

Evolution and Application of the Brazilian Legislation for the Traffic of Tractors on Public Roadways

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Abstract

The evolution of Brazilian agricultural mechanization increased, within with the cultivated area, searching to satisfy the demand for food. The agricultural tractor is the main source of power in meeting this demand. However, due to its increasing use, incidents have been observed in public roadways. The lighting and signaling elements of these machines are critical in preventing these occurrences, and there is, in Brazil, legislation in this area, the CONTRAN (National Traffic Council) and the Ministry of Labor. The objective of this study was to demonstrate the evolution and application of the Brazilian law for the lighting and signaling requirements for tractors on public roads traffic and relate these aspects to scientific studies relevant to the topic. Through the study, it was observed that there was an evolution in the Brazilian legislation, especially since 2014, with the term of CONTRAN Resolution no. 454. From this evolution, there was misalignment between the items required by the different legislative bodies on the subject and, in addition, the provisions from both the CONTRAN and the Ministry of Labor have no technical and/or dimensional requirements relative to the location of items on the machine. The scientific studies analyzed showed that there was also progress in the implementation of legislation in new agricultural tractors. However, it is not enough for the machine to leave the factory in a proper way, it must be maintained in working conditions for its operation. Finally, it was observed the need for the implementation of awareness campaigns on the context of road safety and the use of methods for assessing their effectiveness.

Keywords: accidents, lighting and signaling, highway, mechanization

1. Introduction

The world population is growing and, consequently, it increases the demand for food in the world (Gergoletti, 2008), making it necessary the use of technologies in agricultural production, given that they contribute significantly so that we can meet such a need (Matos & Pessôa, 2011). Thus, aiming at sustainability and food security, the Brazilian agricultural production needed to be optimized (Molin, Amaral, & Colaço, 2015). This occurred with the increase in cultivated area, clearing of agricultural borders, implementation of new technologies and farming practices. The combination of these techniques enabled the production scale, turning Brazil into one of the major producers of soybeans in the world (Espíndola & Cunha, 2015); and still has the potential to increase its agriculture production by 40% by the year 2019, according to Vieira Filho, Gasques, and Sousa (2011).

The mechanization in Brazilian agriculture has followed the development of agricultural borders since the manufacturing of the first national tractors units in 1960. The new scale production scenario demanded tractors with more power and technological innovation, in the pursuit for higher productivity and reduction of production cost (Ferreira Filho & Felipe, 2007; Oliveira, 2000; Melo, 2012; Vian et al., 2013; Silva Junior, 2017). This reality required a renewal of the tractor fleet to provide compatibility, since they cannot be adapted to older

machines (Ferreira Filho & Felipe, 2007; Vian et al., 2013). This way, Brazil presented in 2016 the newest tractor fleet composition of the past 29 years, with more than half of the machines with up to ten years of use, according to Bellochio et al. (2017).

The tractor is characterized as the main source of power for rural areas (Rinaldi et al., 2016), being widely used in agricultural activities. The increasing use of tractors in the agricultural mechanization process caused the evolution of safety measures. On the other hand, incidents remained. According to Silva (2015), the use of tractors contributes to placing the agricultural activity among the ones with the highest risk of accidents, and Fernandes et al. (2014) point out that working with tractors is highly susceptible to accidents. In addition, the International Labor Organization (ILO) highlights that about one in three rural work accidents involving agricultural machinery result in worker's permanent disability (ILO, 2004).

Work incidents are of enormous social and economic importance. Statistical studies have shown the seriousness of this problem, either for their incidence, or the age of the injured, or their consequences. These accidents are becoming increasingly common not only in farms but also on highways, due to the constant traffic of agricultural machinery between production areas, to change the workplace or to transport goods and supplies (Monteiro, 2010).

As for the intensification of tractors displacement on public roads, Greenan et al. (2016) observed that the increase in the risk of collisions with farm machinery is related to the increase in the annual average number of vehicles circulating daily on American highways in the state of Iowa. When comparing the number of accidents involving tractors to the number of accidents involving passenger vehicles and transportation, the values are lower. However, when comparing the severity of the accident, those involving agricultural tractors show higher values than other vehicles. This fact shows the high degree of danger that these accidents represent (ANSR, 2014; Monteiro, 2014).

The elements of lighting and signaling of agricultural machinery are essential in preventing accidents on public roads. In a study in the American agricultural areas, Ramirez et al. (2016) show that the greater the compliance of agricultural machinery with the requirements of ASABE lighting and signaling standards, the less likely they are to be involved in accidents on public roads.

There are in Brazil, legislating in this area, the CONTRAN (National Traffic Council) and the Ministry of Labor (MTE). Thus, the aim of this study was to demonstrate the evolution and application of Brazilian law for the lighting and signaling requirements of tractors for the traffic on public roads, as well as to relate these aspects to scientific studies relevant to the topic.

2. Brazilian Legislation on Agricultural Tractors Lighting and Signaling for Traffic on Public Roadways

2.1 Brazilian Traffic Law

Conceição (2017) conducted a retrospective study related to the legislation that deals with the traffic issue in the country. The study highlights Decree number 8,324, from 1910, as the first on the subject, being promulgated about a decade after the arrival of the first car in Brazil. From this point came the need to expand and further detail the laws, when in 1941 it was approved the first National Traffic Code by Decree-Law number 2,994, with wording altered in the same year by Decree-Law number 3,651, where the National Driver's License (CNH, in Portuguese) became mandatory. In 1966, there was the adoption of the second National Traffic Code, by Law no. 5,108 and 31 years later, in 1997, under the Law no. 9,503, it was set up the CTB (Brazilian Traffic Code), currently in effect. This evolution is shown in Figure 1.

Table 1. Chronological evolution of Brazilian traffic law

Traffic law			
Year	Event	Legislation	Situation
1900	First car in Brazil	-	-
1910	First Brazilian legislation concerning traffic	Decree no. 8,324, of October 27 th , 1910	-
1941	First National Traffic Code	Decree-Law no. 2,994, of January 28 th , 1941	-
1941	Change in the wording of the National Traffic Code	Decree-Law no. 3,651, of September 11 th , 1941	-
1966	According to National Traffic Code	Law no. 5,108, of September 21 st , 1966	-
1997	CTB - Brazilian Traffic Code	Law no. 9503, to September 23 rd , 1977	In force

Source: Adapted from Conceição (2017).

In view of the technological evolution, the increasing population and vehicle fleet, as well as the interrelationships of traffic and the number of accidents, it is necessary to demand that the competent bodies are aware of the changes to innovate and adapt the legislation to this reality. In this sense, the CTB has already undergone several amendments, mainly related to mandatory equipment. In 1998, the CONTRAN (National Traffic Council) Resolution no. 14 (1998) came into force, establishing mandatory equipment for the fleet of vehicles in circulation, thus to be able to circulate on public roads the vehicles should provide the required equipment, to be found by the inspection in working order. The scope of this resolution includes the following categories of vehicles, according to DENATRAN (2017):

- Automotive vehicles and electric buses;
- Trailers and semi-trailers;
- Mopeds;
- Scooters, motorcycles and tricycles;
- Four-wheelers;
- Wheeled and mixed tractors and
- Track-type tractors.

Referring to tractors, this resolution remained unchanged until the end of 2013, when it was replaced by CONTRAN Resolution no. 454 (2014), currently in force and which comprises a further array of items in the subject compared to the previous resolution. Figure 2 shows the chronological evolution of resolutions related to the equipment required for tractors.

Table 2. Chronological evolution of the resolutions related to mandatory equipment for tractors to circulate on public roads

Mandatory equipment-CTB				
Year	Event	Legislation	Situation	Mark
1998	CONTRAN Resolution no. 14	Law no. 9,503 of September 23 rd , 1997 Decree no. 2,327 of September 23 rd , 1997	Increased by Resolutions no. 34/98, 43/98, 87/99 and 44/98, 46/98 and 129/01. Altered by Resolutions no. 87, 228, 259 and 592/16	Establishes mandatory equipment for the fleet of vehicles in circulation and other measures (includes wheeled and track-type tractors).
2014	CONTRAN resolution no. 454	Law no. 9,503 of September 23 rd , 1997 Decree no. 4,711, of May 29 th , 2003	In force	Alters the CONTRAN Resolution no. 14 to establish new safety items and dimensions for agricultural and construction tractors, among others, capable of transiting on public roads.

Source: Adapted from DENATRAN (2017).

2.2 Brazilian Legislation on Occupational Health and Safety

In addition to the CTB, the Ministry of Labor and Employment also has legislation on safety and lighting items in tractors. Law no. 6,514 of 1977 approves the NRs (Regulation Rules) on Occupational Safety and Medicine. Discussing the issue, NR 31 (2005) and NR 12 (2010) are highlighted.

The Regulation Rules (NR) on occupational safety and health are obligatory for private and public companies and public agencies of direct and indirect administration, as well as the bodies of the legislative and judiciary that have employees covered by the CLT (Consolidation of Labor Laws). Failure to comply with laws and regulations on safety and health at work will cause to the employer the application of the penalties provided in the legislation (MTE, 2017).

The NR 31 (2005), published in 2005, concerns occupational safety and health in agriculture, livestock, silviculture, forestry and aquaculture. This provides, among others, general principles for agricultural machines. With respect to lighting, self-propelled machines manufactured from May 2008 must have the following items: headlights, position taillights, horn, rear view mirror and automatic reverse beep coupled to the transmission system. The self-propelled machines manufactured before this date must have headlights and horn.

In this sense, the NR 12 (2010), referring to Safety in Machinery and Equipment, also addresses this issue. This rule has undergone several updates and, in the review published in 2010, in order to cover and specify machines and applications sets, included such items for the lighting of agricultural tractors. Thus, it is possible to see in Figure 3 the chronological evolution of the Regulation Rules in the aspect related to the lighting of agricultural tractors.

Table 3. Chronological Evolution of the Regulation Rules related to lighting in tractors

Mandatory equipment-MTE			
Year	Event	Legislation	Mark
1977	NR (Regulation Rules)	Approved by Law no. 6,514, of December 22 nd , 1977, through Ordinance no. 3,214, of June 8 th , 1978	No specific requirements of lighting for tractors
2005	Establishes the NR 31: Occupational Safety and Health in Agriculture, Livestock, Silviculture, Forestry and Aquaculture	MTE Ordinance no. 86 of March 3 rd , 2005 Undergoes changes: MTE Ordinance no. 2,546, of December 14 th , 2011 MTE Ordinance no. 1,896, of December 9 th , 2013	It establishes, among others, general lighting principles for agricultural machinery manufactured from May 2008
2010	Review of NR 12: Safety in Machines and Equipment	Annex inserted by MTE Ordinance no. 197 of December 17 th , 2010	Adds Annex XI relating to machines and implements for agricultural and forestry use, which aligns with the NR 31 the general principles of lighting for agricultural machinery manufactured from May 2008

2.3 Items Related to Lighting and Signaling in Tractors, According to the Legislation Requirements of CONTRAN and Ministry of Labor and Employment

Based on the evolution of the legislation aspects on this area, it is possible to draw a parallel comparison between the requirements of the different regulations from CONTRAN and Ministry of Labor and Employment (MTE) with their in force period, seen in Figure 1.

	CONTRAN Resolution no. 14	MTE NR31	MTE NR12	CONTRAN Resolution no. 454
Period in force	From February 1998 to December 2013	From March 2005-Present	From December 2010-Present	From January 2014-Present
Headlights	X	X	X	X
Position taillights	X	X	X	X
Brake lights	X	-	-	X
Reverse lights	-	-	-	X
Automatic audible reverse signal coupled to the transmission system	-	X	X	X
Horn	-	X	X	X
Turn signal lights, front	X	-	-	X
Turn signal lights, rear	X	-	-	X
Hazard lights	-	-	-	X
Back plate lighting	-	-	-	X
Retro Reflective tapes	-	-	-	X
Rearview mirror	X	X	X	X
Seat belt	-	X	X	X
Rollover protective structure (ROPS)	-	X	X	-

Figure 1. Comparison of legislative requirements of CONTRAN and MTE for items related to lighting and signaling in tractors

The data analysis shows that the CONTRAN legislation has become more comprehensive over the years, having a greater range in lighting and signaling requirements of tractors when in traffic on public roadways. Currently, the amount of items required by Resolution no. 454 (2014), which is in force, is 216% higher than Resolution no. 14 (1998), which lasted until the end of 2013. The added items were related to lighting and reverse sound signal, horn, turn signals, rear plate lighting, retro-reflective tapes and seat belt.

Regarding the MTE, the requirements in this area, given by NR 31 (2005) and NR 12 (2010), are more recent, becoming effective in 2005 and 2010, respectively. As for the number and content of the requirements, they are equivalent in the two regulations and the items are contained in the resolution CONTRAN no. 454 (2014), except for the rollover protective structure. However, they present a significantly lesser extent as compared to the CONTRAN no. 454 (2014) resolution, being similar to the former resolution CONTRAN no. 14 (1998).

3. Brazilian Scientific Research Related to Compliance of Lighting and Signaling Items in Tractors

3.1 Assessment of Lighting and Signaling Items in New Tractors and in Use, Prior to 2005

From the legal aspect, it is possible to analyze the scientific studies that carried out the verification in the field of the presence of lighting and signaling items in tractors in use and in new tractors, over the years.

In this regard, Correa et al. (2005) evaluated the safety conditions of 487 tractors in use in 270 properties and 31 new tractors available in dealerships and on display at agricultural fairs in São Paulo state, from August 2000 to December 2001. They found that the tractors in use do not favor the safety and comfort of the operator, while new tractors show a tendency to fulfill the safety and comfort requirements, having as favorable points, in most cases, the requirements for traffic on highways. Out of these, the device which was most often available in the analyzed tractors is the headlight. It can be seen in Figure 2 a comparison of the percentage of presence of the analyzed items, for the traffic on public roads, of tractors in use and tractors available to the market in 2001.

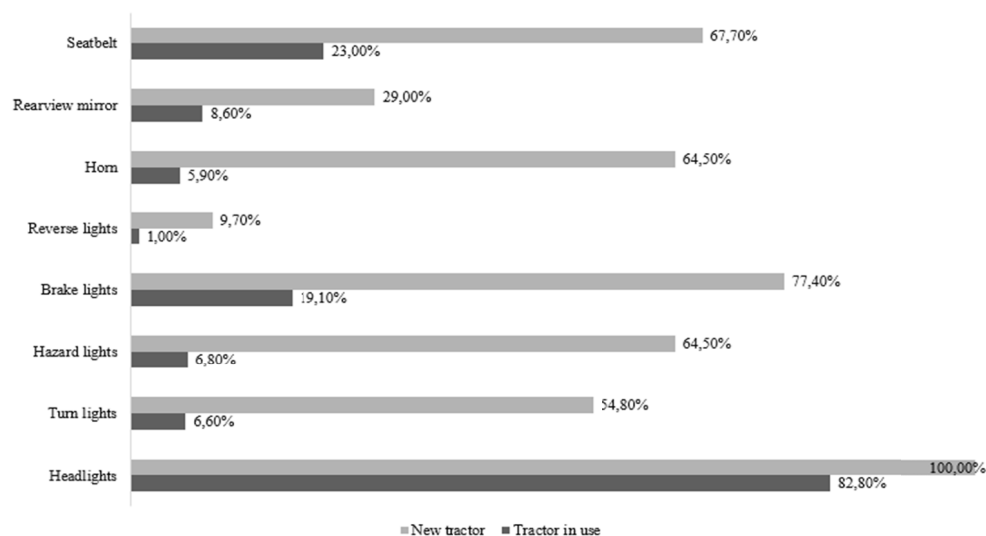


Figure 2. Presence percentage of the requirements for traffic on highways, in 2001, in the state of Sao Paulo, in 487 tractors in use and 31 new tractors

Source: Adapted from Correa et al. (2005).

It was observed that the new tractors available in the market did not meet in their entirety at least two of the lighting requirements of the time. In addition, only the headlight was present in all new tractors, the item with the largest percentage also in used ones, with 82.80%. On the other hand, the reverse light represented the lowest indexes present within the analysis both for new tractors as for used ones, with 9.70% and 1.00%, respectively.

3.2 Ergonomics and Safety Coefficient of Agricultural Tractors

Debiase et al. (2004) created a coefficient of ergonomics and safety for agricultural tractors and applied it in 175 tractors in use in 114 properties in the state of Rio Grande do Sul, in the municipalities of Santa Maria, Restinga Seca and Cachoeira do Sul. Of the items related to lighting standards, the ones evaluated were the presence of headlights; taillights; work light; brake lights; reverse light; turn indicators; hazard lights; backrest; horn;

rearview mirror and seat belt. In the sampled tractors, the overall average index was less than 35 on a scale up to 100, what characterizes poor conditions related to lighting and signaling in the agricultural tractors covered by the survey.

3.3 Lighting Information in Technical Catalogs

As for the information contained in the catalogs of the machines, a study was conducted by Francetto et al. (2010) through the creation of a data bank with the available data from the websites of 9 brands and 141 models. From the assessment of the technical information provided by the national tractor manufacturers, the authors concluded that the data do not allow a technical comparison between models and that there is no standard among companies, and the pieces of information related to the lighting items are among ones with the highest lack of information provided by the manufacturers.

3.3 Evaluation of the Conservation Status of Lighting Items and Aspects Related to the Operator

Additionally, Flores et al. (2015) demonstrated through a questionnaire applied to 35 operators, visiting 27 farms in the Zona da Mata of Minas Gerais, in 2013, that 100% of tractors in use (37% were manufactured from 2010 on) are not identified with sound or light hazard signaling alert, front and rear. Additionally, 18% of turn signal lights and 9% of the headlights were not working properly. Still, more than 60% of respondent operators transit on public roads with farm machinery, 26% do not have a driver's license and 60% did not know the rules of the Brazilian Traffic Code for the transport and driving farm machinery on public roads. These results confirm that the machines left the factories without any state inspection, without complying to the regulation rules in force at the period, as in this period the rules that established the standards for reverse lighting and sound signaling attached to the gearbox transmission, position taillights, rear and front turn signal lights, were already in force.

3.4 Evaluation of the Presence of Lighting Items in New Tractors in the Year 2017

Recently, Barbieri (2017) evaluated the compliance of operating stations for agricultural tractors safety and ergonomic standards (comprised wheeled tractors with power over 50.1 hp, superior gauge to 1280 mm and 600 kg minimum weight, new, with original factory safety features, available in the Brazilian market until the month of September 2016). With regard to NR 12 (2010), regarding the mandatory lighting and signaling items that should be present in the operation station of agricultural tractors, such as: reverse beep signal, seatbelt, rearview mirror, ROPS and horn, it was found that all were present in the 34 operating stations evaluated. This figure, when compared to previous studies, shows the evolution of compliance to the legislative aspect of this issue in Brazil, where, currently, the requirements of lighting and signaling of tractors are provided by the factories and available to the buyer of the product.

4. Conclusions

There has been an evolution in the Brazilian legislation for the lighting and signaling requirements of tractors for their traffic on public roadways, especially from the year 2014, with greater coverage of the items over the period in force of CONTRAN Resolution no. 454 (2014). From this evolution, there was the misalignment between the items required by the different legislative bodies on the subject and, in addition, the provisions of both the Ministry of Labor and the CONTRAN do not present technical and/or dimensional requirements relative to the location of items on the machine.

The scientific studies analyzed showed that there was also progress in the implementation of the legislation in new agricultural tractors. However, it is not enough for the machine to leave the factory with the lighting and signaling requirements, as they must be used and maintained in working conditions for its operation.

Finally, it was observed the need for the implementation of awareness campaigns in the context of road safety and the use of methods for assessing their effectiveness.

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