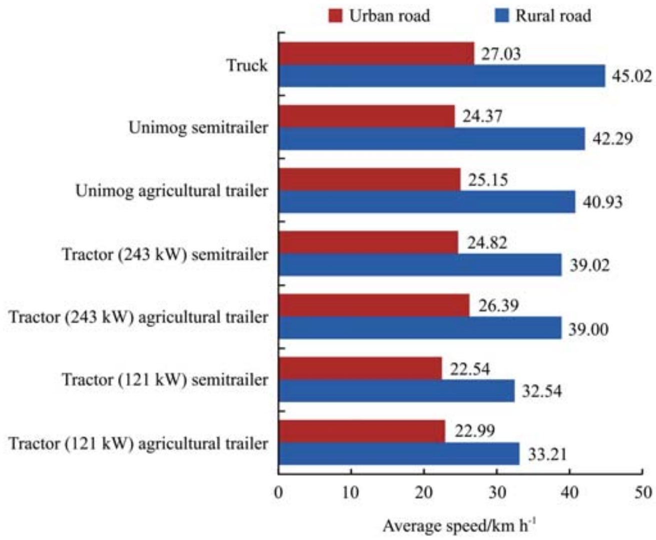

Figure 7 Average speed on different types of street

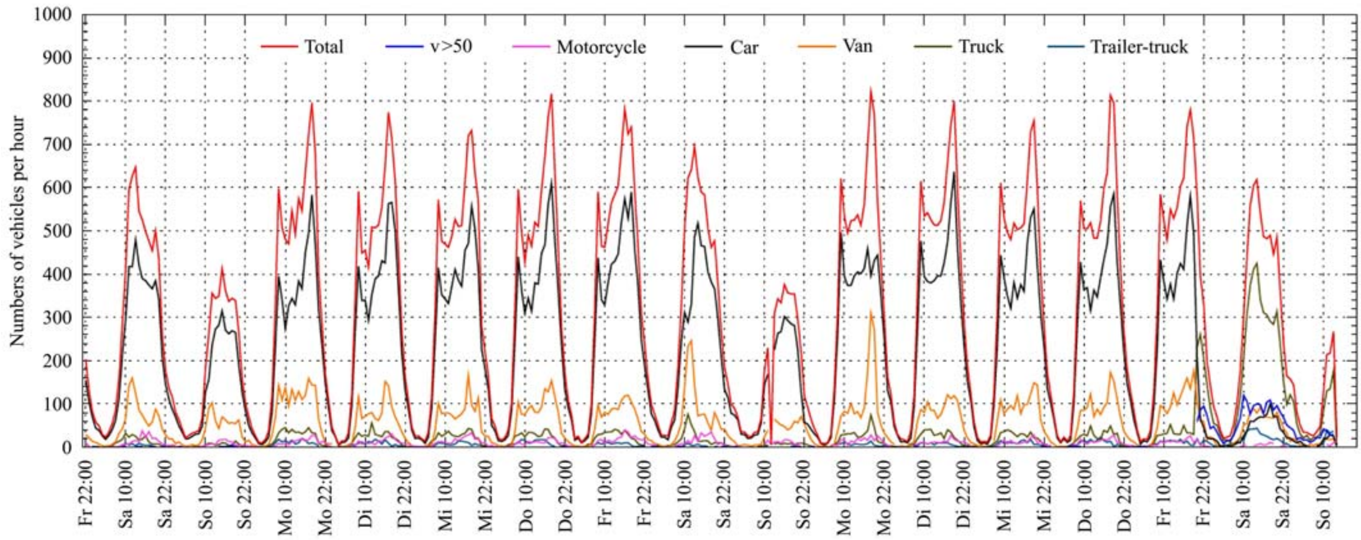

Figure 8 Traffic situation cross-town

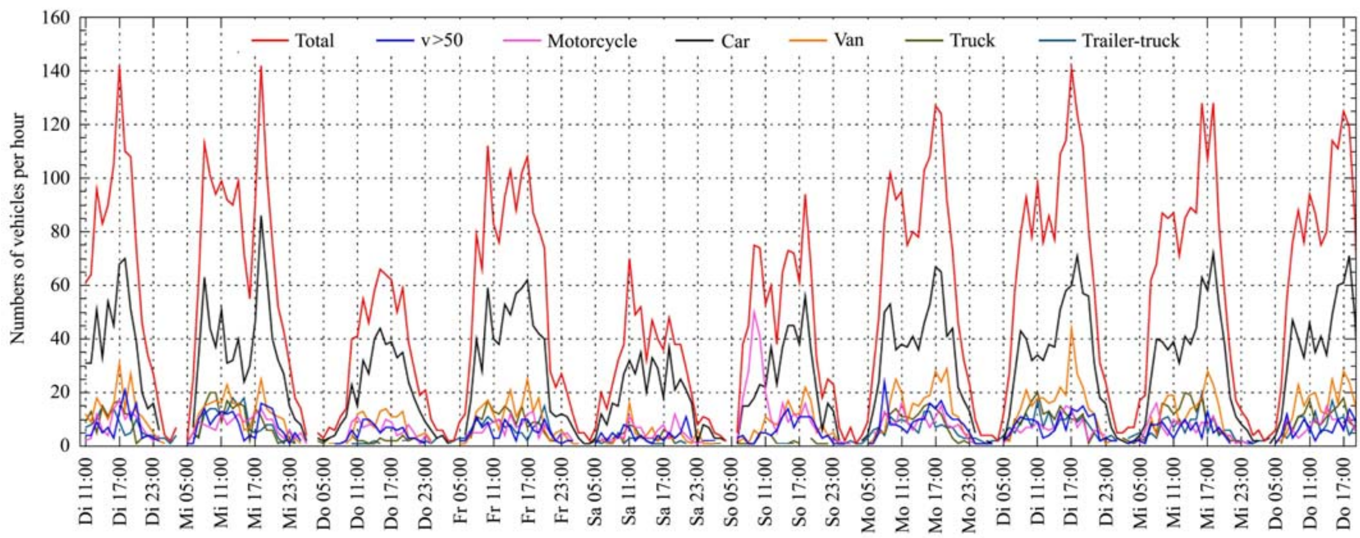

Figure 9 Traffic situation country road

In the case of the cross-town route, on weekdays, traffic increases up to 9 a.m. then decreases until 3 p.m. At 8 p.m. traffic reaches its daily climax, and then drops rapidly. On Saturdays, only slight traffic occurs. The traffic volume peaks – other than on weekdays - around 10 a.m. and then slowly decreases. Sundays, a third traffic pattern could be recorded: the overall traffic is less than on the other days with its climax around noon. Summarizing the traffic analysis, it can be said that the time slice, in which queues of traffic result in road users influencing one another intensively, is 23.57% of the complete traffic volume. Heavy goods vehicle traffic accounts for 11.67%.

The traffic situation on country roads seems to be structured alike, though it is conspicuous that the variations during the day are more distinct, than on the cross-town route. The percentage of heavy goods vehicle traffic adds up to 19.84% but has no major influence on the complete traffic volume, since the percentage of queues of traffic on country roads is only 11.86%.

5 Discussion

The comparison of the different vehicle combinations concerning their fuel consumption shows the advantages of trucks in classic transport business. The Unimog – though related – show in the fully loaded status higher fuel consumption than the truck, due to less motor power. Since it is designed for a broad field of applications, especially the 243 kW tractor cannot keep up with the classic transport vehicles, because of high fuel consumption when performing sole transport functions.

The analysis of the fuel consumption in relation to different types of road (cross-town and county road) shows higher fuel consumption for cross-town routes. This result should be taken into account, when trying to optimize transport routes.

Through the analysis of the motorization level of the different vehicle combinations, it can be shown, that a higher level of motorization in the trucks, leads to a reduction of fuel consumption for overland drives, due to the lower engine speed. This observation could not be made for the tractors.

Regarding the tractors, a higher engine power leads to a higher average speed, especially during acceleration and while driving uphill. But energy savings could not be observed by the analysis of the transport capacity.

The small (121 kW) tractor offers a significantly inferior acceleration performance which leads – especially on routes that include a great deal of stop-and-go situations – to a lower average speed. The 243 kW tractor and the Unimog indicate only slight differences concerning their average speed. Even the truck doesn't show significant advantages in the matter of average speed on the analyzed types of street: directly compared to the unloaded 243 kW tractor, the unloaded truck is only 0.5 km/h faster, if both vehicles are fully loaded, the truck is 6 km h^{-1} faster than the tractor. Only when it comes to driving on the highway, the truck becomes the vehicle of choice due to its permitted maximum speed of 80 km h^{-1}.

The analysis of the traffic situation suggests an off-peak transport planning, preferably during the late afternoon, to capitalize from higher average speed and less fuel consumption.

Summarizing it can be said, that there is potential for the optimization of the energy consumption in agricultural transports. There are different possibilities for optimization according to the emphasis which is laid on the single factors.

6 Conclusions

The latest developments within the agricultural sector require a lot of flexibility from the farmers, especially during the harvesting periods. Smooth logistical processes are an important factor for a successful crop year. To implement suitable logistical processes, it is necessary for the framers to know their costs and to have an idea on how to reduce them. This article gives an overview on possibilities to reduce costs in the agricultural transport sector. Even if the truck seems to be a great alternative to standard tractor and trailer combinations, it is not a universal remedy. Since the truck is not applicable as working machine the tractor will remain an important member of the farming equipment. Each agricultural holding has individual structures and processes that have to be considered before changing their basic concepts of transport. For some farms it may be interesting to employ trucks or Unimogs, others should consider an outsourcing option and allocate their transports to a logistic service provider. To make a safe decision the next step of scientific research will be to develop an algorithm containing all relevant variables (for example route characteristics, individual characteristics of the examined farm, traffic volume etc.) that allows to give individual recommendations for each farm.

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