ORGANIC FERTILISERS OF THE MAC TRIAL AND THEIR IMPACT ON SOIL QUALITY, ENVIRONMENT AND CLIMATE CHANGE

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Abstract
After 8 years, the MAC field trial in Lelystad, the Netherlands, shows the effects of different fertiliser strategies, ranging from animal manure to plant compost to mineral fertiliser. The impact on yield, soil quality, soil health, environment and climate change is discussed. The trial is unique in monitoring the effect of so many types of fertilisers over so many years.

Introduction
Applying fertiliser is the easiest measure a farmer can vary to maintain soil health. Uncertainty about the different characteristics of fertilisers means that the choice of fertiliser varies widely between farms.
After a completed rotation of eight years (1999-2006), organic soils of the Manure as a Chance (MAC) trial were analysed for the effect of amendments on yields, soil quality and soil biodiversity properties.

Materials and Methods
The experiment (Lelystad, The Netherlands, 5° 30' East, 52° 32' North, precipitation 780mm), was set up as a randomised complete block with four replications and 7m x 9m plot size. The manure or compost addition (Tab. 1) is limited by:

- a maximum of 100 kg N ha^{-1} $year^{-1}$
- a mean net legal maximum of 80 kg P_2O_5 ha^{-1} $year^{-1}$
- a legal maximum of 6000 kg dry matter ha^{-1} $year^{-1}$.

Table 1: Selected strategies of the MAC trial and nitrogen mineralised, P_2O_5 application, dry matter and organic matter from the amendments in $kg.ha^{-1}$ $year^{-1}$.

Strategy	Nitrogen active*	P_2O_5*	Dry matter*	OM*
Deep stable manure (FYM)	67	66		4930
Cattle slurry (CS)	67	35		1530
Mineral fertiliser (MIN)	67	43		0
Household and slurry (HC+CS)	67	69		2910
Poultry manure (PM)	47	80		1680
Plant compost 1 (PC)	24	80		7870
Household compost (HC)	9	57	6000	1490
Plant compost 2 (GC)	8	48	6000	1770

* amendments are applied two years in three.

The organic vegetable rotation of the host farm includes red cabbage, potato, beet, carrot, parsnip, broccoli, squash and cauliflower in 2006. It is of common intensity for Dutch organic horticulture. The light sandy clay soil was analysed for soil physical, chemical and biological properties.

Microbial and fungal biomass, N mineralization, nematodes and basal respiration were determined according to Mulder et al., 2005. Data were analyzed by analysis of

variance (ANOVA). Significant effects were separated by the least significant difference (LSD) at P = 0.05.

Results and Discussion

Yields suggest significant differences due to different organic amendments after 8 years (Fig. 1). In treatments receiving farm yard manure and household waste compost yields increased over time. Soil properties indicate changes, among others, in nitrogen mineralization, soil organic matter and biological properties like earthworm burrows and plant feeding nematodes. No significant changes in microbial and fungal biomass were found.

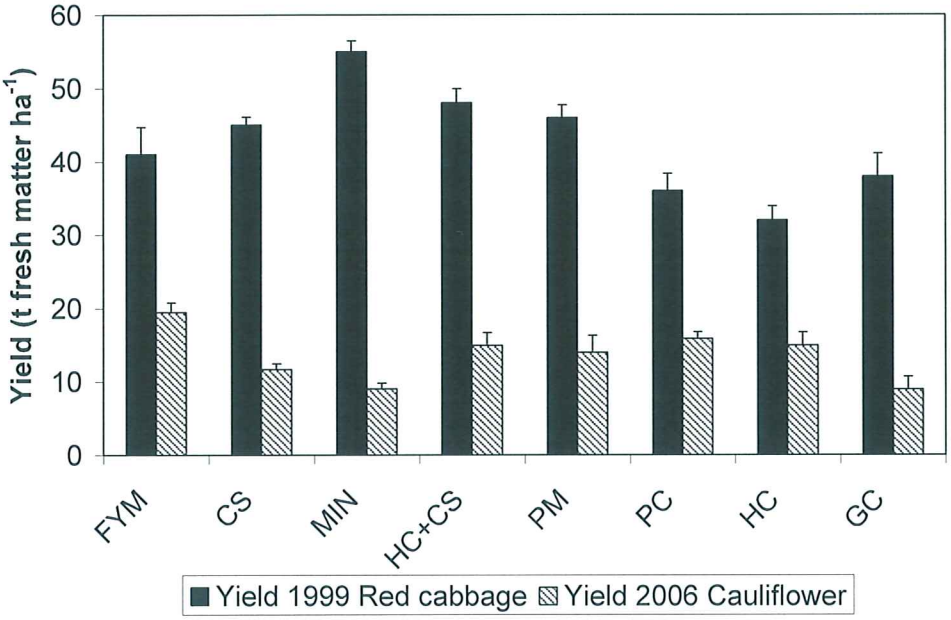

Fig. 1: Yields of red cabbage (1999) and cauliflower (2006) in the MAC trial. Bars indicate standard error of the mean.

The strategies were evaluated in terms of five challenges society is facing nowadays: Sustainable yields, a sustainable soil quality, soil health, prevention of environmental contamination and climate change. Tab. 2. links these challenges in a qualitative way to indicators measured in our evaluation.

From the evaluation it is clear that no strategy scores high in each of the five evaluation criteria. After 8 years deep stable manure results in highest yields. Fertilisers which supply little or no organic matter show a decline over the years. If soil quality is evaluated in terms of the capacity to supply nitrogen, the deep stable manure, slurry and composts score highest. The least harmful plant feeding nematodes were found in household waste combined with slurry and poultry manure. Plant based compost score highest in terms of low phosphate surpluses in a balancing approach and (modelled) nitrate leaching. In terms of climate change the deep stable manure and plant based compost show a slight increase in organic matter of the soil.

Table 2: Qualitative evaluation of the fertilization strategies in MAC trial linking soil indicators to challenges of society and yield.

Evaluation Criterion	Yield	Soil quality	Soil health	Environment	Climate Change
Indicator	Fresh yield 2006	Nitrogen supply	Parasitic nematodes	Phosphate surplus and nitrate leaching	Organic matter sequestration
FYM	+	+	0	0	+
CS	-	+	0	0	-
MIN	-	-	-	+	0
HC+CS	0	+	+	-	0
PM	0	0	+	-	0
PC	0	+	-	+	+
HC	0	-	0	+	+
GC	-	0	0	+	+

The study shows that organic amendments used within the legal framework of organic farming impact soil quality and soil biodiversity indicators within eight years. The results suggest a neutral or overall positive effect from deep stable manure in the long run on indicators linked to societal challenges. In terms of environment and climate change the different compost strategies seem to perform surprisingly well.

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