

Efficient and safe production processes in sustainable agriculture and forestry
XXXIV CIOSTA CIGR V Conference 2011



Safety of Tractor PTO Drive Shafts: Survey on Maintenance on a Sample of Farms in Central Italy

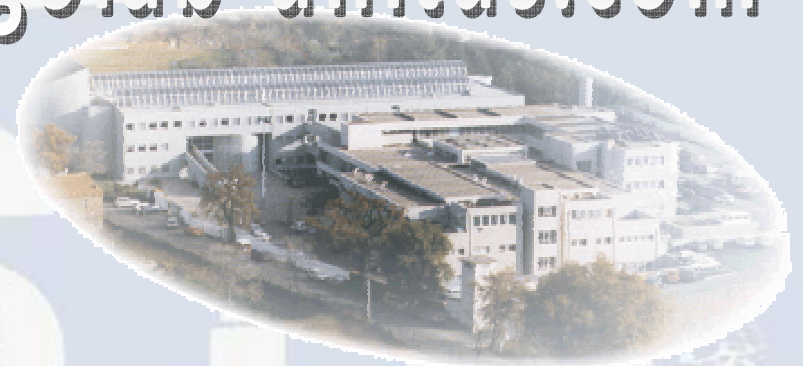
M. Cecchini, D. Monarca, P. Biondi, A. Colantoni, G. Menghini, A. Brenciaglia

29 June - 01 July 2011

Vienna - Austria



www.ergolab-unitus.com



Introduction

- **Cardan shaft:** a mechanical device for transmitting torque and rotation, used to connect a machinery to the PTO of the tractor. Its purpose is to transmit power across a broad range of directions in space up to the machine and enable all tractor-driven machine to execute turns, lifting and lowering each other
- The point of our research is to get a general condition framework of the safety of PTO drive shafts in Central Italy
- For each power take-off drive shaft some features have been analysed: presence and effectiveness of safety devices, storage, maintenance and any difficulties encountered during the use.



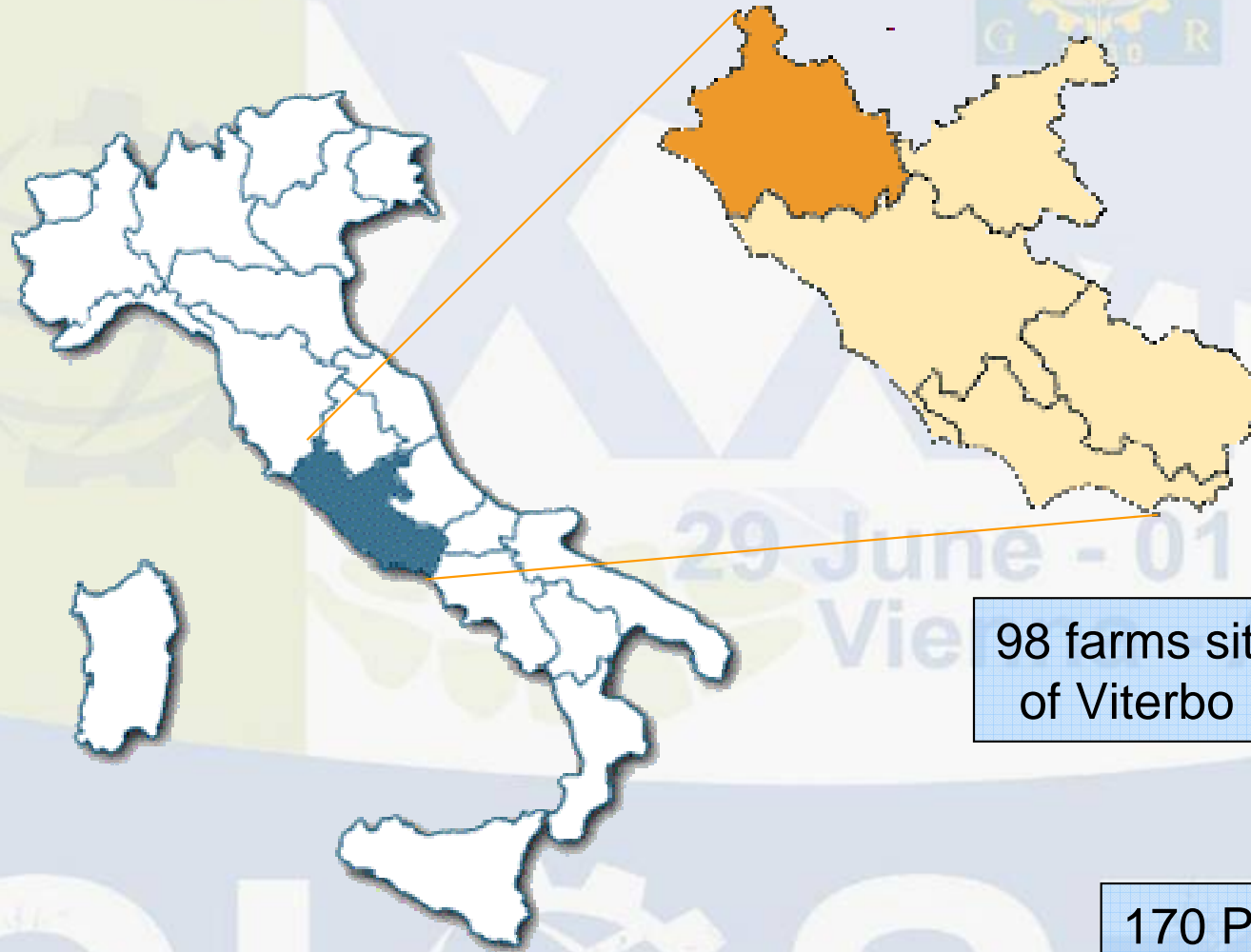
Materials and Methods



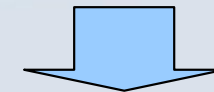
- Test area
- Standards and Laws
- The data acquisition card



Test area



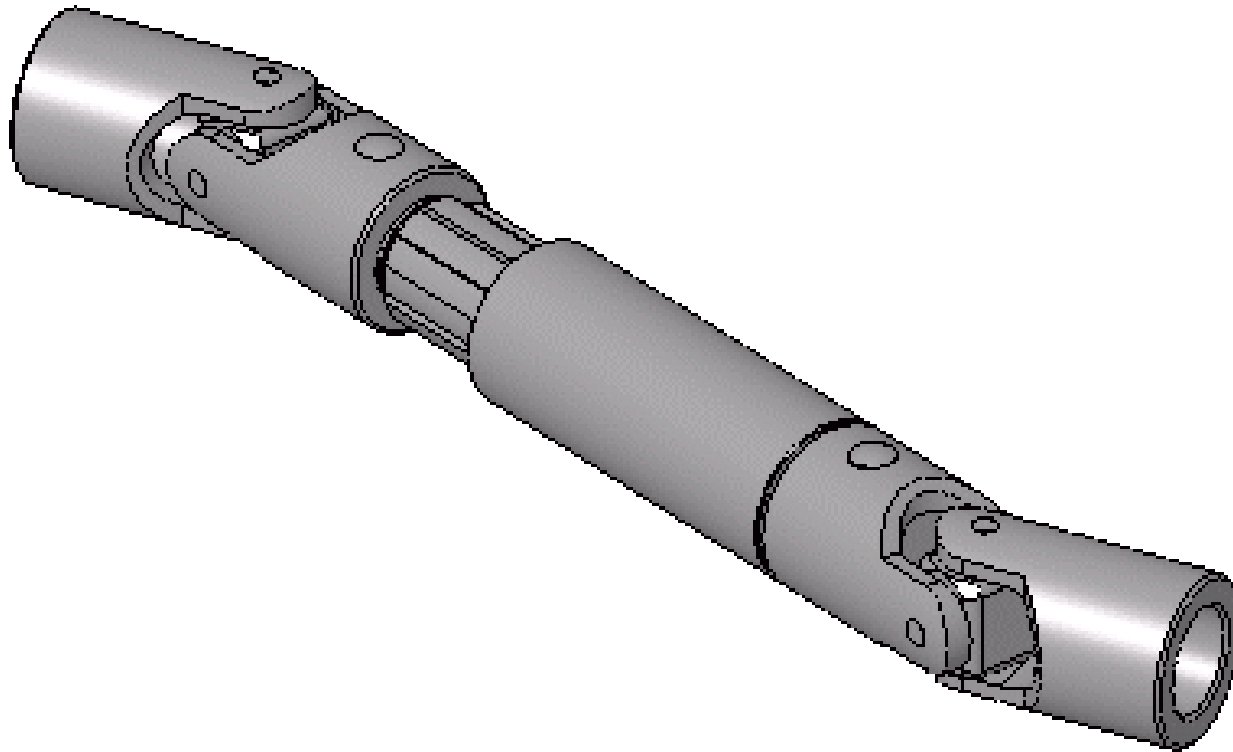
98 farms situated in the province of Viterbo have been analyzed



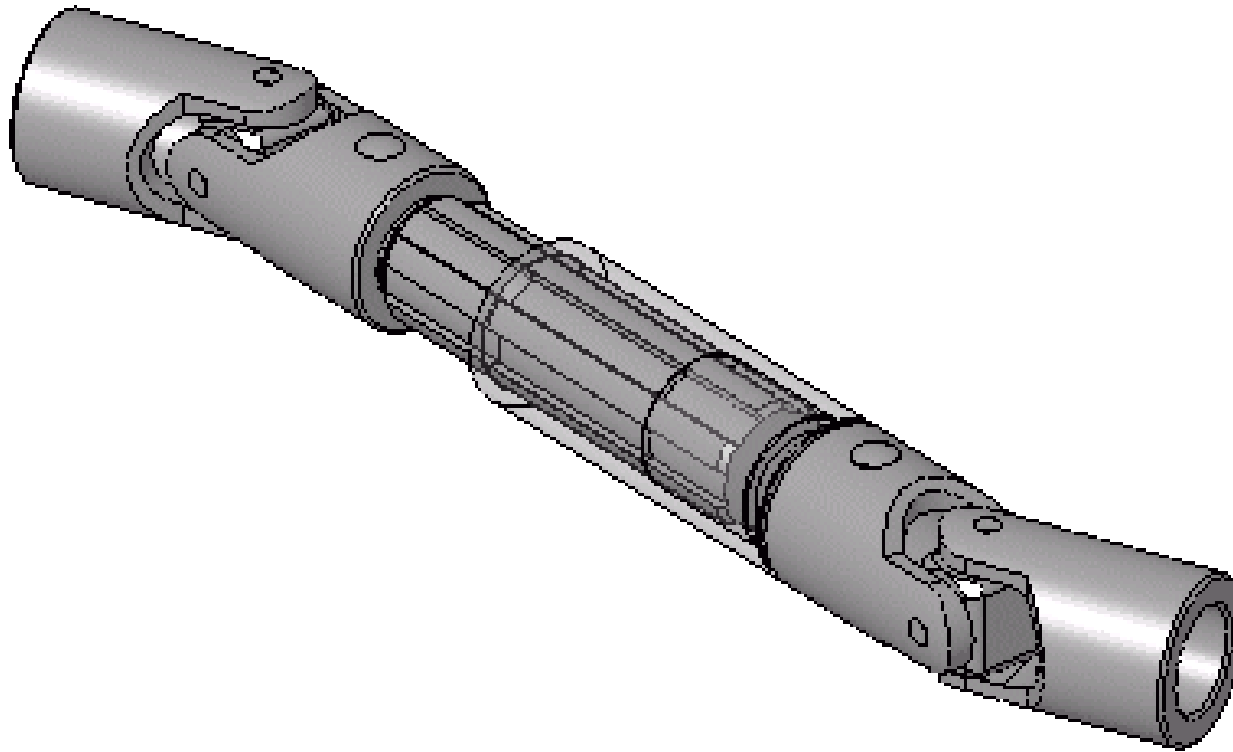
170 PTO drive shafts



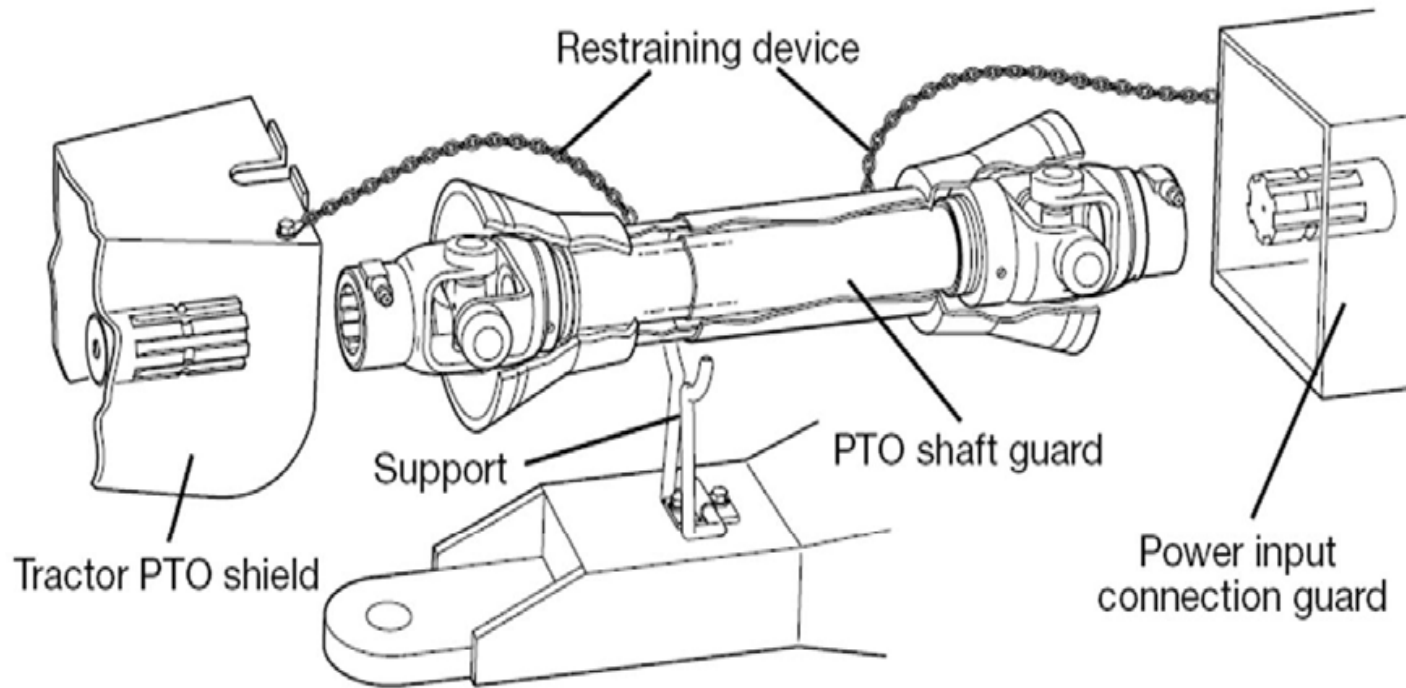
Protection devices on a PTO drive shaft



Protection devices on a PTO drive shaft



Protection devices on a PTO drive shaft



(HSE, 1997)



Protection devices on a PTO drive shaft

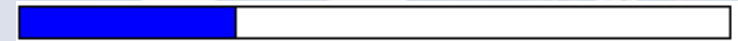


Danger!!!

STA



A 23-year-old employee was killed when he caught his wax coat in the partly exposed revolving PTO shaft of a roller mill. He was dragged over the shaft and struck his head on one of the mill's supporting girders.



Standards and Laws

- **European directive 2006/42/EC** - New “machinery directive” of 29 December 2009 applied to the machines by establishing the **essential requirements for safety and health**, but also applied to safety components placed on the market separately.
- **Italian legislative decree 81/2008** - In particular paragraph 6 shows the risks associated with the machine's moving: **if there are risks of mechanical contact that can cause accidents, there must be protection devices to prevent access to danger zones** or to halt the dangerous movements before you can enter these areas.
- **EN 12965:2003+A2:2009** - This standard specifies **safety requirements and their verification for the design and construction of power take-off drive shafts (and their guards)** linking self-propelled machinery (or tractor) to the first fixed bearing of recipient machinery, by describing methods for the elimination or reduction of risks which need specific requirements. In addition, it specifies the type of **information on safe working practices to be provided by the manufacturer**.

Standards and Laws cont'd

- **EN ISO 5674:2009** – The standard specifies laboratory tests for determining the **strength and wear resistance of guards for PTO drive shafts** on tractors and machinery used in agriculture and forestry, and their acceptance criteria. It is intended to be used in combination with ISO 5673.
- **ISO 5673-1:2005** – It specifies the power take-off drive shafts of a tractor or self-propelled machine used in agriculture and the power-input connection (PIC) of its implement, establishing a method for determining PTO static and dynamic torsional strength while giving manufacturing and **safety requirements**.
- **ISO 5673-2:2005** - The standard gives the forms and applications of PTO drive shafts for tractors and self-propelled machines used in agriculture, and specifies the dimensions (and clearance zone around) for the implement power-input connection (PIC) for a variety of attachments. Its intent is **to ensure proper clearance between the PTO drive line and adjacent components** on the implement and tractor when both implement and tractor have compatible power levels.

The data acquisition card

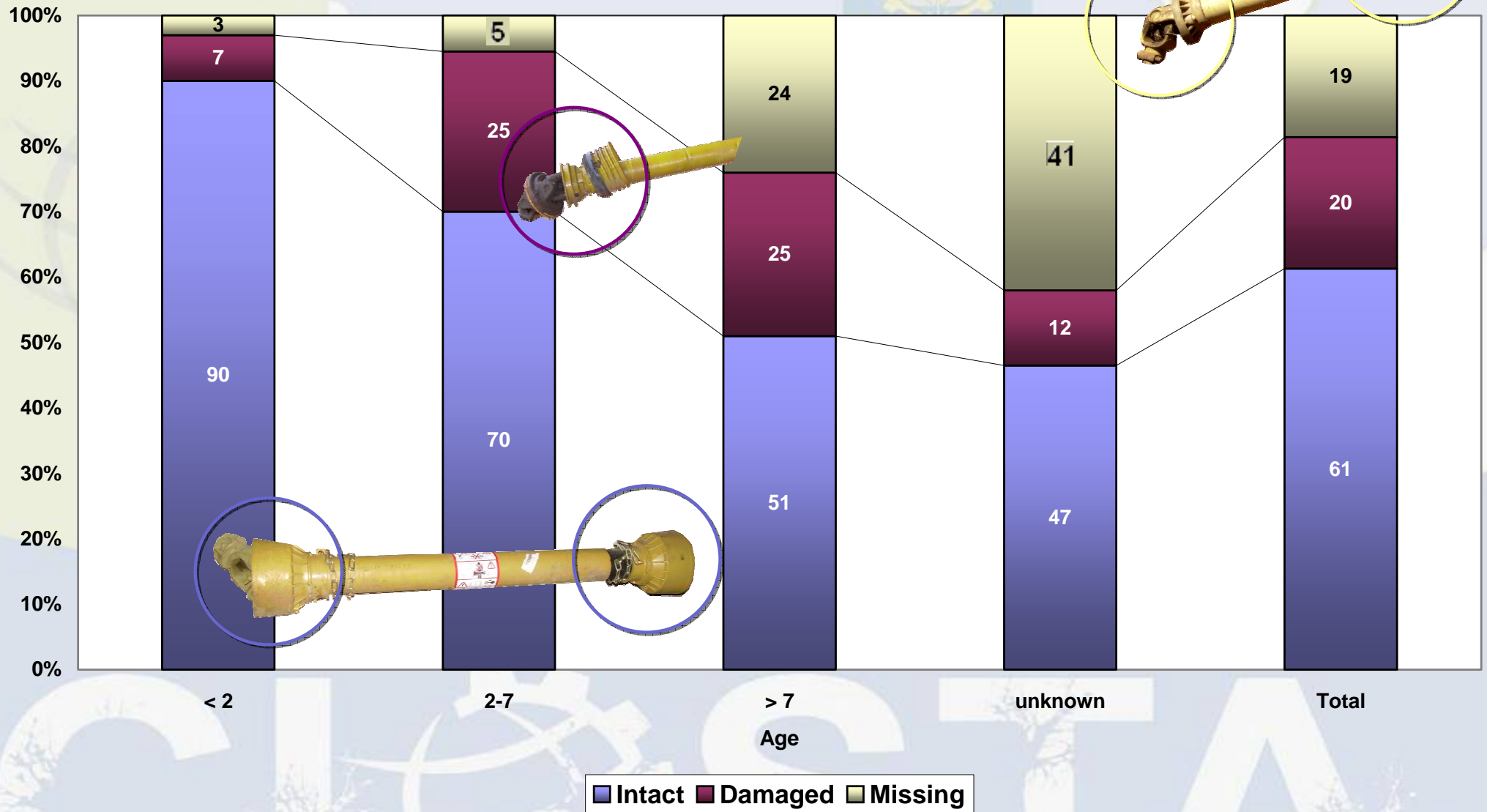
- Presence and efficiency of safety devices
 - Maintenance
 - Storage
 - Difficulties encountered in using the PTO drive shafts
- All data were placed in special forms made for the acquisition of information

Scheda tecnica n°..... 5	
Albero Cardanico	
Indirizzo dell'azienda: CEREALICOLO FORAGGIERO	
Località TUSCANIA (Cardarelli)	Data del rilievo 27/01/2010
Albero cardanico n.	5
Marca	BONDIOLIE PAVESI
Modello	399072000
Anno di fabbricazione	1997
Tipologie di trattori Associate all'albero cardanico	FIAT 680 DT
Attrezzature associate all'albero cardanico	
Libretto d'uso e manutenzione	SI
Scudo di protezione	SI
Catenelle di ritegno	SI
Pittogrammi	SI
Marchio CE	SI
Stato dei dispositivi di protezione	BUONO
Presenza del registro di manutenzione	NO
Tipo di manutenzione effettuata	INGRASSAGGIO: OGNI 8 ORE LE CROCIERE, OGNI 16 ORE L'ASSE DELL'ALBERO, OGNI 50 ORE SMONTAGGIO E PULIZIA COMPLETA
Modalità di immagazzinamento in fase di non utilizzo	RIPOSTO IN GARAGE ATTACCATO ALL' ATTREZZO
Presenza dei DPI consigliati	GUANTI E SCARPE ANTINFORTUNISTICHE
Descrizione tecnica ed uso in azienda	DA FERMO VIENE AGGANCIATO AL TRATTORE
Modifiche apportate	NON E' STATA APPORTATA NESSUNA MODIFICA CHE POSSA COMPROMETTERE LA STRUTTURA ORIGINARIA DELL'ALBERO CARDANICO
Stato di uso	DISCRETO
Eventuali difetti di funzionamento segnalati	NESSUNO



Results

Cone guards

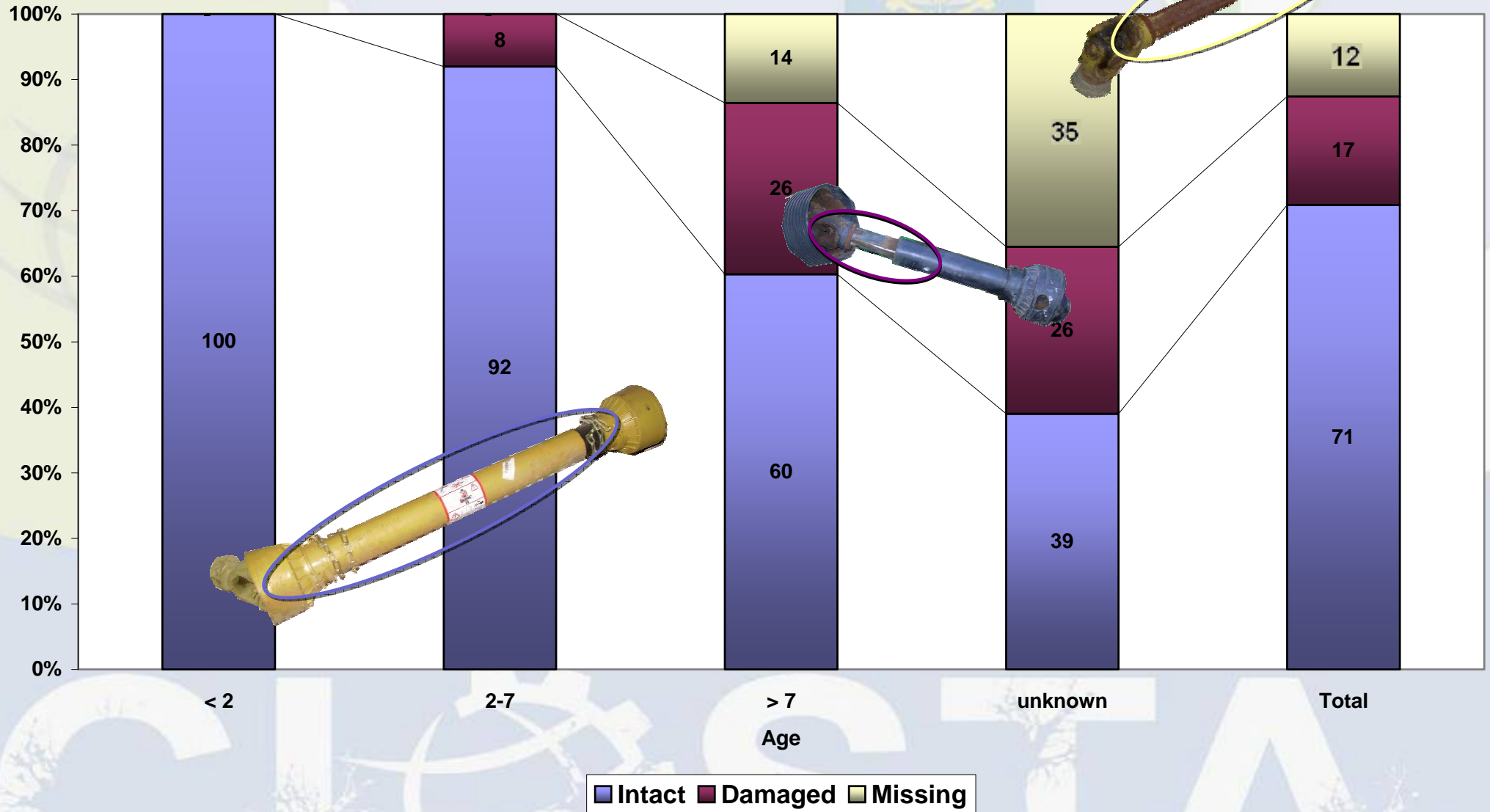


Safety of Tractor PTO Drive Shafts:
Survey on Maintenance on a Sample of
Farms in Central Italy



Results

Telescoping tube type guards

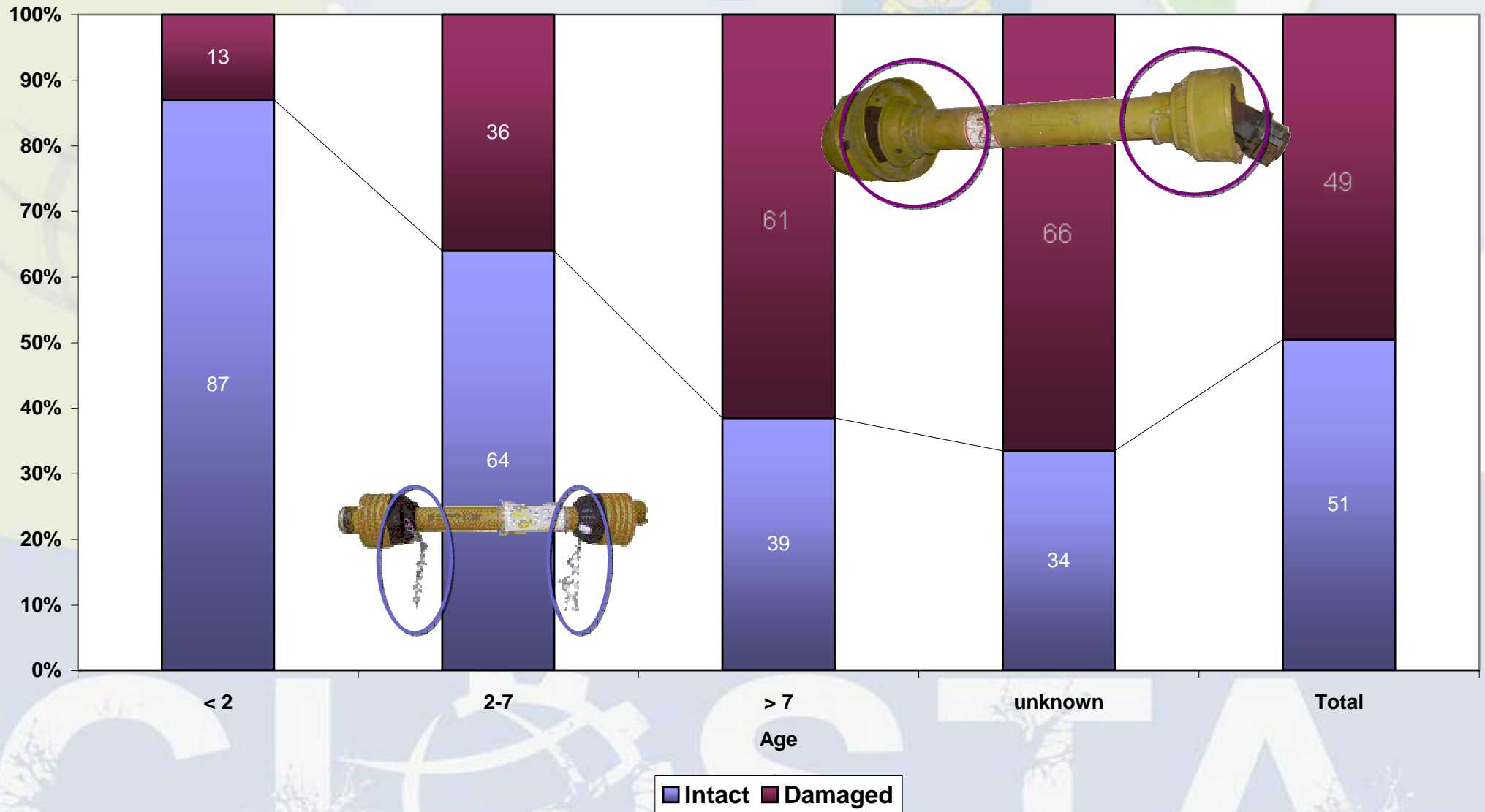


Safety of Tractor PTO Drive Shafts:
Survey on Maintenance on a Sample of
Farms in Central Italy



Results

Restraining devices

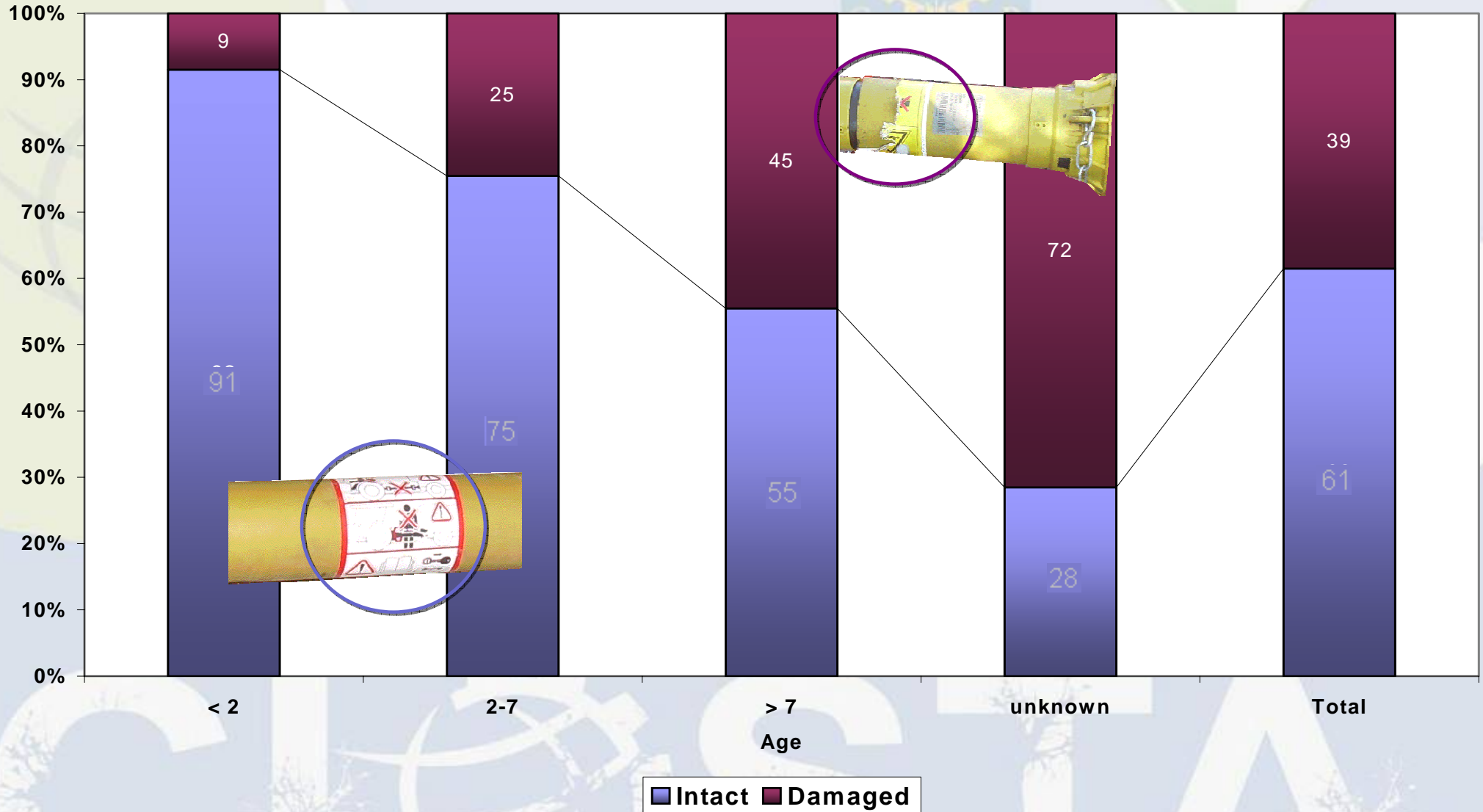


Safety of Tractor PTO Drive Shafts:
Survey on Maintenance on a Sample of
Farms in Central Italy



Results

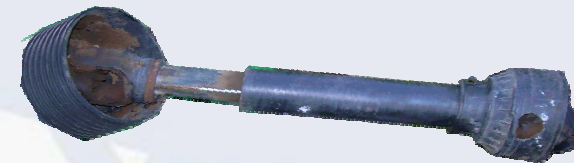
Pictograms



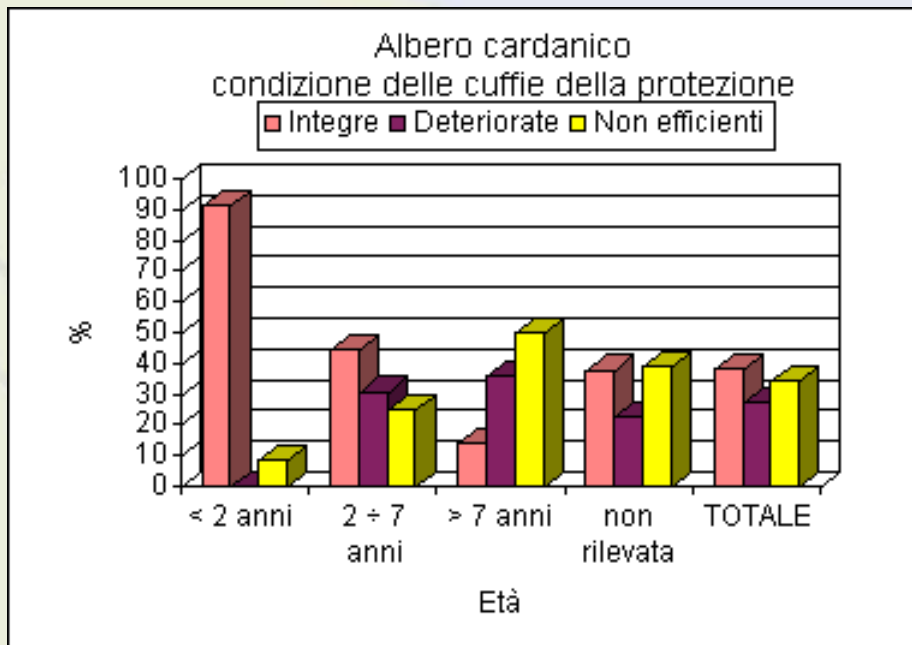
Safety of Tractor PTO Drive Shafts:
Survey on Maintenance on a Sample of
Farms in Central Italy

Results of a similar research

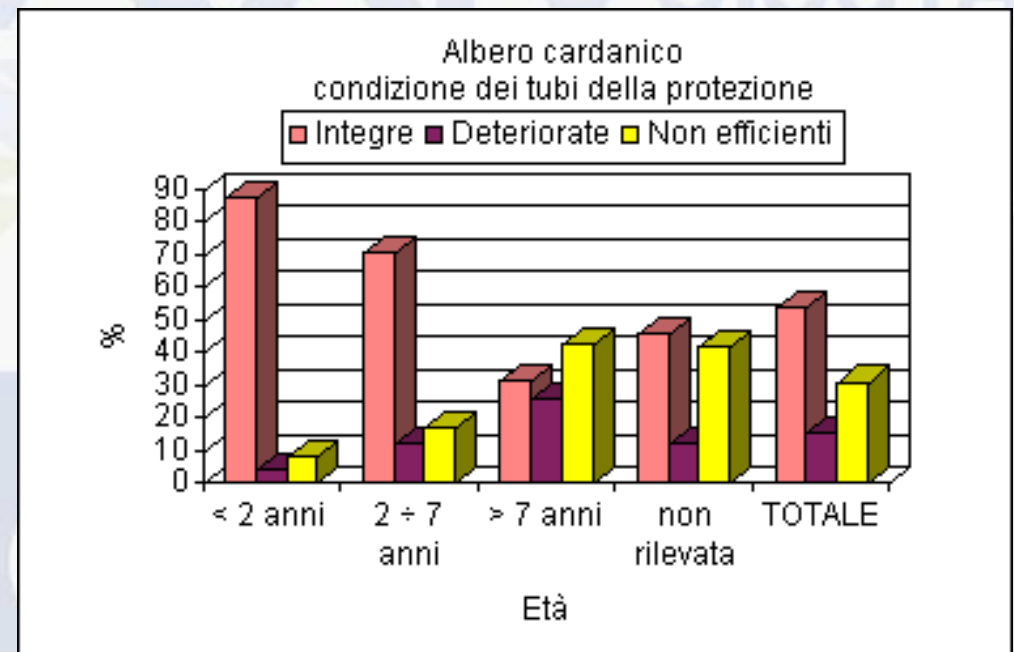
(Pessina *et al.*, 2008)



50% of telescoping tube type guards damaged



85% of cone guards damaged



Safety of Tractor PTO Drive Shafts:
Survey on Maintenance on a Sample of
Farms in Central Italy

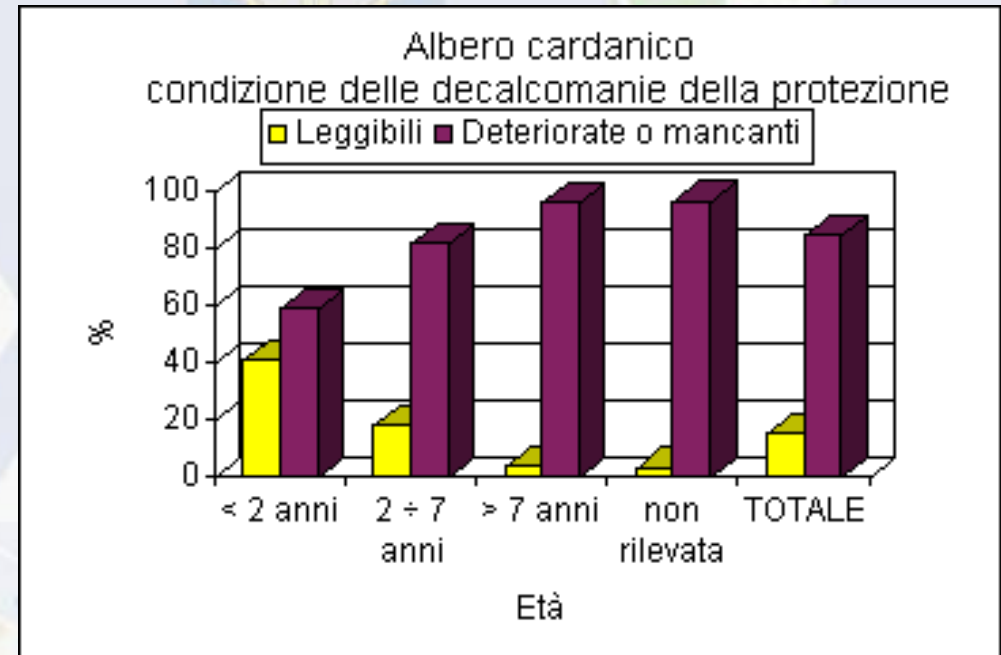
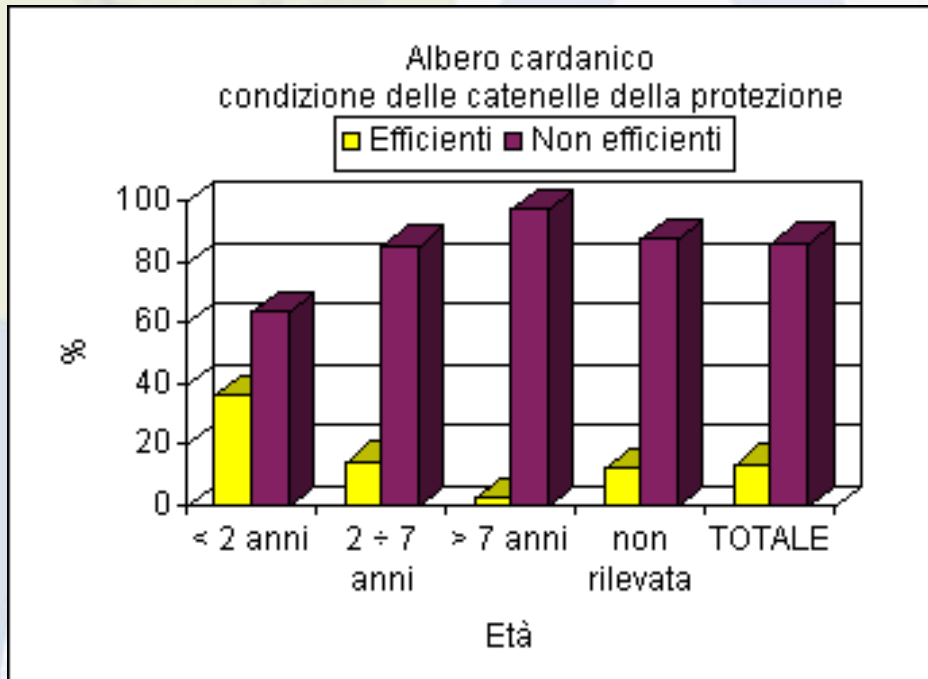


Results of a similar research

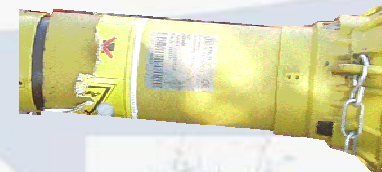
(Pessina *et al.*, 2008)



90% of *restraining devices* damaged or missing



85% of *pictograms* missing



Conclusion

- Efficiency of protection devices changes according to their age
- **CONE GUARDS:**
 - About 61% of intact cone guards
 - PTO drive shafts < 2 years \Rightarrow 90% of intact and in good condition cone guards
- **TELESCOPIC TUBE TYPE GUARDS:**
 - About 71% of intact telescopic tube type guards
 - PTO drive shafts aged between 2 and 7 years \Rightarrow intact telescopic tube type guards or slightly deteriorated compared to the older ones

Conclusion cont'd

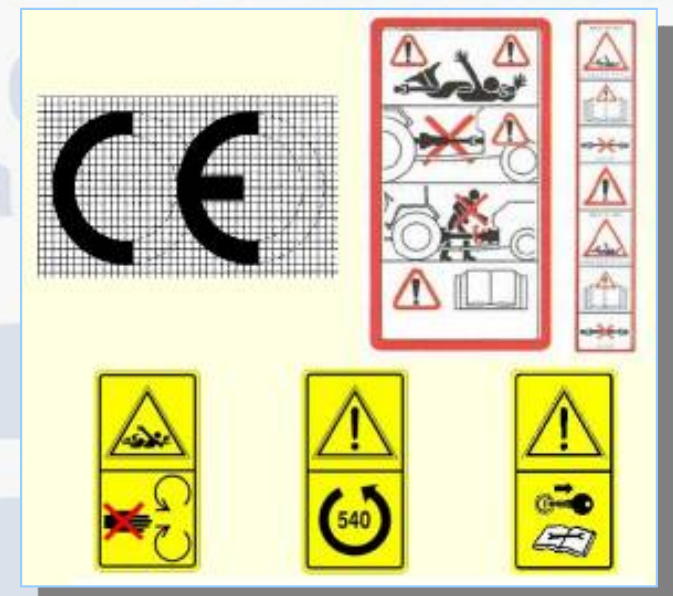


- **RESTRAINING DEVICES:**

- 72% of the total PTO drive shafts do not have restraining devices
- PTO drive shafts < 2 years \Rightarrow higher percentage of presence of chains than the older ones

- **PICTOGRAMS:**

- Only 39% of the PTO drive shafts has readable pictograms
- The newest PTO drive shafts exhibit a higher percentage of legible signs.

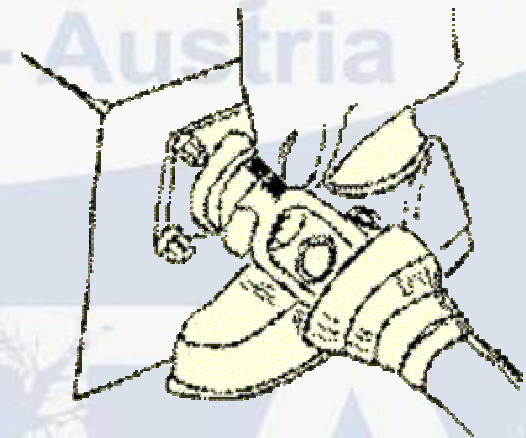


Conclusion cont'd



- **From the interviews conducted during the compilation of the forms:**

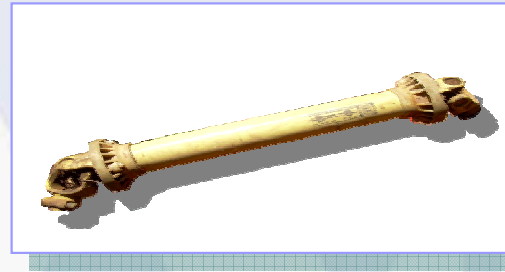
- the presence of the cone guards makes particularly difficult coupling PTO drive shaft to the machinery, due to the limited space between the cone guards and the protection shield on the tractor and/or on the equipments
- the connection to the tractor is generally less difficult, but the tractor PTO shield is often removed!



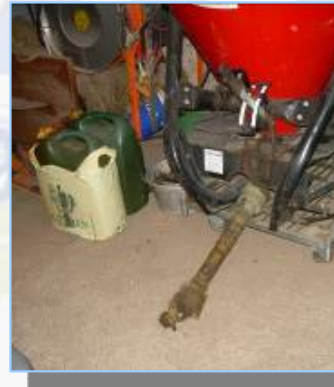
Conclusion cont'd



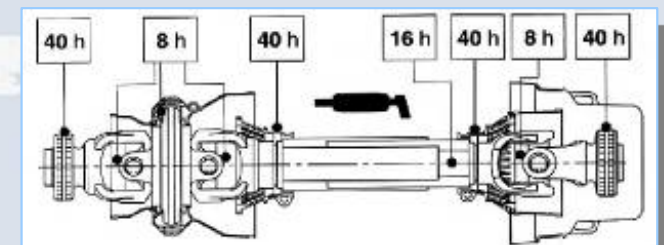
- Users don't tend to replace damaged safety devices !!!



- Users don't carry out proper storage !!!



- Users don't carry out proper maintenance !!!



Conclusion cont'd



- To reduce the immediate risks associated to PTO drive shaft: appropriate training and information on the use, maintenance, conservation and above all the risks associated with it may be provided for all agro-forestry operators



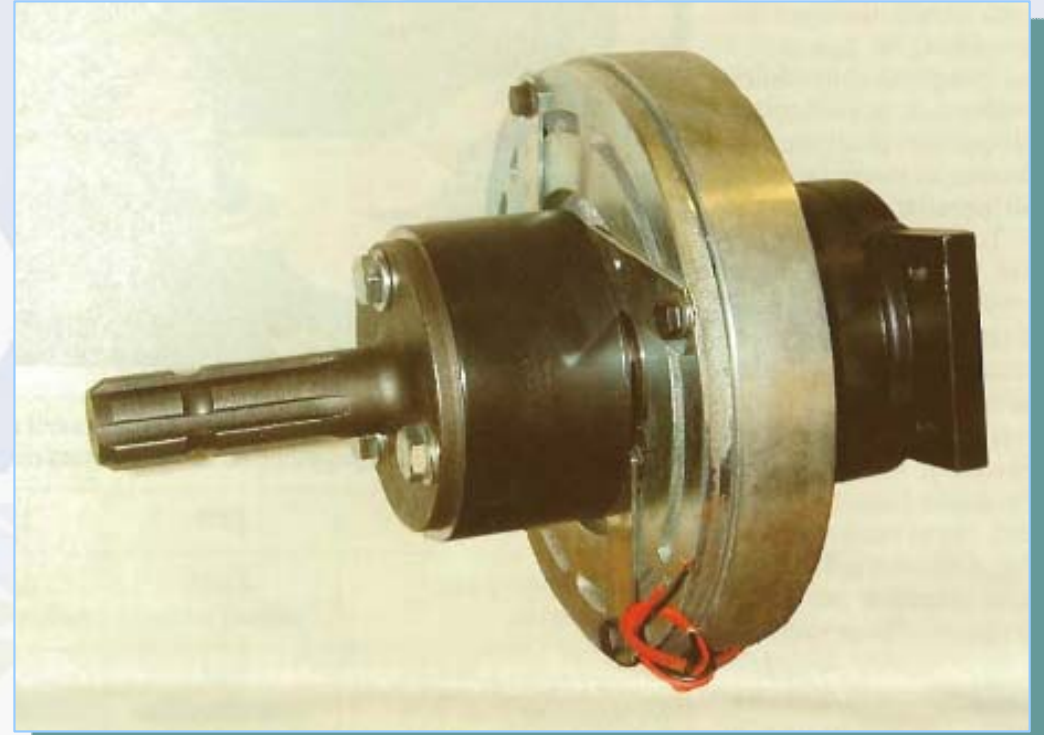
No more!!!



Conclusion cont'd

- **For the future:**
technological innovation

(e.g.: systems to block the moving parts of machinery in case of damaged or absent safety devices; PTO with electro-magnetic clutch + sensors located at critical points on the machine...)



Vieri M, Laurendi V., 2003. Prove di un giunto di protezione per il disaccoppiamento rapido della presa di potenza nelle macchine operatrici. Rivista di Ingegneria Agraria. XXXIV, 2/2003, 61-65.

Vieri M., Laurendi V., 2003. Tests on a Safety coupling for Tractors and Agricultural Machines. Meeting CIOSTA. Torino, 22-24 september 2003. 149-156

Thanks for your attention...



www.ergolab-unitus.com

Via De Lellis s.n.c. - 01100 Viterbo - Italy

Tel +39 0761 357357, Fax +39 0761 357356,

ergolab@unitus.it

Safety of Tractor PTO Drive Shafts:
Survey on Maintenance on a Sample of
Farms in Central Italy

CI  STA



www.ergolab-unitus.com

OSTA
2011
a

CI  STA 

Safety of Tractor PTO Drive Shafts:
Survey on Maintenance on a Sample of
Farms in Central Italy