A HIGH-PRECISION AND LOW EMISSION DIGESTATE SPREADER FOR MOUNTAIN AREAS

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INTRODUCTION

Livestock farming in the Wipptal Region of Alta Valle Isarco (South Tyrol, northeast Italy) generate approximately 250000 tons of manure per year. Nearly a half of the produced manure coming from about 400 dairy farms can no longer be applied to farm areas due to: i) the limit set by the Nitrates Directive (91/676/EEC) and, ii) the inaccessibility of almost 40% of agricultural lands. The latter are indeed laying in steep sloped surfaces inaccessible to traditional spreaders for safety reasons. Moreover, the region is a touristic spot during summer season, this leading to conflicts between livestock activity and mountains goers as a consequence of odours emission when manure is applied to grassland. Gun sprayers and splash plate indeed are still the most diffused spreading techniques in the area. To cope with these problems, a new digestate treatment system has been developed and installed at a 1 MWel. centralised anaerobic digestion plant having 67 farmers as members and operating in Vipiteno (BZ). 50% of the produced digestate is turned into pellet and exported to orchards/vineyards areas, whereas the remaining 50% is applied to lands in the Wipptal Region by means of a self-propelled manure spreader designed and constructed with the financial support of the Life-OPTIMAL project (LIFE12 ENV/IT/000671).

MATERIALS AND METHODS

The spreader (fig. 1a) was constructed by partner Zunhammer GmbH and comprises several components: 1) 3400 litres fiberglass tank mounted on a 72kW power MULI T9 transporter with purpose-modified chassis, 2) distribution device (working width 6m) of trailing shoes (fig. 1b) to reduce ammonia emissions during application, 3) automatic rate controller to apply nitrogen per crop requirements, 4) the *Van Control 2.0® system* consisting of a Near Infrared Spectroscopy (NIR) unit able to detect the total (TN) and ammonia (TAN) nitrogen, phosphorous (P), potassium (K) and total solids (TS) of digestate in real time during the tank loading, 5) a GPS system to make spreading operations traceable.

Given the low centre of gravity of the machinery it can be utilized also on steep sloped surfaces where traditional slurry spreader can't be operated due to risks of overturning.

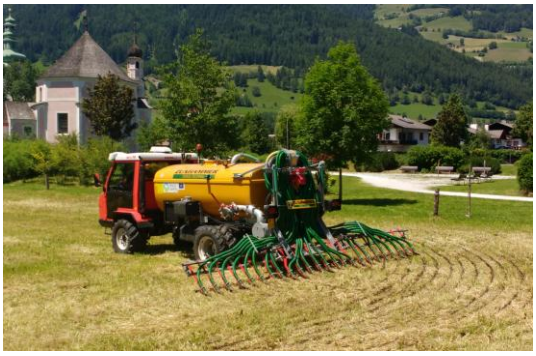
a  b 

Fig. 1: a) the digestate spreader, b) detail of trailing shoes

The machinery was tested for: transverse and longitudinal spreading evenness, precision of application rate

control system with respect to the machine's forward speed variations (*3÷6 km/h)*, ability to measure real-time the NPK content of digestate and for capability to reduce ammonia emission after digestate application to grassland when compared to traditional broadcast application by splash plate.

RESULTS AND DISCUSSION

Field trials showed the machine to evenly apply digestate on the soil surface. Calculated Coefficient of Variation (CV) was on average 16,5% (12.0%÷21.5%) for transverse spreading evenness. Longitudinal spreading evenness was characterized by an average CV of 7.6% (3.0%÷11.0%).

The automatic rate controller demonstrated its ability to adjust pump rotation speed quickly after machine forward speed changes. Indeed, the system applied digestate at the desired application rate (30t per hectare) with minor variations (-1.4% ÷ 6.0%), despite continuous changes in forward speed (range 3-6km/h). Similar results (-6.6%÷+3.3%) were achieved with no variations in forward speed.

The online system for NPK real time measurement is able to reliably measure nutrients concentration in digestate with special regards to total (TN) and ammonia (TAN) nitrogen, and potassium (K) as shown in table 1. At the contrary, phosphorus (P) concentration in digestate was not determined in a precise manner by the NIR system.

Trial	TN	TAN	P	K
1	5,63%	-1,89%	-7,52%	-2,00%
2	6,71%	-2,62%	-11,26%	-6,11%
3	3,77%	-1,52%	-15,42%	12,43%
Average	5,37%	-2,01%	-11,52%	1,42%

Tab. 1: variations between parameters measured by the NIR system and by laboratory analysis

Band application of slurry by trailing shoes reduced ammonia emissions respectively by 17% and 37% in autumn (10°C) and summer (20°C) temperature conditions when compared to the common broadcast application system utilized in the area (splash plate).

CONCLUSIONS

The developed prototype digestate spreader was shown to be a reliable machine for digested slurry application in mountain areas for three principle reasons: 1) proper nitrogen quantity application due to the efficacy of its automatic rate controller and NIR system; 2) uniform slurry spread due to the performance of the metering pump and rotary distributor; 3) low environmental impact as a result of reduced ammonia emissions during slurry application.

REFERENCES

European Commission, 1991. Council directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources. Off. J. Eur. Comm. 1e8.

Acknowledgement

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