

## AN INVESTIGATION AND COMPARISON INTO OPERATOR FIELD OF VISION FOR MODERN TRACTOR CABS

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### Abstract

*An investigation into the operator's field of vision of modern agricultural tractor cabs. Visibility patterns and areas of blind spots were compared for people of different heights and for 2 tractors from the same manufacturer (Fendt) but fitted with different operator's cabs. The testing was carried out using 2 tractors of similar physical and hp size with test subjects of below, above and of average height. The test procedures similar to those used in British Standards [1].*

*By comparing the cab fitted to the older tractor with the most modern cab fitted to newer, the results can be analysed and concluded.*

*Comparing the new cab to the older cab showed a moderate improvement in all round visibility; due to the newer cab construction having fewer and slimmer cab pillars this resulted in decreased areas of blind spots, although direct forward visibility was not improved.*

*The investigation provided areas of further research, testing and recommendations to see whether operator field of vision can be improved further.*

### INTRODUCTION

In recent years there has been an increased emphasis on health and safety. Agriculture is one of the most dangerous industries in Britain [2]. There are plenty of statistics to back up the need for an increase in health and safety.

In 2008 there were nearly 3 times as many deaths as the second most dangerous industry, construction. 24% of the accidents were related to agricultural machinery, resulting in 42 deaths, [3], in the 600- 800 road traffic accidents that occur each year involving agricultural vehicles [4].

#### Background to the investigation

There was no law stating agricultural tractors had to be fitted with cabs until 1970 when The Tractor Cab Regulations 1967 came into force [5].

All tractors manufactured after 1<sup>st</sup> September 1970 had to be fitted with a roll over protective structure and older vehicles to be compliant from 1<sup>st</sup> September 1977 if driven by workers. Pre 1970s tractors were retro fitted to comply with the regulations [6].

Many were fitted by aftermarket companies from the late 1940s onwards. There were several different companies manufacturing and fitting these with the most well known being, Duncan, Sekura, Sirocco and Lambourne. Even though these were not made by the tractor manufacturers they still had to conform to Organisation for Economic Co-operation and Development (OECD), Society of Automotive Engineers (SAE) and International Organisation for Standardisation (ISO) standards [1].

In 1966 the National Institute of Agricultural Engineering (NIAE) devised a test for approving safety cabs. These tests consisted of a 2 tonne pendulum weight hitting the cab. Cabs that were badly distorted or broke were redesigned until they passed the test. The outcome was some good sensible standards and well engineered operator protection, which did much to improve agriculture's safety record [7].

After the 1970 regulations came into force some of these companies were discontinued and others continued to supply manufacturers with cabs, e.g. Duncan and Lambourne (MF 200 series). Lambourne fitted MF 200 series tractors which in the UK were supplied with cabs from GKN Sankey and Duncan, Collins A. Classic Tractor [8].

## **MATERIAL AND METHODS**

This report will analyse the operator's field of vision, the area which can be viewed from the seated operator's eye position (for 2 modern wheeled tractors of similar physical and horsepower (hp) size. The aim of the test is to compare the horizontal plane of vision and to calculate the areas of poorer visibility and total blind spots. A blind spot, or zone of invisibility, is a distortion or absence of sight in a small portion of the visual field [9]. The blind spots on a vehicle will generally be to the left and right of the vehicle which are not covered by internal or external mirrors and where the peripheral vision ends [10].

The testing will use the same methods as the British Standard methods for 'Determination of operator's field of vision for agricultural tractors.

The results produced by the test were analysed with future recommendations and conclusion being drawn up.

### **Height of participants**

The test included 3 people of different height

- A person of average height (5' 9"/175 cm).
- A person below the average height.
- A person of above average height.

This will then give a wider range of results for the comparison of different views from the operator's seat. The results from both tractors were then analysed. The two tractors were compared to each other with the results for the three people of

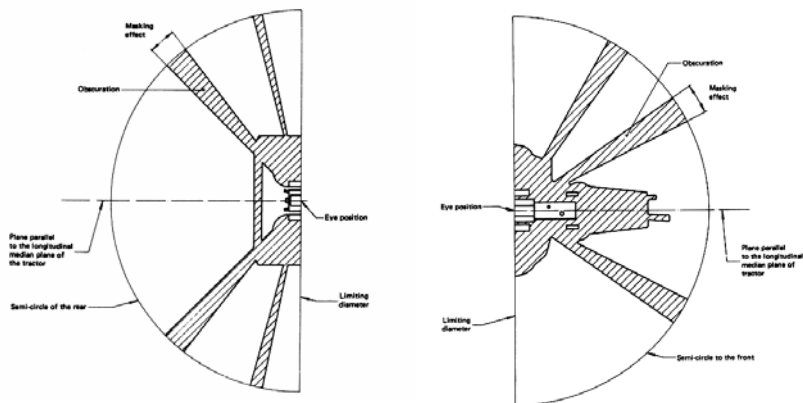
different heights. As agricultural machinery is predominantly operated by men the average height figures used for the report will be for UK males.

The average height for UK males is 5' 9" (175 cm) [11, 12].

A person of average height was used for the testing along with persons 6" (15 cm) either side of average.

### Testing method

The testing was based on the ISO Agricultural tractors-Operator's field of vision method. The seat position is the centre of the circle. The clear area is area visible from the seat and the shaded areas are areas that are not visible areas from the seat.



**Fig. 1. Semi circle of visions showing the front and rear (showing typical obscuration) Taken from the ISO document ISO 5721:1981**

### Machinery used for testing

For the testing 2 tractors were used of similar physical size and hp.



Tractor 1 Fendt 926



Tractor 2 Fendt 930



**Fig. 2. The cherry picker used for aerial photographs. A 2008 Genie Z60/34**

### **Test subjects**

For the methods of testing 3 people were used. Each subject was sat on the tractor in their theoretical driving position:

- Base of spine in the back of the seat to prevent back problems.
- Holding the wheel at ten to two or quarter to three - keeping thumbs vertical
- Arms slightly bent.
- Legs slightly bent when feet are on the pedals.
- The back of the seat should be fairly upright, giving a good view of the road ahead, and of course mirrors (rear and door) display and dials.
- Head restraints adjusted so they align with the top of head [15].

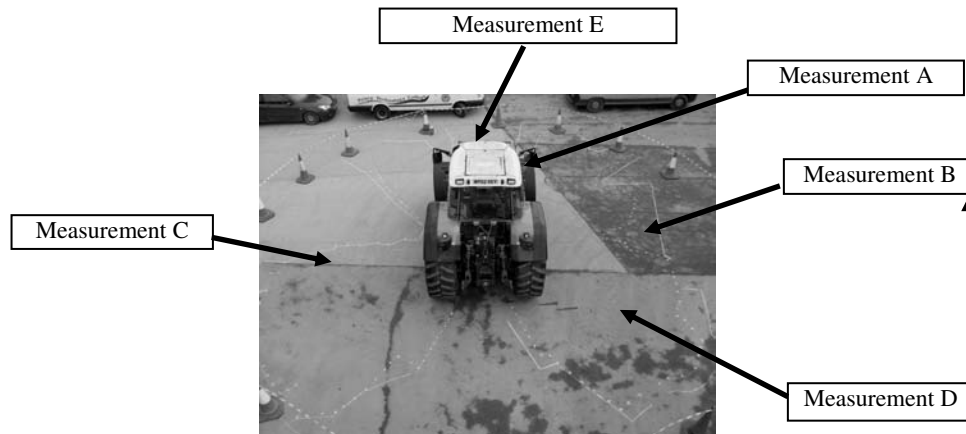
### **Testing**

The field of vision for the three test subjects was marked on the ground surrounding the tractor. This process was then repeated for the other subjects on the same tractor.



**Fig. 3. Showing testing area**

The same method was then applied for the second tractor. This provided 6 different sets of results that were marked out on the same test area.



## RESULTS AND DISCUSSION

	Fendt 926			Fendt 930		
	Below average height	Average height	Above average height	Below average height	Average height	Above average height
A	3.70 m	3.63 m	3.60 m	3.69 m	3.79 m	3.47 m
B	3.80 m	2.10 m	1.95 m	1.50 m	1.85 m	0.90 m
C	3.26 m	3.4 m	3.55 m	4.43 m	4.50 m	3.95 m
D	4.30 m	3.94 m	3.97 m	3.47 m	4.44 m	3.48 m
E	6.55 m	6.00 m	5.96 m	7.40 m	7.12 m	6.70 m

### Analysis

- Forward visibility on a standard equipment tractor is poor, even for the tallest person.
- Rear vision either side the tractor is poor.
- Sideways vision is not good and the drive would not be able to see other traffic or pedestrians who come alongside.
- Generally the taller person has slightly better visibility.
- Even the shortest distance of 5.96 m would be a sufficient amount to conceal, pedestrians, cyclists or even a small car, especially in heavy traffic. This emphasises the importance of ways required to improve forward visibility to reduce the possibility of accidents caused by this blind spot.

Whilst the driver can make allowances for the poor frontal vision, and possibly the rear the visibility on either side of the tractor is close to zero, mirrors help but it is easy for a bicycle or motor cycle to be completely out of vision. On turning, the long over hang of mounted implements swing out into the complete blind spot at the rear and side. Many tractors are fitted with a front linkage and this creates a

similar problem, most of the machine will be invisible in the straight ahead position and if turning it will be entering a blind spot.

## CONCLUSIONS

1. The report focuses on tractor cab visibility from the point of Health and Safety and the prevention of accidents and it is apparent that the majority of the area around the modern tractor is a zone of invisibility creating a potential trap. In addition, if the same principles are applied in the field, a number of obstacles or growing crop will not be visible to the driver.
2. Further research is required to produce more accurate data, which could be linked to a camera which could be activated by position sensors and pictogram.

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