Sweet Clover as a Conservation Crop in the Palouse[1]

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Continuation of a profitable system of agriculture in the inherently cash grain-producing Palouse area of eastern Washington and northern Idaho depends primarily upon the conservation of its soil resources.

Cropping systems used on Palouse farms consequently must provide for both conservation of the soil itself and maintenance of soil fertility. They include soil-improving forage crops grown in systematic rotation with soil-depleting grain crops. The frequency with which the soil-improving crop is used in the rotation is determined by the type of forage crop itself and the soil requirements for erosion control.

Soil-improving rotations adapted to a major part of the land in the Palouse vary from four to seven years and include biennial sweet clover as the base soil-improving crop.[3] A typical rotation that is being used widely is six years long. It consists of tall white biennial sweet clover alone, with grass, or with peas as a companion crop, the first year; sweet clover for green manure, hay, pasture or seed the second year; cash grains the third and fourth years; peas or summer fallow the fifth year; and cash grain the sixth year.

Sweet clover has been raised for many years on Palouse farms, but only during the last decade has it appeared in systematic rotations.[4] In the South Palouse Project, approximately 220 fields comprising some 24,000 acres have been seeded since 1934 to sweet clover or to sweet clover and grass in soil-improving rotations.

Records have been kept on the effect of the sweet clover crop in succeeding grain yields and on erosion control for many of these fields. This paper, however, deals only with information obtained from 44 fields seeded to sweet clover or sweet clover and grass in 1936. These 44 fields, all of which are situated on typical farms in the demonstration project, total 2,160 acres.

A complete plan of improved land use practices for soil conservation was in effect on these farms prior to 1936; hence, only soil, slope and erosion conditions under which soil-improving rotations were deemed adequate for erosion control were included in the study. This paper must be considered as a discussion of progress, because data from which it is drawn do not cover a complete rotation cycle.

Twenty-four fields studied were Palouse silt loam, fourteen Thatuna silt loam, three Koster silt loam, two Palouse silty clay loam, and one Santa silt loam. This distribution was proportionate to the extent of these soils in the South Palouse Project.

Data have been obtained by field observation and study on one grain crop and the first two years' erosion following the use of sweet clover and sweet clover and grass. Summarization of the material for this paper consisted of listing various factors which might influence erosion and grain yields. All of

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[3]Sloan, Sam L., Jacklin, Arden W., and Kaiser, Verle G. Soil-conserving and soil-improving crop rotations for the Palouse. Jour. Amer. Soc. of Agron. 31: 300-313. 1939.

[4]Schafer, E. G., Wheeting, L. C., and Vandecaveye, S. C., Crop Rotations. Wash. Agric. Exp. Sta. Bulletin 344. 1937.

the field data then were applied to each variable individually without regard to interplaying relationships between the variables. These relationships can be obtained only by considering each factor separately and then reviewing them all as a unit.

A Comparison of Wheat Yields Before and After Sweet Clover and Sweet Clover and Grass.

A comparison of grain yields before and after the use of sweet clover and sweet clover and grass was made on all fields which produced wheat in 1935 and 1938.

In 1935, before soil-improvement cropping, the average production of these fields was 29.9 bushels per acre. In the first crop after the soil-improving crop, they produced an average of 42.3 bushels per acre, or an increase of 41 percent. Average grain yields in the area were very similar in 1935 and 1938. Twenty of the 22 fields in this group were cropped with winter wheat in 1935 and 1938, and two with spring wheat.

Yield of the First Wheat Crop After Sweet Clover as Affected by the Inclusion of Grass With the Green Manure Crop.

A comparison was made between the yields of grain before and after plowing down the two types of green manure; i. e., sweet clover with grass and sweet clover alone. An increase of 15.2 bushels per acre, or 59.2 percent, after sweet clover and grass resulted as compared to a 12-bushel, or 38.1 percent, increase after sweet clover alone. The fields on which a mixture of grass and clover was used, though, generally were more severely eroded and in a poorer condition prior to the use of the soil-improving crop than were those on which sweet clover alone was planted. On the fields where sweet clover alone was grown, the clover had been established during the first year with peas as a companion crop.

Yield of the First Crop Following Sweet Clover and Sweet Clover and Grass as Affected by the Tonnage of Green Manure Turned Under.

The amount of green manure was divided into classes as follows: Light, under five tons per acre; medium, from five to ten tons per acre; and heavy, ten tons or more per acre. The same classification of tonnage of green manure is used throughout this paper.

Total tonnage of green manure turned under at or before the early blossom stage varied from 2.25 tons per acre to 19 tons per acre. Sweet clover pastured or cut for hay or seed yielded four to twelve tons per acre of aftermath, which was turned under in the fall.

Twenty-two fields were cropped to winter wheat and 14 to spring wheat after the soil-improving crop was plowed.

Of those seeded to winter wheat, seven were on light green manure fields and averaged 42.4 bushels per acre; six were on medium green manure fields and averaged 42.5 bushels; four were on heavy green manure fields and averaged 42.5 bushels; and five were on pastured green manure fields and averaged 39.8 bushels per acre.

These data show little correlation between the tonnage of green manure plowed under and the yield of winter wheat in the first crop following.

Yields of spring wheat in the different tonnage classes showed about the same variation as was found in the winter wheat. The heavy tonnage and the pastured classes gave a slightly lower average yield than the light and medium tonnage classes. This decrease may have been the result of moisture lost while preparing a satisfactory seed bed for spring wheat or to open, porous seed beds, both of which conditions may have been caused, in turn, by the large amount of crude organic matter that was present in the surface soil.

Greater variation in yields of the different tonnage groups may be expected later in the rotation cycle.

Yield of the First Wheat Crop After Sweet Clover and Sweet Clover and Grass as Affected by the Intensity of Tillage and Resultant Soil Pulverization.

The surface condition of the field, measured in degree of soil pulverization, was divided into three classes, namely, fine, medium, and rough. Fields were inspected prior to the run-off season.

The average yield of winter wheat on nine fields which were finely pulverized was 47.3 bushels per acre. On nine fields left in a rough condition, the average yield was 39 bushels per acre, a difference of 8.3 bushels in favor of the finely worked fields. The high yields from the finely worked fields were accompanied, however, by serious erosion and undesirable physical condition of the soil. These points will be discussed later in the paper.

The average yield of winter wheat on fields pulverized to a medium degree was very similar to those resulting from a rough condition.

No significant difference was noted in the yield of spring wheat on fields pulverized to varying degrees prior to the first run-off period.

Erosion as Affected by the Tonnage of Green Manure Turned Under.

Erosion during two run-off seasons was observed, including the erosion during the year following plowing of the green manure and the year following the first crop after the green manure.

The tonnage of green manure plowed under was grouped in four classes: Light, medium, heavy, and pastured, as previously described.

The degree of erosion was based on the average amount of soil lost per acre from the entire yield as determined by field observation. This information was supplemented by taking actual measurement of soil losses using a modification of the rill method of measurement developed by Alutin.[5]

Four degrees of erosion are established in terms of soil loss. "None" includes those fields which apparently lost no soil; "slight" includes fields on which from 1 to 2.9 tons per acre were lost; "moderate" includes fields which lost from 3 to 5.9 tons; and "severe" includes fields which lost 6 tons or more. This classification of degree of erosion will be used throughout the paper.

The tonnage of green manure plowed under apparently had little effect on the degree of erosion resulting in the first erosion period after plowing the green manure. A very pronounced effect, however, was shown in the degree of erosion during the second period after plowing. A majority of the fields on which light or medium tonnage of green manure was plowed eroded moderately or severely; whereas most of those fields on which heavy tonnages were plowed and on which the sweet clover was pastured showed none to slight erosion. In fact, only 15 percent of the heavy tonnage and pastured sweet clover fields suffered severe soil losses in the second erosion season.

These results must be tempered by the fact that many of the light and medium tonnage fields were also finely pulverized and that the stubble was at least partially burned prior to the run-off period.

Erosion as Affected by the Inclusion of Grass With the Sweet Clover.

A comparison was made of the relative erosion-resisting effectiveness of sweet clover alone as compared to sweet clover and grass in the rotation.

A mixture of grass with sweet clover was slightly more effective in controlling erosion during the first run-off

[5]Alutin, A. N. Unpublished material. Soil Conservation Service, Region 9, U. S. Dept. of Agri.

period after plowing the green manure than was sweet clover alone. None of the fields on which a mixture was plowed eroded more than slightly, but 13 percent of the fields having sweet clover alone plowed for green manure eroded moderately and severely.

The effect of the grass was even more pronounced during the second erosion periods. Nearly 90 per cent of the fields on which a mixture with grass was plowed showed none to only slight erosion; whereas only 37 percent of the fields on which sweet clover alone was plowed showed none to slight erosion, and 63 per cent showed moderate and severe erosion.

Erosion as Affected by the Intensity of Tillage and Resultant Soil Pulverization.

A finely worked surface after the first grain crop seemed to be conducive to more serious erosion than was finely worked green manure land. The same comparison held true for the medium class of pulverization.

Soil pulverized to a fine surface condition eroded severely. Soil pulverized to a medium condition suffered slight and moderate erosion, except where the stubble was burned, in which case it eroded severely. A rough soil surface usually provided complete erosion control, though a few cases of moderate and severe erosion were found on rough tilled fields. In these cases, the stubble had been burned prior to the tillage operation.

Although the degree of soil pulverization markedly influenced the erosion after the green manure, it was more important in combination with residue utilization as a contributing factor to soil loss after the first wheat crop.

Erosion as Affected by Fall Utilization of Residues From the First Wheat Crop After Sweet Clover.

Three classes of utilization were determined. The classes are: Completely utilized, one-half or more utilized, and less than one-half utilized.

Completely utilized stubble was very effective in controlling soil loss. Burning of residues, **even only partial burning,** resulted in severe erosion.

Standing stubble allowed only slight soil losses by erosion.

Completely utilized stubble on plowed fields resulted in 13 percent of the fields' showing no perceptible soil losses, 70 percent showing slight soil losses, 13 percent showing moderate soil losses, and only 4 percent of the fields showing severe soil losses.

All plowed fields on which less than one-half of the stubble was burned showed moderate and severe losses; 43 percent were moderately eroded, and 57 percent were severely eroded.

Plowed fields on which more than one-half of the stubble was burned were almost uniformly severely eroded. Eighty-six percent eroded severely, and the other 14 percent eroded moderately.

The method of utilization did not seem to be as important as the degree of utilization in conserving soil. This study is not sufficiently conclusive at this time, however, to make any definite or final statements concerning this point.

An outstanding effect from the utilization of crop residues was the improvement in tilth of the topsoil. On fields where the residues were burned, extreme puddling and baking occurred in addition to severe soil losses. On those fields where the stubble was utilized, an open, friable condition existed after the run-off period.

Conclusions.

This paper discusses only preliminary data and covers only one crop year and two erosion seasons within a six-year rotation.

The use of sweet clover or sweet clover and grass, when supported by rough or semi-rough surface soil conditions and surface utiizlation of all crop resi-

dues, minimized erosion and markedly increased grain yields. The use of sweet clover or sweet clover and grass in combination with intensive tillage to pulverize the soil increased the yield of the first crop following the green manure, but only at the price of subsequent serious soil losses and undesirable physical condition of the soil. The use of sweet clover or sweet clover and grass in a system wherein crop residues are burned, produced a soil condition in terms of tilth and erosion which was comparable to soil conditions in a wheat-fallow system. The condition may be even more undesirable, because the nitrogen made available by the leguminous green manure may serve as a stimulating influence to the breaking down of soil humus.

The superiority of sweet clover and grass over straight sweet clover was evident from both the soil productivity and the erosion control standpoints.