Forage
FACTSHEET

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CROP ROTATIONS FOR CENTRAL BC

Soils in Central BC are generally very low in organic matter. Thus on most soils, maintaining and increasing the organic matter content is the key to good soil management.

When the Experimental Farms were established at Smithers in 1938 and at Prince George in the early 1940's, some of the very first research in Field Husbandry included the establishment of a number of crop Sequence and Crop Rotation experiments. These trials have provided us with a good deal of basic and useful information which merits re-examination from time to time.

Soil surveys in this area show the organic matter content of the topsoil ranging from one to two percent. (Data from the fall of 1999 show ranges of 4 to 15% D.M. content in Highway 16 area soils.)

Organic Matter

Organic matter helps physically by keeping the soil open and improving the moisture holding capacity. It helps chemically by releasing energy and nutrients for the growth of soil organisms of all kinds. When organic matter decomposes, it helps to improve and stabilize aggregation.

The relative proportion of primary particles which make up a soil, eg – sand, silt and clay is known as texture. How these
particles are grouped together into aggregates is structure. Soils having good structure permit water and air to circulate freely. Crusting, baking, and puddling do not occur as readily. Manure, crop residues and forage crops such as alfalfa, clovers and grasses have a great influence on soil aggregation. They are excellent sources of organic matter which reduces the impact of rain and permits water to seep gently into the soil.

When organic matter decomposes, it releases substances which act as a solvent on soil minerals making them more available to plants. For example, soil phosphorus in acid soils is made more readily available. Decomposed organic matter (humus) provides a storehouse for plant foods.

Early Experiments

Smithers Experimental Station

Crop Sequence Experiment

In 1940, a fairly intensive experiment was laid out on a newly cleared area of gray wooded soil (Telkwa Clay) in the form of a 3 year rotation. Two blocks were occupied by preceding crops and a third block by indicator crops sown in the third year. A fourth block consisted of crops grown continuously on the same ground. There were no applications of manure or fertilizer. (see Table 1).

Table 1

Indicator Crop Yields 1942-49

Preceding	Oats (bu/acre)	Barley (bu/acre)	Wheat (bu/acre)	Oat Hay (tons/acre)	Potatoes (tons/acre)	Turnips (tons/acre)
Oats after turnips	41.9	26.2	16.4	3.87	12.52	5.46
Oats after fallow	44.9	25.3	18.8	3.44	12.44	6.09
Potatoes after fallow	75.4	50.8	32.9	4.51	16.94	8.48
Turnips after fallow	61.8	30.3	24.6	4.78	14.76	6.98
Oat hay after fallow	44.4	34.1	16.6	3.49	13.18	7.07
Sweet clover after fallow	78.1	44.6	30.7	5.64	19.07	9.19
Sweet clover[1]	96.1	55.6	38.7	6.42	19.56	9.98
Red clover[1]	95.4	59.1	37.5	6.83	20.86	9.95
Alfalfa[1]	79.2	51.3	34.1	6.89	19.55	7.42
Timothy[1]	69.7	43.8	29.6	4.82	15.41	7.49

[1] Established without a nurse crop in the first year.

The most outstanding feature of the yield data was the tremendous yield increase of all indicator crops grown after sweet clover, red clover and alfalfa. Over a period of 8 years, the average yields of wheat, oats and barley in the legume sequence were roughly double the yields of these crops in the non-legume sequence.

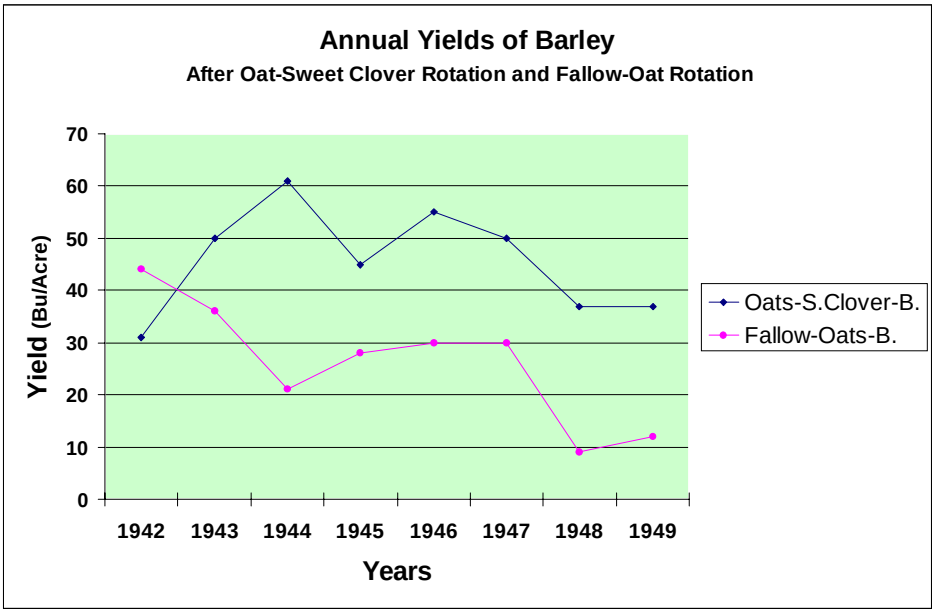
Some interesting trends were obtained when the annual results were plotted. The following graph (Figure 1) compares the annual yields of barley in the fallow-oats-barley sequence to the annual yields of barley in the oats-sweet clover-barley sequence.

During the first 3 years, there was a sharp decline of the indicator crop in the non-legume sequence which was in direct contrast to a steady increase in the yield after legumes. After 1944, the differences remained fairly constant depending on seasonal variations.

Of the crops grown continuously on the same ground, wheat, oats and barley rapidly declined in yield after the first 3 years. In addition, they

became heavily infested with weeds, chiefly wild oats, mustard, stinkweed and lambsquarters.

Figure 1



Subsequent Crop Rotation Trials at Smithers

Based on the results of the Crop Sequence studies, rotations of three, four, five and six years duration were designed and studied. (Table 2: Yields from 6-Year Rotations).

Table 2

Average Yields of Various Crops in a Series of 6-Year Rotations

	Year Within Rotation							
Rotation	1	2	3	4	5	6	Grain lbs/rotation	TDN lbs/rotation
1	Fallow	Oats 66.0 bu	Hay-1st yr 2.3 tons	Hay-2nd yr 1.8 tons	Hay-3rd yr 1.9 tons	Barley 36.8 bus	3952	8156
2	Oats 58.0 bu	Hay-1st yr 1.2 tons	Hay-2nd yr 1.8 tons	Hay-3rd yr 1.5 tons	Hay-4th yr 1.9 tons	Barley 42.0 bu	3991	10313
3	Potatoes 8628 lbs	Oats 53.0 bu	Hay-1st yr 1.2 tons	Hay-2nd yr 1.5 tons	Pasture 1.8 tons	Barley 37.0 bu	3709	9489
4	Potatoes 8352 lbs	Barley 56.0 bu	Hay-1st yr 1.5 tons	Hay-2nd yr 1.6 tons	Pasture 1.9 tons	Oats 36.0 bu	3602	9894
5	Barley 53.3 bu	Grass-legume Seeded down*	Hay-1st yr 2.1 tons	Hay-2nd yr 1.6 tons	Hay-3rd yr 2.0 tons	Oats 36.3 bu	3520	9174
6**	Potatoes 8484 lbs	Oats 51.0 bu	Hay-1st yr 1.4 tons	Hay-2nd yr 1.9 tons	Hay-3rd yr 2.1 tons	Barley 39.0 bu	3597	10395
7**	Oats 55.0 bu	Oats 38.0 bu	Hay-1st yr 1.5 tons	Hay-2nd yr 1.8 tons	Hay 3rd yr 2.0 tons	Barley 39.0 bu	4940	10738

* All hay crops were seeded with a nurse crop except in rotation 5.

** Rotations 6 and 7 contained a seventh field on which the alfalfa in pure stand was seeded for a 6 year period. This in effect makes it a 12 year rotation consisting of 6 years alfalfa followed by the 6 year rotation. Alfalfa yields from rotations 6 and 7 were 1.12 and 1.14 tons per acre respectively. Alfalfa was not used in the calculations of TDN in rotations 6 and 7.

Conclusions:

(a) Fallow is not a necessary practice.

(b) Harvesting the legume crop for hay or seed produced nearly as much grain the following year as green manuring the legume crop plus a substantial return of hay or seed.

(c) Establishing the forage crop with a companion or nurse crop resulted in greater total production of feed over the length of the rotation although the seeding of the forage crop without a nurse crop produced a better hay yield in the first year of production.

(d) A good rule of thumb in designing rotations is to maintain a ratio of two years legume forage to one year grain. The main farm rotation at Smithers consisted of 2 years grain and 4 years hay.

Establishing Stands of Perennial Forage Crops

Seeding too deeply was the most common cause of failure in stand establishment. On Telkwa Clay, the optimum depth of seeding was ¼ to ½ inch; on Driftwood Loam, ½ to 1 inch maximum.

Prince George Experimental Farm

Tillage Experiments

Fall plowing at depths of 4 to 7 inches, disced in the spring gave the highest oat yields over a six year period (1945 – 1951).

Green Manure and Barnyard Manure

Barnyard manure applied and incorporated in the first year of a 3 year rotation (oats, alsike, barley) resulted in a good response in the oats and in the subsequent hay crop. When the alsike clover was used as a green manure crop there was little effect on the yields of the grain crop. Harvesting the alsike for hay would have provided greater total returns.

Crop Sequence

Yields of oats following a legume or grass-legume mixture were considerably higher than oats after a grain crop. Continuous grain crops declined sharply in the third year.

Physical Effects

Various organic materials markedly improved the soil structure in both field and laboratory. Dry matter yields increased, moisture holding capacity increased and aggregation of particles increased.

Lime and Manure

Applications of lime and manure to Pineview Clay over a long period of years gave gradual yield improvement. Laboratory analysis showed that the treatments improved soil structure (1957-62 Research Report).

Summary

Although economics will dictate the type of crop planted, there are certain guidelines which must be kept in mind.

1. Central BC soils are low in organic matter.

2. The organic matter content and soil structure can be improved, and yields can be greatly increased by including forage crops, especially legumes, in the rotation.

3. All available manure and trash cover should be utilized, preferably by incorporating and mixing with the surface soil. A soil structure that will allow water penetration and aeration must be maintained.

4. A good rule of thumb in designing rotations is to include at least two years of forage crops for every year of cereals.

5. Plow shallow – no deeper than subsequent tillage operations, so that all manure and crop residues can be reached and mixed with the surface soil by discs and cultivators.

6. Cultivation operations should be as few as possible in order to maintain good structure.

7. Summerfallowing or even partial fallowing should be avoided. Plowing should be done in the fall and any additional cultivation should be left until spring.

8. In establishing forage crops, care must be taken to ensure shallow seeding. The optimum depth is ¼ to ½ inch. Companion or nurse crops may be used. The competitive effect of the nurse crop can be reduced by early removal for forage purposes

9. A good general purpose rotation for Central BC would consist of 4 years of forage crops and 2 years of cereal crops. If including canola it would replace one of the cereal crops. Under good management and absence of winter injury, forage stands may be kept for longer periods. Cereal crops should not be grown for more than two successive years.

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