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RATTAN LAL CENTER FOR CARBON MANAGEMENT AND SEQUESTRATION
OHIO STATE UNIVERSITY EXTENSION OF STARK COUNTY

Impacts of fertilizer management on soil health of small farms in Stark County, OH

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RATIONALE

Nutrient management issues that impact soil health and water quality in Stark County provide a baseline for comparative statewide analysis due to county /state similarities.

Land use shows that 68% of Stark County's 1,547 farms are comprised of small family farms of 50 acres or less.

These operations typically include manure as part of their fertilization methods.

A lack of nutrient testing on both soil and manure, along with a failure to accommodate for the additional nutrients contained in animal manure fertilizers has led to both an under and over application of key macro-nutrients like Phosphorus (P). Over application of (P) leads to environmental impacts affecting both soil health and water quality while under application reduces crop productivity and increases weed and disease pressure on crops.

OBJECTIVES

- Determine how fertilizer management on small farms in northeast Ohio impacts soil health
- Determine the causes for deficient and excessive soil test P

METHODS

Of the twelve farms participating in this project, five used manure in their fertilizer program in 2020. Five GPS locations were randomly selected across fields with the one parameter that the predominant soil type present be Canfield silt loam with a 2-6% slope.

- Farmers were surveyed regarding their fertilizer program (Table 1)
- Soil and plant samples were collected at harvest time in late September and early October 2020.
- Soil and plant samples were submitted to Ohio State University's (OSU) STAR lab for nutrient testing. Mehlich-3 was used to determine soil nutrient content.
- Estimated biomass P removed from fields was determined by multiplying estimated yields by grain or plant P content (Table 2).

Table 1. Description of fertilizer program of farms using manure

Farm	Fertilizer program
Farm1	Organic farm applied 7.2 Mg/ha horse manure as fertilizer applied with 2.9 Mg manure cart; small grain crop rotated annually
Farm2	Applied 15.7 Mg/ha sheep manure with small manure cart; hay field rotated with row crops every year
Farm3	Applies ammonium sulfate and potash in synthetic form and manure applied when field is grazed by beef cattle; hay field
Farm4	Applies 33.6 Mg/ha beef manure and two applications of synthetic fertilizer; corn silage only
Farm5	Applied approximately 22 Mg/ha beef manure and two applications of urea
*Manure applied as solid with bedding	

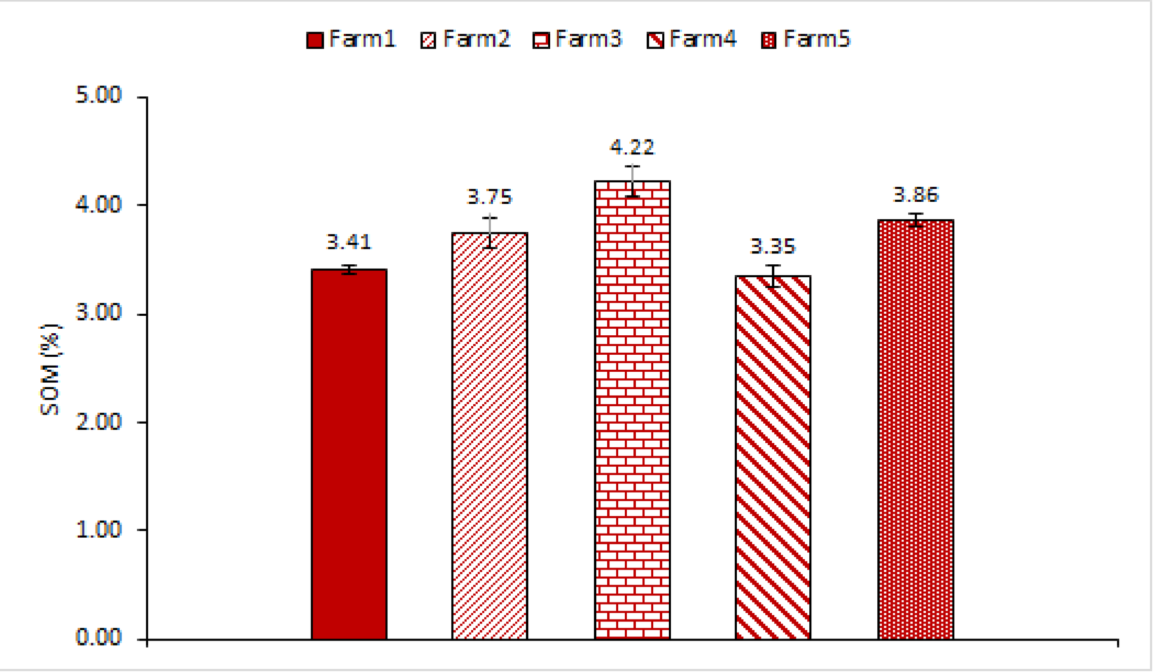

Fig. 1 Soil organic matter of farms that incorporated manure in their fertilizer program. Top 15 cm soil depth

Table 2. Estimated biomass P removed from farm fields in kg ha^{-1}

Farm	Crop	Yield (kg ha^{-1})	P ppm	P removed
Farm1	Buckwheat	7500	2551*	19
Farm2	Hay (clover)	6000	2758	16.5
Farm3	Hay/Pasture (orchard grass & alfalfa)	5600	3981	22
Farm4	Corn silage	35000	3103	108
Farm5	Corn	12000	2982*	27
*Denotes grain P content as plant residue remained in the field				

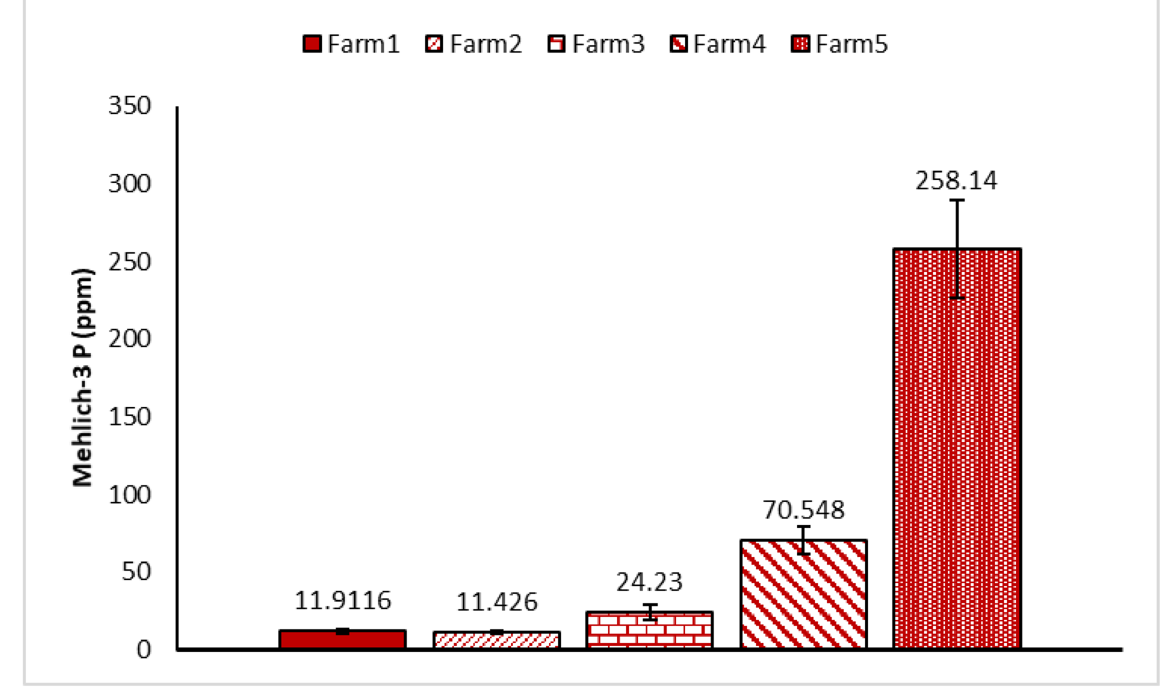

Fig. 2 Soil test P of the farms that incorporated manure in their fertilizer program. Top 15 cm soil depth

Table 3. Amount of manure and manure nutrient content by livestock type

Animal	Manure	N	P	K
			kg day^{-1}	
Beef cattle 500 kg	42	0.28	0.10	0.16
Sheep 45 kg	1.8	0.02	0.009	0.02
Horse 500 kg	25	0.12	0.06	0.06
*Adapted from Ohio Livestock Manure Management Guide				

RESULTS and DISCUSSION

While all farms in the project utilizing manure fertilizer had relatively high (>3%) SOM (Fig. 1), soil test P was much more variable. Farm 4 produced corn silage removing the most significant amount of P in biomass from the field (Table 2). However, the soil test P was still over the recommended amount of P (Fig. 1) which is 20-40 ppm P for corn production (Culman et al. 2020). Farm 5 produced a corn crop which has the second most P removal but has a soil test P (Fig. 1) much greater than recommended for this crop. Farm 3 was an orchard grass and alfalfa hay field which was grazed late in the season and received manure at that time. Farm 1 produced buckwheat which was harvested for organic flour and while the buckwheat is known to be able to acquire soil P, the soil test P was very low (Fig. 1) and below that recommended for wheat (Culman et al. 2020), the expected next crop. Farm 2 had a lower P removal rate than all the other fields (Table 1), however, the soil test P was lower than recommended for corn (Culman et al. 2020) which is the expected next crop.

Farm1 and 2 had the lowest soil test P likely due to the low P content of their manure source, horse and sheep (Table 3), respectively and inefficient manure application equipment. However, multiple years of application of beef cattle manure and bedding resulted in excessively high amounts of soil test P in Farm 4 and 5. These fields were also conveniently located in close proximity to the cattle barns. Producers took advantage of this convenience rather than haul the manure to a more distant location or a designated manure storage facility. This practice is not uncommon in Ohio (Hanrahan et al. 2019).

CONCLUSIONS

Manure implementation is a beneficial and economic source of fertilizer. However, there are many challenges facing small farms that raise livestock and incorporate manure in their fertilizer program including lack of efficient equipment for manure application and convenience of field locations relative to the livestock barns. There is also a detrimental omission of manure and soil nutrient testing which if implemented more regularly may encourage manure management adjustment.

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