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Livestock manures for crop production and soil improvement

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LIVESTOCK MANURES FOR CROP PRODUCTION AND SOIL IMPROVEMENT

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The utilization of livestock manures for improvement of crop production is as old as agricultural history. With the advent of commercial fertilizers at relatively low prices and the labour involved in application of livestock manures, utilization of livestock manures for land application has frequently been considered of questionable economic value.

Recent increases in the price of commercial fertilizer, higher prices for cash crops, and the requirements related to the environment require some further consideration of livestock manure in soil fertility and production maintenance.

Some testing of crop response to applications of manure has been carried on by research stations and universities in western Canada for many years.

Although a number of long term rotations which included the application of livestock manure were started in early years, one or two of which have continued until recently, most of the data obtained in earlier years were from low rates of application and yield data was obtained only on a short term basis.

Yield increases were frequently rather minimal on dryland and in some cases no yield increase and occasional yield decreases were recorded.

The result has been a tendency to downgrade the economic returns from applying livestock manure to the land, since response to commercial fertilizer has been more consistent and returns per dollar for labour and fertilizer cost are higher. The benefits attributed to the organic matter from manure, possible trace elements, or other biological components were considered to be vastly over-rated.

The benefits of manure in maintaining nitrogen levels are, however, demonstrated by data on long term plots at the University of Manitoba in 1955. These plots were in a four-year rotation of fallow - wheat - corn - wheat, with 10 tons of manure applied during the summerfallow year. Soil analyses for nitrogen in 1930, 1948, 1955 and wheat yields for 1946 - 55 are shown in Table 1.

TABLE I

	PER CENT NITROGEN			WHEAT YIELDS	
	1930	1948	1955	Summerfallow	Stubble
CHECK	.374	.323	.297	28.2	23.5
MANURE	.388	.338	.340	35.6	30.4

The Research Station at Lethbridge has had an 8 - year irrigated rotation of wheat, alfalfa and sugar beets in effect since 1929. Manure is applied at 30 tons per acre on the wheat stubble before sugar beets. 11-48-0 at 100 pounds per acre was applied to sugar beets. Yields for the year 1966 are shown in Table 2.

TABLE 2

		MANURE & FERTILIZER	MANURE	FERTILIZER	CHECK
WHEAT	(bus.)	55.0	44.1	27.3	23.6
ALFALFA	(tons)	5.54	5.10	3.18	2.38
ALFALFA	(tons)	4.46	4.40	3.44	1.78
ALFALFA	(tons)	4.06	3.77	0.85	0.64
WHEAT	(bus.)	62.8	68.4	45.2	34.5
SUGAR BEETS	(tons)	22.74	22.06	11.84	2.29
SUGAR BEETS	(tons)	21.26	17.39	18.84	6.28
WHEAT	(bus.)	68.4	68.9	67.5	52.6

The strong residual effect of the 30-ton manure application once every eight years is obvious. Phosphate in addition to the manure gives further increases on some crops.

The Lacombe Research Station reported data on a 6 - year barley - hay rotation.

One 15-ton per acre application during the rotation increased barley grain and hay yields by 22.5 cwt. over a treatment using 450 pounds of 16-20-0, and 46.8 cwt. greater than the check over the rotation cycle.

Experiments conducted by Bowren at Parkside in northern Saskatchewan, compared fertilizer, using 30 lbs. P_2O_5 on summerfallow and stubble, 30 lbs. N on stubble and 50 lbs. N on hay, with manure at 15 tons per acre applied and incorporated in the summerfallow year.

TABLE 3

CROP	# YEARS	YIELDS LBS/ACRE FERT.	MANURE
FALLOW		--	--
WHEAT	37	155	570
WHEAT	13	306	387
HAY	7	908	1098
HAY	7	821	1108

McIver at Indian Head has used various rates of manure on a 3-year rotation of wheat-wheat summerfallow with manure applied in the summerfallow year. Yields for 1970 - 74 are shown in Table 4.

TABLE 4

TREATMENT	YIELD INCREASE BUS/ACRE	
	Summerfallow	Stubble
MANURE - 9 TONS	9.1	6.6
MANURE 9 - TONS + 11-48-0 @ 40	11.9	7.6
MANURE - 12 TONS	10.1	7.9

Data from Indian Head and Lethbridge show a cumulative yield increase trend.

A 4-year irrigated rotation of corn, wheat, and sugar beets at Lethbridge has received 12 tons of manure per acre once in the rotation, on wheat stubble ploughed in for sugar beets.

The results for 3 cycles of the rotation are shown in Table 5.

TABLE 5

	YIELD INCREASE
CORN - 1960 - 63	.23 Tons
1964 - 67	.45 Tons
1968 - 71	.86 Tons
SUGAR BEETS - 1960 - 63	1.12 Tons
1964 - 67	1.87 Tons
1968 - 71	4.56 Tons
WHEAT - 1960 - 63	2.5 Bus.
1964 - 67	0.7 Bus.
1968 - 71	3.2 Bus.

The yields on the soft spring wheat are not fully reflected due to lodging problems.

At Indian Head, 5-year moving averages of yield increases for wheat are shown in Table 6, for the 12-ton rate.

TABLE 6

	FALLOW	STUBBLE
1957 - 61	2.1	0.9
1960 - 64	4.0	3.3
1962 - 66	5.6	6.9
1965 - 69	8.4	6.4
1968 - 72	10.7	7.7
1970 - 74	10.1	7.9

The long term applications of manure have had significant effects on the phosphorus, and to a lesser degree on the nitrogen status of the soil. Table 7 shows the N and P in lbs. per acre for the 12 ton rate of application at Indian Head in 1974.

TABLE 7

	POUNDS PER ACRE							
	SUMMERFALLOW				STUBBLE			
SOIL DEPTH	CHECK		12 TONS		CHECK		12 TONS	
	N	P	N	P	N	P	N	P
0 - 6"	19	28	46	123	7	18	10	59
6 - 12"	25	15	44	59	5	12	5	12
12 - 24"	35	17	47	45	4	10	5	10
24 - 36"	15	13	32	46	1	7	4	9
36 - 48"	11	14	22	35	3	6	6	13

Physical and chemical properties of the soil at Parkside are shown in Table 8 as determined in 1964.

TABLE 8

	WATER STABLE AGGREGATES	WATER AT - 5 BAR	N %	P %	K P.P.M.
FALLOW-MANURE	34.4	16.6	.410	.034	57.1
CHECK	19.7	16.2	.414	.029	24.8
STUBBLE-MANURE	29.0	19.1	.457	.026	62.5
CHECK	19.4	14.6	.365	.021	25.7

The increase in water stable aggregates is noteworthy. Effect on matric suction is noted mainly on stubble. The increase in potassium status should be noted. 1974 data for the Parkside location shows extractable phosphorous values of 9 lbs. per acre for the check and 31 lbs per acre for the manure plots.

Stewart and Unger (1) have measured the effect of rates of feedlot manure on soil properties. Some results are shown in Table 9.

TABLE 9

	APPLICATION RATE -TONS/HA.				
	0	22	67	134	268
Water - 1.5 bars	28.0	28.6	29.2	30.3	32.3
Bulk density	1.37	1.33	1.28	1.20	1.12
O.M.	1.41	2.14	2.59	2.79	2.58
Strength - (Bars)	9.1	9.2	8.8	8.7	7.7
Porosity Index	1.20	1.22	1.47	1.60	1.48
Conductance	0.61	1.21	2.03	2.06	3.14

The effect of the lowest rate is generally small, except on organic matter and conductance. Evaporation rates were determined in soil columns. Evaporation was reduced by all rates with the highest rate showing about 80 per cent of the check.

The data presented shows that livestock manure, at present crop prices, can give quite satisfactory economic returns.

Moderately high rates applied in rotations of 4 to 8 years have given strong residual effects on crop yields, probably due to nutrients applied and effect on soil physical condition.

For soils requiring extensive improvement in physical condition much higher rates should be studied for effects on crops and soils. Application of heavy rates at low frequency would effect some economy in application, could reduce the weed control requirements, and provide more rapid physical improvement of the soil.

Research requirements include, of course, possible nutrient leakage. Cropping programs, utilizing crops to give the maximum removal of nitrogen, and possibly potassium, will need to be adopted, to utilize high rates of manure.

Crop quality measurements will include assessment of nitrate content, possible effects of high potassium status on elements such as magnesium, and phosphorus content of forage.

Residual phosphorus from manure may not correlate satisfactorily on present soil test caliberations using the 0 to 6 inch depth of sampling.

The potential for an increase in salt concentration from high rates of manure will also require study. This will be particularly true for feedlot manures where moderately high levels of salt are used in the ration.

References -

(1) Unger Paul W. and Stewart B.A. 1974 Feedlot Waste Effects on Soil Conditions and Water Evaporation. SSSAP 38:6 pp 954 - 57

DISCUSSION

Question: Is manure more efficient in increasing yields on summerfallow than stubble as charts indicated?

Answer: Could very well be; there is a large residual phosphate input from manure.

Question: Are responses from manure on alfalfa usually as high as overheads indicated?

Answer: Overheads could show slightly higher than normal response, however, responses on alfalfa are good.

Question: Are positive effects of manure enough to offset negative effects from salts?

Answer: Salts can pose a problem, have to be aware of these problems.