Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 25, Issue 1, 2025
PRINT ISSN 2284-7995, E-ISSN 2285-3952

THE IMPACT OF TRANSPORTATION ON THE WHEAT PRODUCTION COSTS

Cristian-Răzvan MARIN[1], Ancuta MARIN[2]

[1]National University of Science and Technology Politehnica Bucharest, 313 Splaiul Independentei, District 6, 060042, Bucharest, Romania, E-mail: cristian.marin0507@upb.ro
[2]Research Institute Agriculture Economy and Rural Development, 61 Mărăști Boulevard, District 1, 011464, Bucharest, Romania, Phone: +40213136087, Mobile: +4087700676, e-mail: ancuta.marin@yahoo.com

Corresponding author: ancuta.marin@yahoo.com

Abstract

Cereals play an important role in both human and animal nutrition. Their transportation from cultivated areas to warehouses and/or silos requires detailed and efficient planning, so that deliveries to consumers are made in a timely manner, with minimal losses in the supply chain. The performance of agricultural producers is negatively impacted by infrastructure constraints related to the sustainability of crop production, which artificially raise transportation costs and hazards. Maintaining an agricultural enterprise's profit margin requires effective fuel cost management. Cost optimization involves adopting measures to reduce all cost elements, starting from those that have the highest share in total expenses and eliminating those considered less useful in the respective process. The paper aims to determine the share of transport costs, in this case diesel, in production costs and their influence on total expenses. The methods used included a bibliometric study of the literature and a study case was presented based the technologial sheet and also the substantiated wheat crop budget, at Research Institute for Agricultural Economy and Rural Development (ICEADR). Based on the data, a model was created to highlight the share of diesel transport costs in total variable costs, respectively total cost. The results proved that the cost of diesel for moving specialized means of transport has a significant share of the total expenses. Farmers have to carefully plan trasnportation taling into account the types of means of transportation, the distance, the wheat amount, the cost of diesel so that to minimize these costs.

***Key words*:** *transportation, grain, diesel, production costs*

INTRODUCTION

Wheat and corn are part of the primary crops category, constituting staple foods for the majority of the world's population. Globally, cereal production in 2022, according to FAOSTAT, was 3,698,383 thousand tons [9].
World wheat production in 2022 was 944,928 thousand tons, representing 25.6% of global cereal production. In the same year, corn production was 1,439,302 thousand tons, representing 38.9% of global cereal production. The world population was 9.37 billion people in 2022. It is estimated that in the next 25 years it will reach 9.8 billion people. In order to feed everyone, cereal production would have to increase by 70-100% [13, 32, 9].
This problem is exacerbated by the drastic reduction in the area of fertile land available for cereal cultivation and by the reduction in yields, with climate change having a major impact on them [34] which determine farmers to adapt wheat technologies. L. You and collaborators stated in 2009 that a 1°C increase in temperature during wheat cultivation would lead to a 3-10% decrease in yield [15, 16, 30, 33].
Cereal production in the European Union decreased as a result of climate change and rising agricultural input costs, particularly for fuel, which have an impact on farmers [24].
According to Gammans, Mérel, and Ortiz-Bobea's 2017 analysis of the effects of climate change on French wheat crops, wheat yields would decline by 3.5–12.9% over the medium term (2037–2065) and by 14.6–17.2% over the end of the century [10].
Consequently, "in a world where population size is increasing and reaching unsustainable levels, a drastic reduction in agricultural

yields of the main cereal crops could significantly hinder food security" [32].

The opening of domestic markets to international competition from around the world has resulted in a shift in focus from the farmer level to the supply chain level. It is essential to look at whether there are more effective ways to plan and run a supply chain in order to handle these new problems [1].

Planning is crucial to reducing food waste and maximizing food quality because crops are prone to spoiling both before and after harvest.

An essential component of the supply chain is the transportation of products from the place of production to the place of consumption, at the right time and with minimal loss of quantity and quality. Intermediaries can buy grains, store them and sell them to processors, but small farmers can carry out these activities limited by the lack of good intermediate storage and transportation conditions. To reduce losses, better coordination between production, transportation and processing capacities is needed [18].

According to estimates by the Food and Agriculture Organization (FAO) of the United Nations, approximately 1.3 billion tons, or 32% of the total weight of food produced for human consumption, was wasted across the food supply chain [9]. Improper transportation planning, timely deliveries, inappropriate demand-production scenario, inadequate infrastructure, and highly inefficient supply chain are the main causes behind this [20].

Also, the exiting conflicts in thee Black Sea Basin has created huge problems related to cereals transportation from Ukraine to the harbour of Constanta [6], affecting the Romanian producers and transporters.

Logistics is one of the many aspects that must be integrated to improve the financial performance and sustainability of agricultural producers.

A crucial component of creating long-lasting connections between farmers, storage and transportation firms, and consumers along food supply chains is the establishment of economical and efficient transportation. In this sense, transportation costs and hazards are artificially raised by infrastructural limitations on the sustainability of crops, which lowers agricultural producers' performance.

Since fuel consumption is the most significant expense in agricultural logistics and is especially susceptible to interruptions in the infrastructure for loading, transportation, and storage, controlling fuel costs is essential to maintaining an agricultural business's profit margin.

Cost optimization must take into account the atomization of the storage structure, the fluctuation of fuel consumption depending on the degree of loading of vehicles and last but not least the use of own means of transport vs. outsourcing it [11].

In this paper we focus on determining the share of transport costs (diesel) in production costs and their influence on total costs.

MATERIALS AND METHODS

As other researchers have emphasized in their works, the cost of fuel is the part with the largest share in transport costs. Therefore, the work was based on a bibliometric analysis that was substantiatedon the SCOPUS database for searching, filtering and extracting scientific articles relevant to the subject addressedwith 2005-2023 as the reference period. The review began by studying the identified scientific articles, filtered by title, abstract and keywords.

During the analyzed period, the number of published research shows an increasing trend, with most of the analyzed works focusing on short-term perishable products, such as fruits and vegetables, not on cereals.

Based on the Technological Sheet and the Substantiated Crop Budget, by Research Institute for Agricultural Economy and Rural Development (ICEADR), a model was created that highlights the share of transport costs (only diesel), in total variable costs, respectively total costs.

RESULTS AND DISCUSSIONS

The transportation of cereals means placing on the market safe products intended for human or animal consumption. Regulation (European Comission) No. 852/2004 lays

downfood hygiene requirements [27]. Cereals delivered by farmers are transported by agricultural trailers or trucks, with farmers having the obligation to keep the internal and external cleanliness of the means of transport, to check and record the nature of previous loads. Food safety must be ensured at all times during the transport.

Road transport may be provided by own means or by external transport companies. Supply by sea is rarer, but in our country, even if the cereals have been transported by water, they are picked up at the harbor by the Romanian Railways (CFR) and National Railways Transportation Company (UAGPS) hopper cars or trucks for transportation to the beneficiary. In the case of the trains, the equipment provided is specialized, i.e. intended exclusively for the transport of raw agricultural products (cereals, oilseeds, pulses, other plant products and products derived from them).

Studying the available literature, it emerged that there are a number of external factors that the farmer cannot influence to increase profit: weather, market demand, available offers for grain transport and handling, but also many others that can be controlled,e.g. on-farm or third-party storage costs,transportation costs that add to the value of production.

Reducing transportation costs relies on organizing an efficient flow from the field to the warehouse.

The dependence on transportation increases as on-farm storage capacity decreases. Since demand is at its highest during the harvest season, transportation expenses are typically at their highest. On-farm storage allows farmers to supply during periods of low demand, which lowers transportation expenses. How is it more cost-effective for farmers to transport grain? With their own or rented transport means?

Simplified theoretical calculation model regarding the share of diesel expenses in total expenses

The choice involves an estimation of the transportation cost, in which sense we will build a theoretical example.

Traditionally, cereals are transported by road using tractors with trailers and trucks or by rail usinghopper cars. Trucks are, however, used more often in recent years, becoming the most common means of grain transportation. A large part of the total costs of wheat production are logistical costs, which is why their reduction is a major objective for any farm manager [2, 4, 17, 31].

Numerous factors influence how logistics costs are calculated, which is why several ways of grouping the cost elements that make up logistics costs have been suggested. Rushton et al. [28] added administrative costs to the three cost components that Sople [29] had identified: inventory, warehousing, and transportation. In contrast to Lambert et al. [19], Zeng and Rossetti [34] developed a different set of five essential logistics cost components: transportation, storage, order processing/customer service, administration, and warehousing. Ayers [3] identified five components of logistics costs: purchased materials and related labour, transportation, warehousing, inventory, and packaging.

Table 1. Systematization of logistics expenses

COSTS	***LOGISTICS EXPENSES***	***GENERAL EXPENSES***
DIRECT EXPENSES	- transportation costs - handling costs - storage costs - customs duties - documentation costs	- storage costs - time value - operating cost
INDIRECT EXPENSES	- packaging cost including materials - logistics equipment cost - costs related to logistics support functions	- a decline in sales - customer support - the price of non-marketable products - the exchange rate

Source: [26].

Rantasil and Ojala [26] systematized logistics costs by arranging them according to the direct, indirect and general cost size (Table 1). In current terminology, fuel, insurance, and car rentals are examples of direct costs, while general expenses resulting from operating a business (general, administrative or set-up costs) are known as indirect costs and are distributed equally between vehicles in use [28].

We will explain only two terms from Table 1, the others are clear from the name. Within the general expenses, the value of time refers to the costs associated with the use of a specific amount of time - an employee's time or equipment, to accomplish an activity. These represent an operatingcost and are not subject

to depreciation. However, depreciation can be indirectly influenced by the value of time, namely: the depreciation of a truck or piece of equipment is related to the time of its actual use.

An asset that is used more intensively or more often may lose its value more quickly, and its depreciation will reflect this.

In the case of grain transport, non-tradables refer to products or services that do not have a distinct brand or are not clearly differentiated on the market, but are rather standardized and not linked to a recognized brand.

These goods are generally characterized by lower prices and less active promotion and are more difficult to differentiate from similar ones.

Cereals such as wheat, maize or barley, which are not associated with a specific brand or label are non-marketable products. They are transported without an identificationmark and sold "in bulk" on the market, under generic names.

In general, companies transport grain in bulk without providing special services and therefore cannot add additional value to the transport through monitoring technologies or premium services.

This fact integrates them into the category of non-marketable or unbranded service.

A truck or train car used to transport grain, which is not part of a specialized vehicle fleet associated with a known brand, can also be a non-marketable good or equipment.

Regardless of the means of transport used, the carrier is responsible for guaranteeing the safety of the transported products, so that during loading and transport itself, the risk of chemical, microbiological and/or physical contamination of the product is as low as possible.

For the model built, we will supose that the area cultivated with wheat is irrigated. This is 250 ha, and the production achieved is 6,150 kg/ha.

In order to determine the share of transport costs in production costs and their influence on total costs, we will take into account several pieces of information:

Table 2. Characteristics of means of transport

	Truck with trailer	**Semi-trailer truck**
Load capacity (Tons)	20-25	40-42
Volume (m^3)	60-80	70-100
Distance travelled/trip (round trip) (km)	10	10
Average fuel consumption (liters/ 100 km)	23-25	30-40

Source: [7].

In 2024, the price per liter of diesel varied between 7.67 lei (July 15, 2024) and 6.98 lei (September 30, 2024), the calculated average being 7.30 lei/liter.

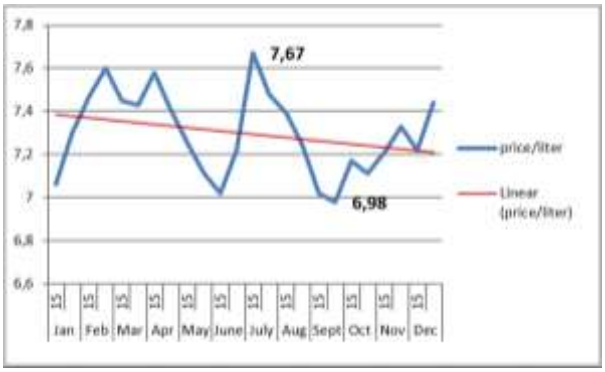

Fig. 1. Evolution of the price per liter of diesel, bimonthly, 2024
Source: [23].

Table 3. Calculation of the diesel for mechanized works

	Amount of diesel fuel consumed (liters/hectare)	Cultivated area (ha)	Total diesel fuel consumed (liters)	Average price per liter of diesel during the period (lei/liter)	Total diesel cost (lei/total cultivated area)
Mechanized works from crop harvesting (July) to sowing (October)	51.3	250	12,825	7.325	93,943
Mechanized work from crop harvesting (February) to harvesting (July)	35.9	250	8,975	7.272	65,266
TOTAL			**21,800**		**159,209**

Source: own calculations.

The total cost of mechanized work per hectare is obtained by dividing the total cost of diesel by the area or by multiplying the amount of diesel per hectare by the average price per

liter. The result is an average cost of diesel of 637 lei/hectare.

From the framework estimate for wheat cultivation prepared by ICEADR, the calculation of the diesel costs for mechanized works is shown in Table 3.

According to GEO no. 115/2023, art LIII (120), a state aid for diesel is granted which in the period January 1 - June 30 was 1.746 lei/liter and in the period July 1 - December 31 of 2.079 lei per liter. It follows that accessing the state aid for diesel reduces the expenses for the fuel necessary for mechanized works by 42,567 lei (26.74%) for the total cultivated area (Table 4).

Table 4. Calculation of the cost of diesel for mechanized works in case of accessing the subsidy

	Average price per liter of diesel during the period (lei/liter)	**Total diesel cost (lei/total cultivated area)**
Mechanized work from crop harvesting (July) to sowing (October)	5.19	66,562
Mechanized work from crop harvesting (February) to harvesting (July)	5.58	50,081
TOTAL		**116,642**

Source: own calculations.

To this cost of diesel for mechanized work is added the cost of diesel necessary to transport the harvest from the field to the farm. The total production achieved on the 250 ha area is obtained by multiplying it by the production per hectare (6,150 kg/ha) and converting the result into tons:

250 ha · 6,510 kg/ha = 1,537,500 kg = 1,537.5 tons

We will suppose that the farmer has the following means of transportation to transport the entire production:

- truck with trailer: 1,537.5 tons / 25 tons (maximum load capacity) = 62 roads
- truck with semi-trailer: 1,537.5 tons / 40 tons (maximum load capacity) = 38 roads

We calculated the cost of diesel fuel required for transport from the field to the on-farm warehouse when using a truck with a trailer, as well as when using a truck with a semi-trailer. In the case of subsidizing diesel fuel, the average price per liter was 5.19 lei per liter. This results in a reduction in the costs of diesel fuel required for transport from the field to the warehouse from 1,135.38 lei to 804.45 lei for the truck with a trailer, respectively from 1,113.40 lei to 788.88 lei for the truck with a semi-trailer (Table 5).

Table 5. Calculation of the cost of diesel for wheat transportation from field to warehouse

	Total distance from field to farm (km)	Specific consumption of means of transport (liters/100 km)	Required amount of diesel	Average price per liter	Total cost of diesel for harvest transport (lei)
Truck with trailer	620	25	155	7.325	1,135
Semi-trailer truck	380	40	152	7.325	1,113

Source: own calculations.

These expenses will be added to those incurred with the diesel fuel necessary for mechanization works:

A. in case the diesel fuel is not subsidized and the harvest is transported by truck with trailer:
   159,209 lei + 1,135 lei = 160,344 lei
B. in case the diesel fuel is not subsidized and the harvest is transported by truck with semi-trailer:
   159,209 lei + 1,113 lei = 160,322 lei
C. in case the diesel fuel is subsidized and the harvest is transported by truck with trailer:
   116,642 lei + 804 lei = 117,446 lei
D. in case the diesel fuel is subsidized and the harvest is transported by truck with semi-trailer:
   116,642 lei + 788 lei = 117,430 lei.

According to the Framework Budget for irrigated wheat crop, carried out by ICEADR, the variable expenses per hectare are 4,359 lei. For 250 ha, the value of these expenses will be 1,089,750 lei.

The calculated percentage of diesel expenses was:

– 14.71% of total variable expenses when using non-subsidized diesel;

– 10.78% of total variable expenses when using subsidized diesel;

– 12.71% of total expenses when using non-subsidized diesel;
– 9.31% of total expenses when using subsidized diesel.

Fuel costs are the largest component of transport costs [8, 28]. Fuel is especially important in agriculture, because specialized agricultural machinery and transport vehicles consume more fuel than typical commercial vehicles. Hence, farms must set up and store large fuel reserves during the winter months due to the seasonality of farming activities.

Fuel costs are more volatile due to the constant increase in fuel prices [8]. Reducing fuel costs contributes most to increasing the profit rate of farms and expanding market areas, allowing more agricultural producers to localize and specialize. [14, 22].

In many countries, the current trend in the agricultural sector is the concentration of farms, food industries and wholesalers into fewer large-sized ones. [5, 25].

Large farms (horizontal integration) arise even in nations with plenty of land as a result of the infrastructural and market shortcomings that agricultural producers face, particularly logistics. [12].

Furthermore, in response to the deficiencies found, vertical integration helps agricultural producers responding to infrastructure and market imperfections.

CONCLUSIONS

Climate change is an increasingly important issue due to its increasingly devastating consequences on every aspect of our lives, from health to the economy. The greatest negative impact of climate change is observed on agriculture, generating significant production losses.

Extreme events that result in a sharp decline in the amount of arable land available for farming are partially to blame for the losses, while other factors include a decline in production yields brought on by undeveloped, sunburned, etc. plants.

In agriculture, methodologies for assessing logistics costs are uncommon. This is a result of the wide range of cost elements involved and the complex interactions within the logistics system. As a growing number of agricultural enterprises contract out their transportation needs to specialist companies, understanding and evaluating transportation and fuel costs becomes critical to profitability.

The paper presents a simplified calculation model to understand the importance of logistics in the wheat production process. It was highlighted that a significant share of the total expenses is the cost of diesel for moving specialized means of transport. Minimizing these costs remains a topic of interest for farmers, and careful planning of transport is recommended, as well as the choice of technically appropriate means of transport. In the case of large farms, requesting specialized help from logistics specialists should not be neglected, their presence bringing considerable benefits to the farm.

REFERENCES

[1]Ahumada, O., Villalobos, J.R., 2009, Application of planning models in the agri-food supply chain, European Journal of Operational Research, Vol. 196(1), 1-20, https://doi.org/10.1016/j.ejor.2008.02.014

[2]Arskiy, A., 2018, Management Triad in the Management of the Organization. Mark. Logist. 4, 5–13.

[3]Ayers, J.B., 2006, Supply Chain Project Management. In A Structured Collaborative and Measurable Approach; Auerbach Publications, Taylor & Francis Group: Boca Raton, FL, USA.

[4]Ballou, R.H., 1999, Business Logistics Management: Planning, Organizing, and Controlling the Supply Chain, Prentice-Hall: Upper Saddle River, NJ, USA.

[5]Bosona, T., 2013, Integration of Logistics Network in Local Food Supply Chains; Swedish University of Agricultural Sciences: Uppsala, Sweden.

[6]Chiurciu, I.A., Soare, E., Voicilas, D.M., Certan, I., 2023, Aspects regarding the production and marketing of cereals in the Black Sea basin area. Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 23(1), 39-146.

[7]Dascalu, R., 2019, Ce greutate maxima poate transporta un TIR incarcat cu cereale (What maximum weight a TIR full of cereals can transport?), Agrointeligenta, https://agrointel.ro/118309/greutatea-maxima-tir-camion-cereale, Accessed on January 10, 2025.

[8]El Bouzekri, E.I.A., Elhassania, M., Ahemd, E.H.A., 2013, A Hybrid Ant Colony System for Green Capacitated Vehicle Routing Problem in Sustainable Transport. J. Theor. Appl. Inf. Technol. 54, 198–208.

[9]FAOSTAT, Analytical Brief 79, Agricultural Production Statistics, 2000-2022, https://openknowledge.fao.org/server/api/core/bitstreams/fba4ef43-422c-4d73-886e-3016ff47df52/content, Accessed on January 5, 2025.
[10]Gammans, M., Mérel, P., Ortiz-Bobea, A., 2017, Negative impacts of climate change on cereal yields: Statistical evidence from France. Environ. Res. Lett. 12, 054007.
[11]Gao, T., Erokhin, V., Arskiy, A., 2019, Dynamic Optimization of Fuel and Logistics Costs as a Tool in Pursuing Economic Sustainability of a Farm, https://doi.org/10.3390/su11195463, https://www.mdpi.com/2071-1050/11/19/5463
[12]Gebresenbet, G., Bosona, T., 2012, Logistics and Supply Chains in Agriculture and Food. In Pathways to Supply Chain Excellence: Groznik, A., Yu, X., Eds.; InTechOpen: London, UK, pp. 125–146.
[13]Godfray, H.C.J., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., Pretty, J., Robinson, S., Thomas, S.M., Toulmin, C., 2010, Food security: The challenge of feeding 9 billion people. Science, 327, 812–818.
[14]Gonzalez, J.A., Guasch, J.L., Serebrisky, T., 2007, Latin America: Addressing High Logistics Costs and Poor Infrastructure for Merchandise Transportation and Trade Facilitation; World Bank: Washington, DC, USA.
[15]Hawkesford, M.J., Araus, J.L., Park, R., Calderini, D., Miralles, D., Shen, T., Zhang, J., Parry, M.A., 2013, Prospects of doubling global wheat yields. Food Energy Secur. 2, 34–48.
[16]Howden, S.M., Soussana, J.-F., Tubiello, F.N., Chhetri, N., Dunlop, M., Meinke, H., 2007, Adapting agriculture to climate change. Proc. Natl. Acad. Sci. USA, 104, 19691–19696.
[17]Jia, P., Sun, X., Yang, Z., 2012, Optimization Research of Refueled Scheme Based on Fuel Price Prediction of the Voyage Charter. J. Transp. Syst. Eng. Inf. Technol.12, 110–116.
[18]Kusumastuti, D., van Donk, P., Teunter, R., 2016, Crop-related harvesting and processing planning, International Journal of Production Economics, Vol. 174, 76-92, https://doi.org/10.1016/j.ijpe.2016.01.010
[19]Lambert, D.M., Stock, J.R., Ellram, L.M., 1998, Fundamentals of Logistics Management, McGraw-Hill: New York, NY, USA.
[20]Maiyar, L.M., Thakkar, J.J., 2017, A combined tactical and operational deterministic food grain transportation model: Particle swarm based optimization approach, Computers and Industrial Engineering, Vol.110, 30-42. https://doi.org/10.1016/j.cie.2017.05.023
[21]Manole, D., Giumba, A.M., Popescu, A. 2023, Technology adaptation and economic efficiency for winter wheat crop in the conditions of climate changes – South-East Romania, Dobrogea area, Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 23(4), 487-514.
[22]Nordmark, I., Ljungberg, D., Gebresenbet, G., Bosona, T., Juriado, R., 2012, Integrated Logistics Network for Locally Produced Food Supply, Part II: Assessment of E-Trade, Economical Benefit and Environmental Impact. J. Serv. Sci. Manag. 5, 249–262.
[23]PECO Online, Evolutia preturilor la benzina si motorina in Romania (Evolution of petrol and diesel price in Romania, https://www.peco-online.ro/istoric.php, Accessed on January 10, 2025.
[24]Popescu, A., Stanciu M., Serban, V., Ciocan, H.N. 2022, Cereals production and price in the European Union. Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 22(4), 565-578.
[25]Ragkos, A., Samathrakis, V., Theodoridis, A., Notta, O., Batzios, C., Tsourapas, E., 2015, Specialization and Concentration of Agricultural Production in the Region of Central Macedonia (Greece). In Proceedings of the 7th International Conference on Information and Communication Technologies in Agriculture, Food and Environment (HAICTA 2015), Kavala, Greece, 17–20 September 2015.
[26]Rantasila, K., Ojala, L., 2012, Measurement of National-Level Logistics Costs and Performance. In Proceedings of the 2012 Summit of the International Transport Forum, Leipzig, Germany, 2–4 May 2012.
[27]Regulation No. 852/2004 of the European Parliament and of the Council on the hygiene and foodstuffs, https://www.fao.org/faolex/results/details/en/c/LEX-FAOC063426/#:~:text=This%20Regulation%20lays%20down%20general,requirements%20relating%20to%20food%20hygiene. Accessed on January 5, 2025.
[28]Rushton, A., Croucher, P., Baker, P., 2010, The Handbook of Logistics and Distribution Management, Kogan Page: London, UK.
[29]Sople, V.V., 2007, Logistics Management. In The Supply Chain Imperative; Dorling Kindersley (India) Pvt. Ltd.: Delhi, India.
[30]Tripathi, A., Tripathi, D.K., Chauhan, D., Kumar, N., Singh, G., 2016, Paradigms of climate change impacts on some major food sources of the world: A review on current knowledge and future prospects. Agric. Ecosyst. Environ. 216, 356–373.
[31]Van der Vorst, J.G.A.J., Snels, J., 2014, Developments and Needs for Sustainable Agro-Logistics in Developing Countries, World Bank Group: Washington, DC, USA.
[32]Wang, J., Vanga, S.K., Saxena, R., Orsat, V., Raghavan, V., 2018, Effect of Climate Change on the Yield of Cereal Crops: A Review - https://doi.org/10.3390/cli6020041 https://www.mdpi.com/2225-1154/6/2/41
[33]You, L., Rosegrant, M.W., Wood, S., Sun, D., 2009. Impact of growing season temperature on wheat productivity in China. Agric. For. Meteorol.149, 1009–1014.
[34]Zeng, A.Z., Rossetti, C., 2003, Developing a Framework for Evaluating the Logistics Costs in

Global Sourcing Processes: An Implementation and Insights. Int. J. Phys. Distrib. Logist. Manag. 33, 785–803.