Economic Considerations in Planning for Soil Conservation on the Chehalem Mountain Project, Oregon

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Photograph by 41st Division Aviation Washington National Guard

View of the Chehalem Valley showing types of farming in the Chehalem Mountain Project Area.

FOREWORD

SOIL erosion is an important problem in Willamette Valley agriculture. Constructive soil conservation planning and action are essential if certain farm lands are to remain permanently productive use.

The Chehalem Mountain Soil Conservation Project, located near Newberg, Oregon was initiated in 1936 to demonstrate effective erosion control measures and to develop a complete soil conservation program for the area.

This study shows that the various soil conservation measures proposed have been effective in preventing erosion and in improving the soil. It points out that a carefully planned soil conservation program fits readily into the farming system, involves relatively minor cash cost, contributes measurably to the annual farm income, and stabilizes the investment value of the land on a permanent basis.

WM. A. SCHOENFELD
Dean and Director

SUMMARY AND CONCLUSIONS

The Chehalem Mountain Soil Conservation Area embraces 35,788 acres of steep and rolling hill soils, and 9,744 acres of gently sloping and level valley soils. The soil and erosion survey disclosed that 5 per cent of the total land area (2,276 acres) has been severely damaged by erosion, and 21 per cent (9,562 acres) has been moderately damaged. In addition to erosion, most Chehalem Mountain soils have been depleted of plant nutrients by heavy cropping and by leaching.

MAJOR ADJUSTMENTS IN FARMING PRACTICES NEEDED TO SAVE SOIL AND MAINTAIN FERTILITY

The initial soil and erosion survey disclosed a need for making adjustments in certain farming practices so as to prevent erosion and maintain the highest possible organic matter content of the soil. This soil content is accomplished by adopting such measures as contour cultivation, more effective use of winter cover crops on orchard land, the rotation of crops including a larger proportion of grass and legumes, and the complete utilization of all crop residues. Commercial fertilizer is recommended where necessary to secure optimum results from legume and grass crops.

ONLY MINOR ADJUSTMENTS ARE REQUIRED IN THE USE OF SOIL CONSERVING CROPS

Land use on the 65 farms under cooperative agreement in this project has been changed only moderately under the soil conservation program. The major shift is from grain and annual row crops to grasses and legumes, involving for the group as a whole a decrease of about 7 acres formerly in grain, corn, and potatoes and a corresponding increase in the soil-conserving grass and legume crops. While the changes are minor in extent, the utilization of increased forage production through livestock on the one hand and the improved care of fruit lands on the other hand, together contribute materially to the farm income and the equally important farm-furnished living.

SOIL CONSERVATION PLANS PRACTICAL

Dairy and fruit farm

Shifting from grain and berry acreage to hay and pasture permits an increase in the dairy herd from 5 cows to 12. This change increases the total labor requirement of the farm but reduces the amount at peak seasons, making it possible for the farmer to do more of the work himself. The analysis shows a probable increase in cash farm income for the conservation plan of more than $100, in addition to conserving the land on a permanent basis.

Renovating old orchards and using eroded cropland for legume and grass seed crops as part of a soil conservation plan shows an increase in the farm income of $180 a year. The program not only protects the land from erosion but it improves the soil through the growing of soil-improving crops and turning under of green manure crops. With the gradual accumulation of organic matter in the soil the income for the soil conservation plan should increase above that estimated, while under the depleting method of farming the income steadily decreases.

Diversified farm

Farmers on small tracts may adjust their land use in line with soil conservation recommendations without sacrificing income. In fact, the analysis for the farm indicates an increase in income of $300 for the soil conservation plan. A farm flock of chickens, a few hogs, and a family cow or some sheep, moreover, improves the family living and materially increases the farm family income.

Small berry farm

The analysis shows that erosion can be controlled and the orchard investment made secure. The cost of the measures suggested herein amortize in 10 years at an annual rate of only $7 an acre. Such an expenditure for conservation is estimated as capable of maintaining the yield of walnuts at least 200 pounds per acre above that on similar land without a suitable conservation program.

Walnut farm

While some adjustments in land use and farming practices are necessary to control erosion, most of these adjustments are of a minor nature and do not greatly disturb the system of farming that has developed and been proved practical through experience. The capital required for erosion control structures is generally nominal (usually less than $100). The facilities for making most conservation improvements are available on the farm. The changes in land use can be fitted readily into and made a part of the farm organization. With proper management the conservation measures will contribute to the family living and the farm income while maintaining the soil for continuous use.

Capital investment in soil conservation not great

MAJOR PRACTICES IN A CONSERVATION AND MANAGEMENT PROGRAM

Practices that have been effective in the development of a sound soil conservation and farm management program are as follows:

1. Improve the cropping system on steep fields by including fibrous-root plants, such as the grasses, that have the ability to keep the soil in place, increase the penetrability of rainfall, and improve fertility.
2. Avoid excessive cultivation, which breaks down the soil structure, reducing the soil to a dust mulch, which

puddles easily when wet, thus preventing water penetration. The excessive surface water in turn readily finds its way downhill across the smooth-surfaced topsoil, tearing away the finely broken soil particles as it gains in volume and momentum.

3. Operate on the contour to leave cultivation marks across the slope, thereby providing a soil-surface condition resistant to runoff.
4. Provide sufficiently continuous ground cover, both during any one crop year and during a period of years, as protection to the surface soil.
5. Provide and maintain a high organic matter content in the soil through use of crop residues and green manures.
6. Add fertilizer where needed to stimulate rapid growth of field crops, grasses, and cover crops to obtain maximum efficiency from all the factors expended in production.
7. Improve pastures by seeding, fertilizing, and proper grazing.
8. Improve woodland by application of woodland management practices, including harvesting of mature or defective trees, thinning of excessively dense young growth, and protecting stands from fire.
9. Change the land-use system from a seasonal to a more nearly year-round farm business organization, particularly with regard to the utilization of the operator's own labor and equipment, and with regard to receipts and disbursements.

Economic Considerations in Planning for Conservation on the Chehalem Mountain Project, Oregon*

by

G. W. KUHLMAN, H. L. THOMAS, and C. A. LOE†

INTRODUCTION

AN ECONOMIC soil conservation program enables the farmer to establish and maintain the productivity of his soil at a level that will permit him to earn a satisfactory farm income year after year without further impairment of the land as a capital asset. In considering the adoption of soil-conserving measures the farmer is interested primarily in how he may attain the desired results with the least cash outlay and with the minimum disruption to his system of farming; however, several methods of erosion control and many other factors should be considered. A given field may be terraced and no changes made in the crops grown; it may be strip-cropped, with some increase in close-growing crops; or it may be placed under more or less permanent vegetal cover. Farmers need to consider not only the physical effectiveness of control measures, but also their effect upon the farm organization.

The objectives of this study are: (1) to determine the extent of changes in land use and farming practices made by farmers to control erosion in the Chehalem Mountain Project Area, and (2) to show by detailed analysis the probable effects of adopting a soil conservation program on farm production, expenses, and income. These analyses are made for individual farms representative of the chief types of farming in the area.

Conservation measures for a particular situation must be determined by an analysis not only of the land needs, but also of the costs involved, and of the probable effects upon the production and income of the entire farm. In evaluating alternative plans for conservation it is essential that the analysis be based on estimates of future re-

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sults. Such estimates must reflect the effects of proved practices and conservative standards of production and price normal to the region.

A soil conservation program must be based on sound farm management principles. This involves the effective utilization of land, equipment, labor, and management to produce the largest continuous returns. Farm management and soil conservation are therefore complementary aspects of good farming. This report outlines some factors that should be considered, and shows how estimates may be used to determine the probable economic effects of adopting a specific plan of erosion control.

DESCRIPTION OF THE AREA

The Chehalem Mountain Soil Conservation Project was established in October 1936 to demonstrate practical methods of reducing soil losses and for conserving soil moisture. The project, embracing 450 farms, covers 45,532 acres or about 71 square miles. It lies north of Newberg in Yamhill and Washington counties. The area includes the Chehalem Mountain and the Dundee Hills, the rolling foothills, the level valley floor, and alluvial lands along the streams (Figure 1).

Such physical factors as soil, topography, and climatic conditions are of primary consideration in planning a sound soil conservation program. These factors are also fundamental in considering an economic farm production program.*

Climate

The climate of this region is comparatively mild the year round. A winter season of abundant rainfall, extending from late October into April, is followed by a summer period of light, scattered precipitation. These conditions create a two-fold conservation problem. Orchard and cropland generally must be protected during the winter season to prevent water erosion of the exposed soils, and to retain and conserve sufficient soil moisture for maturing crops during the ensuing dry summer. Obviously, the penetration and retention of rainfall is essential both to prevent soil erosion and to store moisture for plant use during the dry summer period.

* For a more complete description of the physical features of the area see the report by H. N. Magness and M. F. Sandoz, "Erosion and Related Land Use Conditions on the Chehalem Mountain Demonstration Project." United States Department of Agriculture, Soil Conservation Service. Erosion Survey No. 20, 1941.

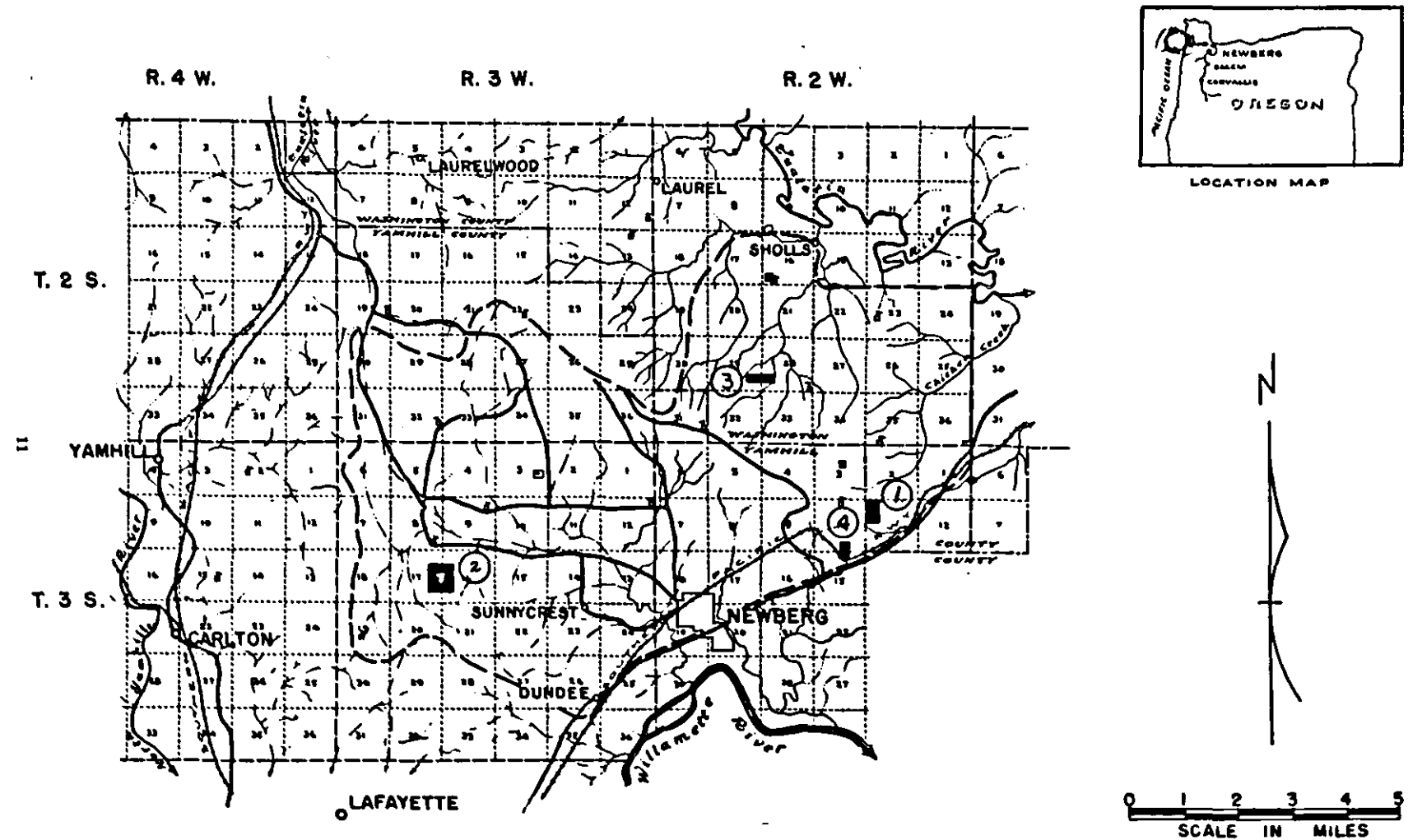


Figure 1. The Chehalem Mountain Soil Conservation Area, showing location of individual farms studied.

Topography and soil

Nineteen different soil types were mapped and arranged in three main groups. The uplands or hill soils comprise 79 per cent of the area. These soils are developed from basaltic rocks, shales, and sandstones. Soils developed from sandstones are especially susceptible to erosion. Much of the land is steep, nearly three-fourths of it having more than 12 per cent slope. Because of the excessive slope, only 46 per cent of it is used for cropping. The valley-floor soils comprise 15 per cent of the area. This land is nearly level, 70 per cent being well-drained and the remainder imperfectly or poorly drained. More than three-fourths of this land is used for crops. The bottom-lands comprise only 7 per cent of the area. Although generally lacking in drainage and subject to overflow, 76 per cent of the acreage is in crops.

Agricultural history

The Chehalem Mountain Area was first settled about 1840. At first spring wheat dominated the cropping system but later oats, potatoes, and clover were introduced, giving rise to rotation cropping. The cropping system has changed gradually from extensive grain and hay production to more intensive grass- or legume-seed, or a grain-legume rotation program. Further diversification occurred when orchards and berries were introduced and when dairying and other livestock enterprises developed.

On diversified farms the number of livestock averages about 10 cows, 20 to 30 sheep, a few hogs, and a farm flock of chickens. Besides the field crops consumed, the livestock also graze over most of the uncultivated land. Since about half of the nontillable land supports a fair to heavy cover of trees and browse, it provides wood for fuel and some saw timber as well as grazing in the open spaces (Figure 2). At the present time about 36 per cent of the cultivated land is in orchards and 9 per cent in berries. (Berries are often interplanted between the young fruit and nut trees, the soil and site requirements being similar.) The fruit acreage, however, is not evenly distributed over the entire area. Two-thirds of the orchard and berry land is concentrated on 45 per cent of the farms in the project area. These fruit farms average only 43 acres of cropland each, more than 80 per cent of which is devoted to fruit production. A high proportion of the fruit acreage is on the upland soils* where the practice of clean cultivation in summer is required to conserve maximum moisture for fruit production. This practice

* Fruit production superseded grain and other field crops when their yields declined under the grain system of farming that predominated at first.

of clean cultivation on steep land is one of the main factors contributing to soil erosion.

Photograph by 41st Division Aviation Washington National Guard

Figure 2. More than one-third (36 per cent) of the area is woodland, 53 per cent is cropland, and 10 per cent is pasture.

Soil erosion and runoff

Soil erosion surveys show that 33 per cent of the land has not been affected by erosion because of protection by timber, 40 per cent has been slightly eroded, 21 per cent moderately so, and 5 per cent severely eroded. Table 1 shows the proportion of each erosion class that was cropland, pasture, or woodland.

Table 1. EROSION AND LAND USE: PERCENTAGE OF AREA IN SPECIFIED USES AND EROSION CLASSES ON 65 FARMS IN THE CHEHALEM MOUNTAIN PROJECT.

Degree of erosion	Per cent of area				
	Crop-land	Pasture	Wood-land	Farm yard	Total
None	0.4	2.2	30.1	...	32.7
Slight	26.9	7.5	5.2	0.8	40.5
Moderate	20.0	0.9	0.4	...	21.3
Severe	4.8	0.1	0.1	...	5.0
Very severe	0.5	.....	.....	...	0.5
TOTAL	52.6	10.7	35.9	0.8	100.0

Causal factors of severe erosion include improper land use and tillage practices on steep slopes under conditions of excessive winter precipitation. Heavy runoff occurs after the soil becomes completely saturated. Slope affects the rate of surface runoff. It also influences the susceptibility of soil to erosion and therefore largely determines the capability of land for continued use. Soil losses are confined largely to the cultivated uplands, which are subject almost entirely to sheet erosion, small gullies being formed in natural drainageways. Deep gully erosion is not prevalent because of the heavy clay subsoil; nor is damage by soil deposition generally serious. Wind erosion is not a problem in this area.

The problems of water loss are nearly as important as those of soil loss. Owing to the unequal seasonal distribution of rainfall and to the small margin of available moisture retained in some soils, all moisture possible must be retained for tree and crop growth after the rainy season ends about April 1.

GENERAL ASPECTS OF THE SOIL CONSERVATION PROGRAM

Land use capabilities

The classification of land according to its use capabilities furnishes a basis for making recommendations regarding the kind of cropping practices that may be followed safely and the intensity and variety of protective measures that need to be applied. Selection of the crops to be grown on cultivated land depends further on the nature of the soil, its relationships to water and air drainage, the steepness and regularity of the slope, the degree of erosion, and the climatic factors.

The percentage distribution of the farm land in the project according to land-use capability classes is as follows:

I	Level, to gently sloping, well drained; requires no special practices	6.5 per cent
II	Requires simple conservation measures, such as contour cultivation	27.9 per cent
III	Requires intensive application of conservation practices	35.7 per cent
IV	Suitable for only occasional cultivation to reestablish cover	7.8 per cent
V	Grazing and forest use only (no cultivation)	22.1 per cent
	TOTAL AREA	100.0 per cent

Class I land is nearly level, having a slope of less than 5 per cent, with little or no erosion, not subject to destructive overflow, and sufficiently well drained to grow the crops common to the region.

Class II land is on slopes up to 12 per cent, with not more than slight or moderate erosion (removal of not more than half the topsoil by sheet erosion or not more than one-fourth if accompanied by infrequent and shallow gullying). It requires proper crop rotations, the use of cover crops, and the utilization of crop residues to increase organic matter and moisture holding capacity. Such land may be kept under cultivation without resorting to further erosion measures.

Class III land occurs chiefly on slopes of 5 to 12 per cent on which sheet erosion has removed 25 to 50 per cent of the topsoil, with some shallow infrequent gullying, and on slopes above 12 per cent on which little or no erosion has occurred. It needs special mechanical treatment to support good tillage practices.

Class IV land includes most slopes up to 20 per cent where erosion is severe (removal of 50 to 75 per cent of the topsoil, with or without gullies), and on steeper slopes, up to 30 per cent, where erosion is only slight or moderate. It should be kept under good plant cover, with cultivation only at long intervals.

Class V land includes very severely eroded and steep areas, suitable only for grass or forest uses. (Standard Land-Use Capability classes now include VI, VII, and VIII as additional groupings for the steeper hill lands.)

The survey showed that about 1,600 acres of cropland or 3.5 per cent of the area, fall in Class IV. This land should be under a permanent cover of grass (or timber) with only occasional cultivation to reestablish grass stands. A similar acreage of cropland falling in Class V is for various reasons not suitable for cultivation, and therefore should be retired to permanent pasture or forest. Most of the permanent pasture and woodland should be retained and properly managed.

Except for these rather minor shifts in land use, the soil conservation problem really resolves itself into the need for *controlling erosion on steep orchard and cultivated croplands, improving and maintaining soil fertility, controlling weeds, and conserving maximum moisture for crop production.*

The first step in preparing the conservation plan for a farm is to determine the classification of each tract of land on the basis of the four physical factors, soil type, slope, erosion, and land use. These factors largely determine the conservation needs of each tract of land. When land is properly classified it is possible to plan the land use for each field within the limits described by the land-use capability class. The specific crops to be grown on each class of land may be determined to some extent by factors additional to those pertaining to the land, such as the livestock feed requirements, the cash crop requirements, or the wishes of the farmer. Any cropping system must of course provide soil improving crops, opportunities for weed control, and other factors affecting soil maintenance.

When the land-use capability class and the cropping system are known it is then possible to plan the specific soil conservation measures required to maintain the highest production level. If, for example, perennial grass for seed production were to be grown on Class III land it would be unnecessary to apply special conservation measures other than those needed to maintain the stand and its productiveness, since a good sod is adequate soil protection. On the other hand, if orchard or grain and other annual crops were to be grown on Class III land the minimum of soil conservation practices might be contour cultivation, return of all crop residues to the soil, provision of winter ground cover by either early-sown fall crop or stubble, and rough surface tillage (Figure 3).

The soil conservation program

In addition to erosion most Chehalem Mountain soils have suffered depletion of plant nutrients by heavy cropping and leaching. Most of these soil damages result from improper land use and farming practices. For this reason the soil conservation program

Soil Conservation Service, U. S. Department of Agriculture

Figure 3. The first orchard site prepared for planting on the contour in Oregon. The orchard planting plan was fitted to the system of water diversions to permit contour cultivation.

stresses the use of crops that provide cover and hold the soil in place during certain critical seasons and, when turned under, increase the fertility and organic matter content of the soil. Soil conservation practices that have been demonstrated and are now being recommended include the following:

(1) More effective use of winter (legume and grain) cover crops on orchard land. This means proper utilization of the crop for mulching and improving the organic matter content of the soil (the addition of straw is also helpful).

(2) The use of terraces, and other supplemental drainage structures to prevent erosion, and to provide an orderly means of draining surplus water during heavy rainfall periods.

(3) The use of a well-balanced crop rotation, including legume and grass crops.

(4) The shift of certain cultivated lands from grains to grass and hay crops.

(5) The use of commercial fertilizer and lime where necessary to secure good stands of grass and legume crops.

(6) The use of contour cultivation on sloping land.

These practices have proved to be effective in the conservation of soil, but some farmers still must be convinced of their practical use as a regular part of the farm organization and management. This study reports the probable effects of soil conservation practices on the farm business of some representative farms in this area.

SIZE AND TYPE OF FARMS

The systems of farming in the area vary with the proportion of production consisting of fruits and nuts, small grains, and different kinds of livestock products. Farms range in size from less than 10

Table 2. PRESENT LAND USE: DISTRIBUTION OF THE 65 FARMS IN THE CHEHALEM MOUNTAIN PROJECT BY SYSTEMS OF FARMING.

Land use	11 dairy and fruit farms	20 diversified farms	34 fruit and nut farms	All farms (65)
Cropland	*Acres*	*Acres*	*Acres*	*Acres*
Orchard	4.6	27.1	25.9	22.7
Berries	3.7	1.8	2.0	2.3
Grasses and legumes	26.4	15.5	2.9	10.8
Grain	33.1	24.5	5.3	15.9
Row crops and miscellaneous	7.2	6.9	.7	3.7
Total cropland	75.0	75.8	36.8	55.4
Pasture	52.7	45.4	8.4	27.3
Woodland	14.2	34.1	9.5	17.8
Farmstead, waste, etc.	6.1	5.6	2.8	4.2
TOTAL FARM	148.0	160.9	57.5	104.7

acres in subsistence tracts to more than 500 acres in large commercial farm units. For purposes of analysis and presentation the 65 farms in the project area, for which soil conservation plans have been made, were classified as 11 dairy and fruit farms, 20 diversified farms, and 34 fruit and nut farms (Table 2). Individual farms, representative of each of these types, have been selected for more intensive study of the economic effects of soil conservation plans.

DAIRY AND FRUIT FARMS

Strictly dairy farms represent a rather minor portion of the farms in the area, although the dairy enterprise is common and is an important source of income on many farms. The 11 so-called dairy and fruit farms in this study average 148 acres in size, half of which is in crops (Table 3); about 8 acres are in orchard and berries. The most significant change in land use to prevent erosion and conserve the soil is an increase (about 5 acres) in grasses and legumes, accompanied by a corresponding decrease in small grains (see Table 2).

Table 3. DAIRY AND FRUIT FARMS: PRESENT LAND USE AND CHANGES IN ACREAGES PROPOSED IN THE SOIL CONSERVATION PROGRAM.

Land use	Number of cows per farm				All dairy farms (11)
	6 farms with fewer than 20		5 farms with 20 or more head		
	Before conservation	After conservation	Before conservation	After conservation	After conservation
Cropland	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Orchard	2.9	2.3	6.6	7.6	4.7
Berries	6.8	6.2	.....	.....	3.4
Grasses and legumes	14.3	23.1	41.0	39.4	30.5
Grains	13.3	5.2	56.8	53.2	27.0
Row crops and miscellaneous	5.8	3.2	9.0	9.6	6.1
Total cropland	43.1	40.0	113.4	109.8	71.7
Pasture	24.4	27.5	86.8	90.0	55.9
Woodland	1.0	1.0	30.0	30.0	14.2
Farmstead, waste, etc.	5.3	5.3	7.0	7.4	6.2
TOTAL FARM	73.8	73.8	237.2	237.2	148.0

A soil conservation plan for an 80-acre dairy and fruit farm

The effects of a conservation plan on the organization of dairy and fruit farms were studied on an 80-acre farm located about 3 miles northeast of Newberg in Washington County (Figure 4). The farm is smaller than the average total acreage of this group and it has fewer cows, but it has a larger acreage of cane fruit. About 65 acres are in cultivation and the remainder is pasture, brush, and farmstead. Black raspberries (blackcaps) have occupied from 15

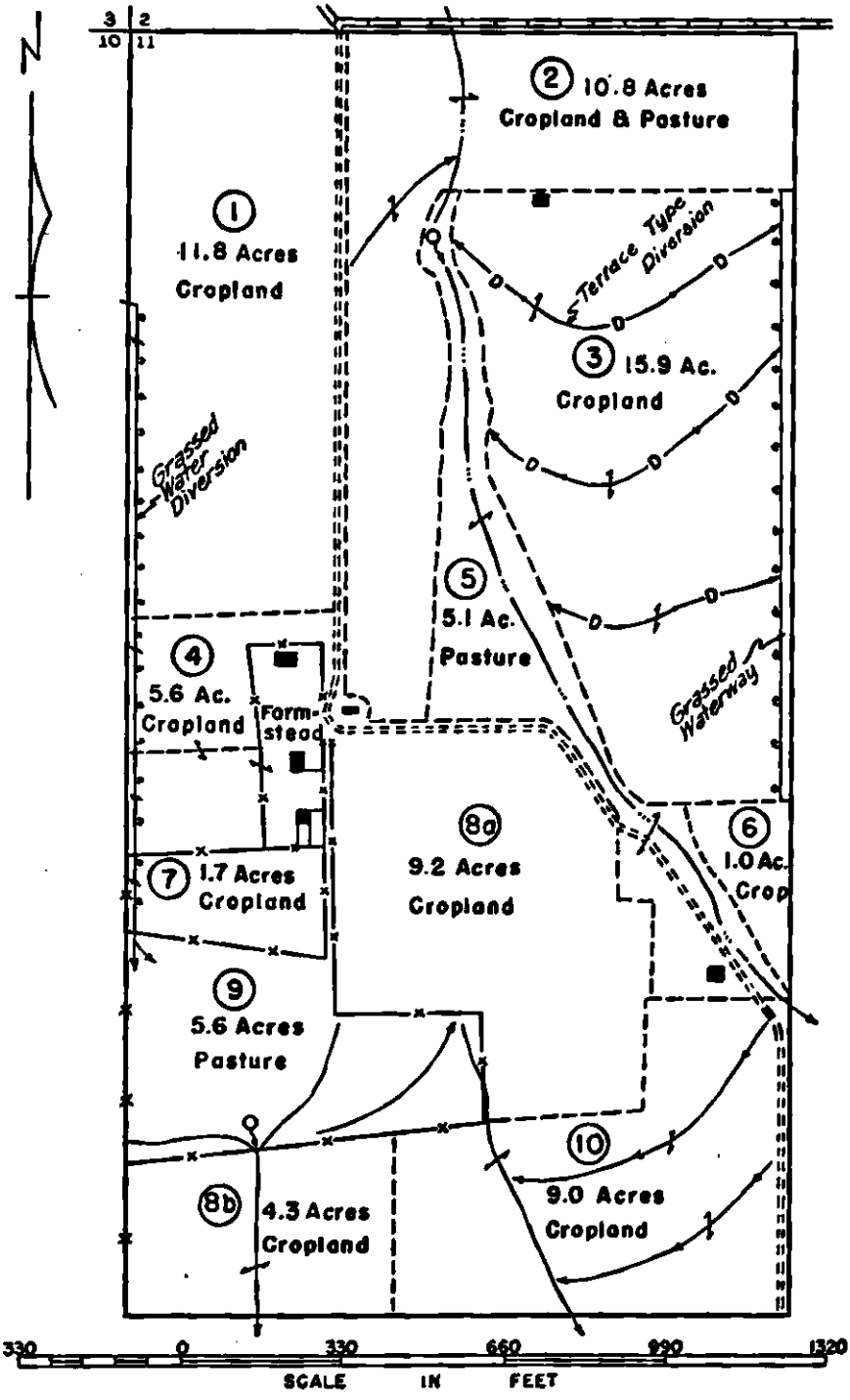


Figure 4. Map of a dairy and fruit farm.

to 30 acres, varying with the particular acreage of new plantings for a given year. Formerly from 35 to 45 acres were in small grains and hay, a small part of which was fed on the farm. The livestock had averaged only 5 cows, 2 heifers, and 3 horses prior to the conservation program adopted.

The soil on this farm is Olympic clay loam. All fields are moderately steep, the cropland ranging from 14 to 18 per cent slope, and the pasture land from 17 to 22 per cent. Hill soils within this slope range are critical from the standpoint of erosion control. For this reason, intensive soil conservation practices must be adopted to maintain soil productivity and prevent erosion (Figure 5).

LAND USE. The survey on this farm in 1938 showed only slight to moderate erosion on 41 acres of cropland (Fields 1, 2, 8a, 10). This degree of loss is considered normal on hill lands that are kept in a fair state of productivity. Evidence indicated, however, that erosion losses even here were increasing at a more rapid rate. For example, on 7½ acres in field 10, erosion was slight but occasional gullies were forming. These gullies were the result of a combination of factors. The runoff water from the fields above concentrated on this land, and the soil was so depleted of organic matter that penetration was apparently very slow. Approximately 18 acres of cropland (Fields 3 and 7) showed moderate to serious sheet erosion, with 30 to 40 per cent of the topsoil removed. This meant that the critical stage had been reached and that the time for action was at hand.

The soils are naturally shallow on this hill farm and continuous cropping with grain and berries has reduced fertility to a rather low level. The operator reports that an apple orchard was located on this acreage 71 years ago when the property was first acquired by his family. Adequate provision was not made for soil maintenance and the physical condition of the soil indicated *serious* depletion of organic matter. The surface soil was compact and it ran together during the winter months, seriously retarding penetration of rainfall and thereby increasing the runoff. During dry weather the soil baked and cracked, further indicating poor physical condition. Any further deterioration of the soil structure would greatly accelerate the rate of erosion.

PROGRAM PROPOSED. The following objectives constituted the basis for the conservation plan designed for this farm:

1. Stop erosion losses immediately.
2. Maintain the farm income, insofar as possible, during and after the establishment of the soil-improving program.

3. Improve the physical and productive properties of the soil to the state where maximum production could be sustained.
4. Establish a cropping system and supporting farm practices that would continuously maintain a high level of production and income.
5. Utilize, as far as practicable, the present farm organization and the operator's experience in order to minimize the extent of changes suggested.

Photograph by J. G. James, Soil Conservation Service, U. S. Department of Agriculture

Figure 5. Long slopes and *insufficient soil protection during heavy rainfall periods* cause serious erosion on grain land.

A program for the permanent improvement and maintenance of the soil on this farm, it was felt, must be based upon a long-time cropping system, including at first a large portion of sod-forming perennial grasses and legumes. The purpose of these crops is to build up the organic matter supply in the soil and to improve the soil structure.

CROPS. The conservation program provided that the most critical areas would be sown to perennial cover and maintained in grass for several years. Nearly 35 acres of perennial grass seeding was designated for the first few years. Eventually, however, only 10 acres of the most seriously depleted cropland will remain in per-

manent pasture, with only an occasional cultivated crop before reseeding. Eighteen acres of perennial grass-legumes are rotated over the cultivated land, stands to remain from 4 to 6 years. A short 3-year rotation on 18 acres is worked within the long-time rotation, using soil-building crops such as vetches and clover for hay or seed along with a year of grain hay for nurse crop. Lime will be applied to a field following a grass and prior to sowing vetch or clover. Annual application of 75 pounds of landplaster (sulphur) per acre early in the spring is recommended for legumes. Manure should be used either on cultivated crops or as a top dressing on the grasses. The effectiveness of manure is increased by adding the phosphate fertilizer to it daily as the manure accumulates at the barn.

The three cropping systems and their respective acreages of crops are as follows:

Cane fruit	Acres	Legumes	Acres	Grasses	Acres
Bearing (5 years)	15	Clover hay (1st year)	6	Hay or pasture	12
New planting	3	Clover hay (2nd year)	6	New seeding*	3
		Vetch seed or hay	6	Grain or corn	3
TOTAL	18	TOTAL	18	TOTAL	18

* New seedings will be made according to actual plots and whenever old stands become thin.

These three systems of cropping provide a balanced land-use program that maintains maximum production of hay, pasture, and fruit. The actual acreages planted should be in accordance with the size and condition of the fields rather than in exact units of land measurement as shown here for convenience.

Cane fruit production continues as the major enterprise, occupying approximately 18 acres of land with 3 acres of new planting set out each year and 15 acres in bearing (Table 4).* The plan is designed to build up the soil with heavy growths of green manure crops and with the crop rotation systems in preparation for cane fruit. A cover crop of 70 pounds vetch seed per acre is sown between the rows of canes each fall and disked into the soil the following spring. A commercial fertilizer containing nitrogen and phosphorus is applied on this seeding at the rate of at least 100 pounds per acre to stimulate rapid growth.

The purpose of having a basic plan of production is twofold: first, it will provide for carefully preparing the soil well in advance of the year that it will be used for a particular crop; second, it will maintain some degree of balance with regard to the production of

* Neither the acreage of new planting nor the life of the stand is intended to be arbitrary. It is probable that under a systematic soil conservation program, coupled with freedom from disease and pests, the profitable bearing life of the blackcaps will usually extend beyond 5 years.

cash crops, feed crops, and pasture, and with regard to farm expenses and receipts.

When the grass hay sod is broken up either corn or kale makes good use of the accumulated soil fertility. These crops, moreover, are preferable to grain because they do not require hiring of machinery. When a berry planting is broken up this acreage also is thrown back into the crop rotation, growing corn, hay, and grass until ready for berries again.

Table 4. AN 80-ACRE DAIRY AND FRUIT FARM: LAND USE AND ESTIMATED CROP PRODUCTION BEFORE AND AFTER ADOPTION OF THE CONSERVATION PRACTICES.

Land use	Before conservation			After conservation		
	Acres	Yield	Total	Acres	Yield*	Total
Cropland		*Pounds*	*Pounds*		*Pounds*	*Pounds*
Berries (new)	3	.....	.....	3	.....	.....
Berries (bearing)	15	2,000	30,000	15	2,400	36,000
Grain	33	1,200	39,600	3	1,800	5,400
Grasses and legumes	13	3,000	39,000	25	4,000	100,000
Grass seeding	.....	.....	.....	3	.....	.....
Corn (green)	1.5	14,000	21,000	1.5	14,000	21,000
Kale	1.5	30,000	45,000	1.5	30,000	45,000
Farmstead and garden	2.3	.....	.....	2.3	.....	.....
TOTAL CROPLAND	69.3	.....	.....	54.3	.....	.....
Pasture†		*A.U.M.*	*A.U.M.*		*A.U.M.*	*A.U.M.*
Improved	.....	.....	....	15	3	45
Native	10.7	1.5	16	10.7	1.5	16
Hayland aftermath	.....	.5	7	.....	.5	12
TOTAL PASTURE	10.7	.....	23	25.7	.....	73
TOTAL ACREAGE	80	.....	....	80	.....	....

* Yields "after conservation" used here and in subsequent tables are estimates of the production expected after the conservation program has had sufficient time to become reasonably effective. These estimates are believed conservative in light of results already obtained by the same farmers following the new program. In fact, reports indicate that frequently the actual yields already exceed those used in this study.

† Measured in *animal unit months* (A.U.M.) or the pasturage that will carry one cow or equivalent 1 month.

LIVESTOCK AND FEEDS. The diversion of acreage from grain production to grass and legume hay and pasture crops makes possible an increase in the dairy enterprise from 5 cows to 12 cows (Table 5). Where previously about 13 tons of grain were sold each year, under the new plan approximately 12 tons of concentrates must be bought for the livestock. The farm, however, will produce all the hay, succulent feeds, and pasture required. The crops of clover, vetch, and grasses are all adaptable for a variety of uses such as seed, hay, and green feed, and therefore some shifting can be done if circumstances require it.

On farms where the manure is carefully conserved and used advantageously on high-income crops such as berries, it becomes an

important factor in justifying selection of the dairy enterprise as part of the farm plan and may justify the purchase of considerable feed and bedding to supplement that produced on the farm.

Table 5. FEED-CROP AND LIVESTOCK BALANCE: EFFECT OF CHANGES IN CROPS AND IN NUMBER OF LIVESTOCK KEPT ON A DAIRY AND FRUIT FARM.

Kind of livestock	Number of livestock		Tons of feed required				A.U.M. pasture required*	
			Concentrates		Hay			
	Before conservation	After conservation	Before conservation	After conservation	Before conservation	After conservation	Before conservation	After conservation
Horses	3	3	1.5	1.5	9.0	9	....	....
Dairy cows	5	12	5.0	12.0	12.5	36	25	60
Heifers	2	6	.2	.8	1.5	4	5	15
FEED REQUIRED	....	....	6.7	14.3	23.0	49	30	75
Feed produced	....	....	19.8	2.7	19.5†	50	23†	73
Surplus	....	....	13.1	−11.6	−3.5	1	−7	−2
To be purchased	....	....	.....	11.6	.....	....	....	....

* Green corn will supplement pastures during early fall and kale is fed from November to April. Either beet pulp or farm-grown root crops (beets or mangels) would be desirable succulent feeds for dairy cows in late winter after kale is gone.

† The abundance of straw on hand would offset small deficits shown here.

EFFECT OF CHANGES ON INCOME. The most important effect of the conservation measures is in connection with the berry enterprise. Much of the land-use system is designed to maintain and improve the production and quality of this crop. The use of sod-forming grass crops, soil-enriching legumes, and fertilized cover crops to supply organic matter to the soil, all contribute toward maintaining a maximum acreage in proper condition for intensive production of berries. The effect of instituting the conservation practices is conservatively estimated, on the basis of results obtained by growers following recommended practices on comparable land, as increasing the average yield of berries on this farm 20 per cent. This increase is 400 pounds per acre or 3 tons per year on 15 acres. (It is probable that under the conservation program the increase in yield will be larger than shown here.) At 6 cents per pound (average of 3-year period 1938-1940) the additional production increases the gross farm income $360 a year (Table 6). The cash cost of handling this extra tonnage at 3 cents per pound is about half the gross returns or $180. The other costs for conservation practices include the purchase of cover-crop seed and commercial fertilizer for the berries; and grass seed, lime, and fertilizer for hay and pasture lands.

Table 6. MAJOR ITEMS OF CASH FARM RECEIPTS AND EXPENSE: ESTIMATED EFFECT OF CHANGES ATTRIBUTABLE TO THE CONSERVATION PRACTICES ON A DAIRY AND FRUIT FARM.

Item	Before conservation		After conservation		Change
	Pounds produced	Total value	Pounds produced	Total value	
Cash receipts					
Grain sold @ 1.25¢	26,200	$ 327	.....	.....	$ −327
Berries @ 6¢	30,000	1,800	36,000	$2,160	+360
Milk @ 35¢ per pound butterfat	1,500	525	3,600	1,260	+735
Total major cash receipts	.....	$2,652	.....	$3,420	$ +768
Cash expense					
Berries, picking, etc. @ 3¢ a pound	.....	$ 900	.....	$1,080	$ +180
Grain seed	.....	50	.....	9	−41
Grass and cover-crop seed	.....	.....	.....	60	+60
Fertilizer on berries	.....	.....	.....	50	+50
Lime, landplaster, etc.	.....	.....	.....	75	+75
Farm repairs	.....	80	.....	80	.....
Grain and hay harvesting	.....	100	.....	35	−65
Feed purchased	.....	.....	.....	348	+348
Taxes	.....	100	.....	100	.....
Miscellaneous livestock expense	.....	50	.....	100	+50
Other miscellaneous items	.....	100	.....	100	.....
Total major cash expense	.....	$1,380	.....	$2,037	$ +657
TOTAL NET INCOME	.....	$1,272	.....	$1,383	$ +111

Outlay for feed and miscellaneous livestock expense (breeding fees, veterinary, etc.) is offset by the increased dairy receipts. Milk production was estimated at 300 pounds of butterfat per cow. Yield per cow and price of the product sold were assumed to be the same under the new plan as they were before, the increase in income from milk being entirely due to the 7 additional cows.

EFFECT ON LABOR. The conservation program increases the total man labor requirement somewhat. Since most of this increase, however, is on the dairy enterprise it is absorbed by the farm family, thereby utilizing this available labor to better advantage than previously. The substitution of hay and pasture on part of the grain acreage gives the operator more opportunity to supervise the berry harvesting. The extra work of sowing and disking cover crops every year is offset by the fact that hay and pasture land is plowed less frequently than grain land under the old system of farming. The total seed and harvest expenses on grain and grass crops probably will not change materially from the old plan.

The dairy enterprise is desirable from several standpoints. It provides productive labor throughout the year, not only for the operator who needs such work during the slack winter months, but also part-time work for a son in school, who in turn is fully occupied on the farm with his father after school closes for the summer.

COSTS. Inauguration of the soil conservation plan involves several expenditures that are regarded as additional capital investment. Some of the measures require cash outlay as for terracing and for grass seeds (Table 7). Others involve only the work of the regular farm help and the use of the available farm equipment. Terrace-type diversion ditches were installed in four fields to take care of the excessive runoff, although since then it has been observed that other conservation practices have sufficiently retarded erosion so that part of the proposed system will no longer be required. The operator has a choice as to whether he buys the additional cattle outright or proceeds more slowly and raises them from his own foundation stock. The latter procedure is recommended because in that case the feed program would be expanding in step with the livestock program.

Table 7. CAPITAL INVESTMENTS: SUMMARY OF THE MAJOR ITEMS IN THE CONSERVATION PLAN ON A DAIRY AND FRUIT FARM.

Item	Amount
Terracing	$ 45
Conditioning gully	58
Seeding permanent pasture	50
Seeding waterways	8
Acquiring 7 dairy cows	525
TOTAL	$686

BENEFITS. Assuming that the actual investment in the new program totals $686, the annual amortization charge against the farm business to cover interest at 4 per cent and retire the principal in 10 years is approximately $85 a year. The difference between the $85 for amortization of the investment in 10 years, and the net gain in income of $111 a year (Table 6) is $26 per year in favor of the conservation plan. Much more significant in the situation than the fact that the program pays for itself is the *certainty which the farmer has that he can maintain his annual income at a reasonable level during the period of development and permanently thereafter.*

Although the analysis shows an increase of only $111 in farm income, the fact must be recognized that under the proposed plan the purchase of fertilizers and dairy feeds is quite certain to increase crop yields much more than is herein indicated. The important consideration, however, in evaluating the success of a soil conservation plan for this farm is not so much whether or not the farm income has been increased, but rather the fact that the farm investment itself has been safeguarded, thus assuring the continuation of a satisfactory income to both the capital and labor of the farmer and a higher degree of stability to the community of which this farm family is a part.

Careful study of the cultivated slopes shows that erosion damage has already reached the moderate to moderately severe stage on one-fourth of the cultivated land, which means that 25 per cent or more of the topsoil is gone. Experience indicates that the rate of loss and damage accelerates from year to year. It is therefore to be expected that yields will decrease as erosion increases. The decreasing productivity, moreover, may eventually compel a change to less intensive use of the land and an accompanying reduction in earning power.. The inevitable effect of these conditions is gradually to reduce the value of the farm property itself, leaving less in capital assets for a retirement fund and turning over to the oncoming generation an asset unnecessarily fraught with hazards caused by failure to correct certain practices in time.

Alternative farm management considerations

This plan has been proposed primarily as a soil conservation measure designed to check and control soil erosion and increase productivity with the least disruption to the present program. From a farm management standpoint some alternative selections could be made, and for a particular operator some substitutions might be preferable. In place of cane fruits, for example, a farmer might prefer filberts or peaches, using the same practices. This operator was a dairyman and wanted more cows. Other farmers may harvest grasses for seed and keep a farm flock of sheep instead of dairy cows. Still others might want chickens in addition to either dairying

Table 8. DIVERSIFIED FARMS: PRESENT LAND USE AND CHANGES IN ACREAGES PROPOSED IN THE SOIL CONSERVATION PROGRAM.

Land use	Acreage per farm in crops and fruit production						All farms (20)
	3 farms with less than 40		9 farms with 40-80		8 farms with 80 acres or more		
	Before conservation	After conservation	Before conservation	After conservation	Before conservation	After conservation	After conservation
Cropland	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Orchard	7.4	5.7	13.3	13.9	50.1	50.1	27.1
Berries	1.3	1.3	1.8	1.1	2.0	1.4	1.2
Grasses and legumes	5.3	12.3	10.5	22.0	25.0	38.6	27.2
Grains	5.0	2.7	17.1	11.1	40.1	26.2	15.9
Row crops and miscellaneous	4.3	1.3	8.7	4.1	5.9	6.3	4.6
Total cropland	23.3	23.3	51.4	52.2	123.1	122.6	76.0
Pasture	12.7	12.7	48.8	51.5	52.9	54.3	46.8
Woodland	7.0	7.0	12.5	9.3	68.3	68.3	32.6
Farmstead, waste, etc.	3.0	3.0	4.7	4.4	7.5	7.6	5.5
TOTAL FARM	46.0	46.0	117.4	117.4	252.8	252.8	160.9

or sheep, in order to increase their volume of business and further diversify farm income.

DIVERSIFIED FARMS

Farms in this group are characterized by having several important sources of income, usually from two or more kinds of fruit or nuts, in addition to dairying or poultry. These farms are much larger than the more intensive orchard farms, averaging 160 acres, of which about 75 acres is cropland (Table 8).

On these farms the acreage of fruit and nuts is maintained at present levels under the proposed soil conservation plans, but there is a large average increase (from 15 acres up to 27) in the area devoted to grass and legume crop production (Table 2). This increase results from a corresponding decrease in the acreage of small grains and row crops.

A soil conservation plan for a 145-acre diversified farm

This farm is located in the southwestern portion of the Chehalem Mountain Area, about 5 miles west of Newberg, Oregon (Figure 6). The soils, classified as the Melbourne series, are residual sandstone and therefore naturally very susceptible to erosion (Figure 7a). The topography, moreover, is typically rolling and part of the farm is very hilly. Most of the land slopes from 5 to 25 per cent. From one-fourth to three-fourths of the topsoil has been removed on the orchard and grain land. Several gullies have been formed where water concentrates in drainageways leading from cultivated fields (Figure 7b).

Prior to the conservation program only about 60 acres, or less than half of the farm was in cultivation, while 79 acres was in native grass pastures and woodland (Table 9). Of the cultivated lands, 12.4 acres is prune orchard of which 6 acres is interplanted with walnuts. Formerly from 10 to 20 acres was used for grain, and 25 to 35 acres for hay and seeded pasture. Soil erosion has resulted from farming steep land without proper precautionary measures, and from clean cultivation of the orchard without using cover crops for winter protection of the soil. Soil fertility is extremely poor as a result of more or less continuous grain cropping. The presence of only 50 ewes and 2 horses reflects the low carrying capacity of the grazing land.

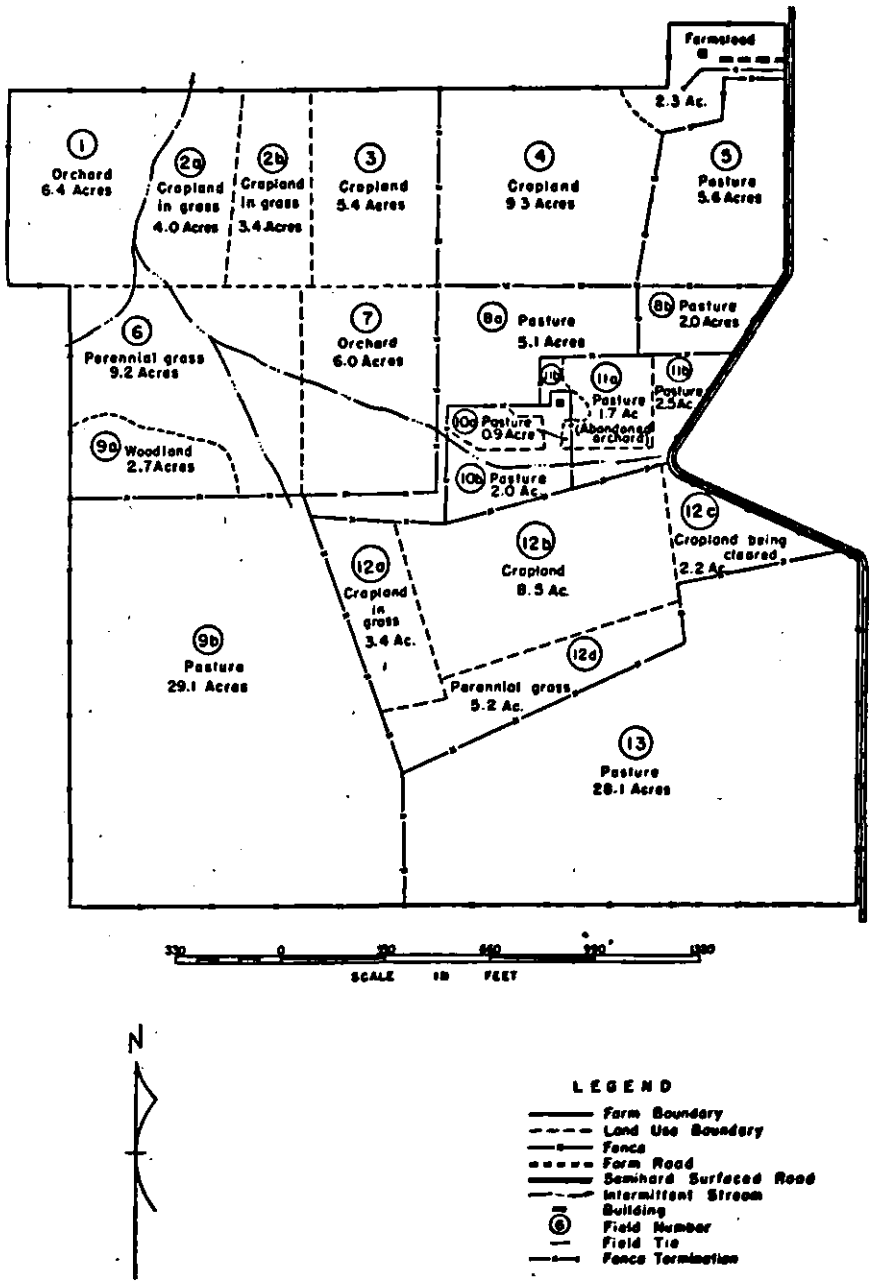


Figure 6. Land-use map of a diversified farm.

Photograph by Soil Conservation Service, U. S. Department of Agriculture

Figure 7a. Orchards disappear when erosion is severe.

Photograph by Soil Conservation Service, U. S. Department of Agriculture

Figure 7b. Gully in a prune orchard. A need for permanent waterway protection is apparent.

Table 9. A 145-ACRE DIVERSIFIED FARM: LAND USE AND ESTIMATED CROP PRODUCTION BEFORE AND AFTER ADOPTION OF THE CONSERVATION PRACTICES.

Land use	Before conservation			After conservation		
	Acres	Yield	Total	Acres	Yield	Total
		Pounds	*Pounds*		*Pounds*	*Pounds*
Cropland						
Prunes	12.4	1,000	12,400	6.1	1,500	9,600
Walnuts	...	...	...	6	300	1,800
Corn	2	1,600	3,200	3	1,800	5,400
Oats (spring)	3.4	400	1,360	...	...	...
Oats and vetch seed	13.7	O: 400	5,480	...	...	...
		V: 250	3,425	...	...	...
Clover hay	5.4	3,000	16,200	6	3,600	21,600
Sudan grass hay	13.3	3,000	39,900	...	...	...
Timothy hay	10.5	3,000	31,500	...	...	...
Oats and vetch hay	...	...	...	3	3,600	10,800
Grass seeding	...	...	...	6	...	...
Ch-wings fescue seed	...	...	...	10	125	1,250
Tall fescue seed	...	...	...	10	150	1,500
Farmstead and garden	2.4	...	...	2.7	...	...
Total cropland	63.1	...	...	53.1	...	...
Woodland	2.7	...	...	2.7	...	...
		A.U.M.	*A.U.M.*		*A.U.M.*	*A.U.M.*
*Pasture**						
Improved	2.6	3	8	12.6	3	38
Brush	76.6	.75	57	76.6	.9	69
Aftermath (hay land)	...	1	29	...	1	29
Total pasture	79.2	...	94	89.2	...	136
TOTAL ACREAGE	145.0	...	...	145.0	...	...

* Measured in *animal unit months* (A.U.M.) or the pasturage that will carry one cow or equivalent 1 month.

PROGRAM PROPOSED. The program for correcting erosion and initiating permanent land improvement measures may be considered under three major headings as follows: (1) rehabilitation of the orchards, (2) production of perennial grass seed crops, and (3) improvement of permanent pasture lands.

ORCHARD. Rehabilitation of 6.4 acres of prune orchard was started by removing every third row of trees and substituting a wide grass sod strip across the slope. This strip is clipped, leaving the clippings on the ground as a mulch. The space between the pairs of tree rows and the ground for at least 6 to 8 feet beyond the trees, adjoining the sod strip, is cover cropped each year (Figure 8a). A seed mixture, 60 pounds of vetch and 40 pounds of rye (or winter barley) per acre, is sown as early in the fall as moisture conditions permit. At least 100 pounds of a nitrogen-phosphorus fertilizer is applied per acre to stimulate a maximum growth. This cover crop is disked into the soil as green manure in late spring. Only occasional shallow cultivation sufficient to control excessive weed growth is necessary during the summer. The last cultivation in the fall is made across the slope to prevent gullying during the winter rains.

The prune trees interplanted with the 6-acre walnut orchard should be removed immediately, because crowding has already become serious. A permanent grass strip is recommended for this young walnut orchard because of the steep slope and the deficiency of organic matter in the soil. Eventually, with restored organic matter, the sod strip may be discarded (Figure 8b). Maximum production of cover-crop growth is essential to make this orchard even moderately profitable.

CROPLAND. Most of the remaining cropland is sown to perennial grasses, some to produce a cash seed crop, and the remainder for hay and pasture. Out of approximately 36 acres of perennial grasses, 20 acres are in fescue seed production, 10 in pasture, and 6 in new seeding each year. This cropping system provides for reseeding the land about every sixth year. Meanwhile, about 12 additional acres are in a 4-year system of mixed legume hay for 2 years, oats-and-vetch hay the third year (if the legume stand becomes too thin), and grain or corn the fourth year. As far as practicable, this acreage is also rotated within the larger grass acreage. (For the purpose of this analysis a uniform acreage is assumed for these crop rotations.) The important consideration for the operator is that the land be used effectively and provide a reasonable balance between the production of cash crops and feed crops each year.

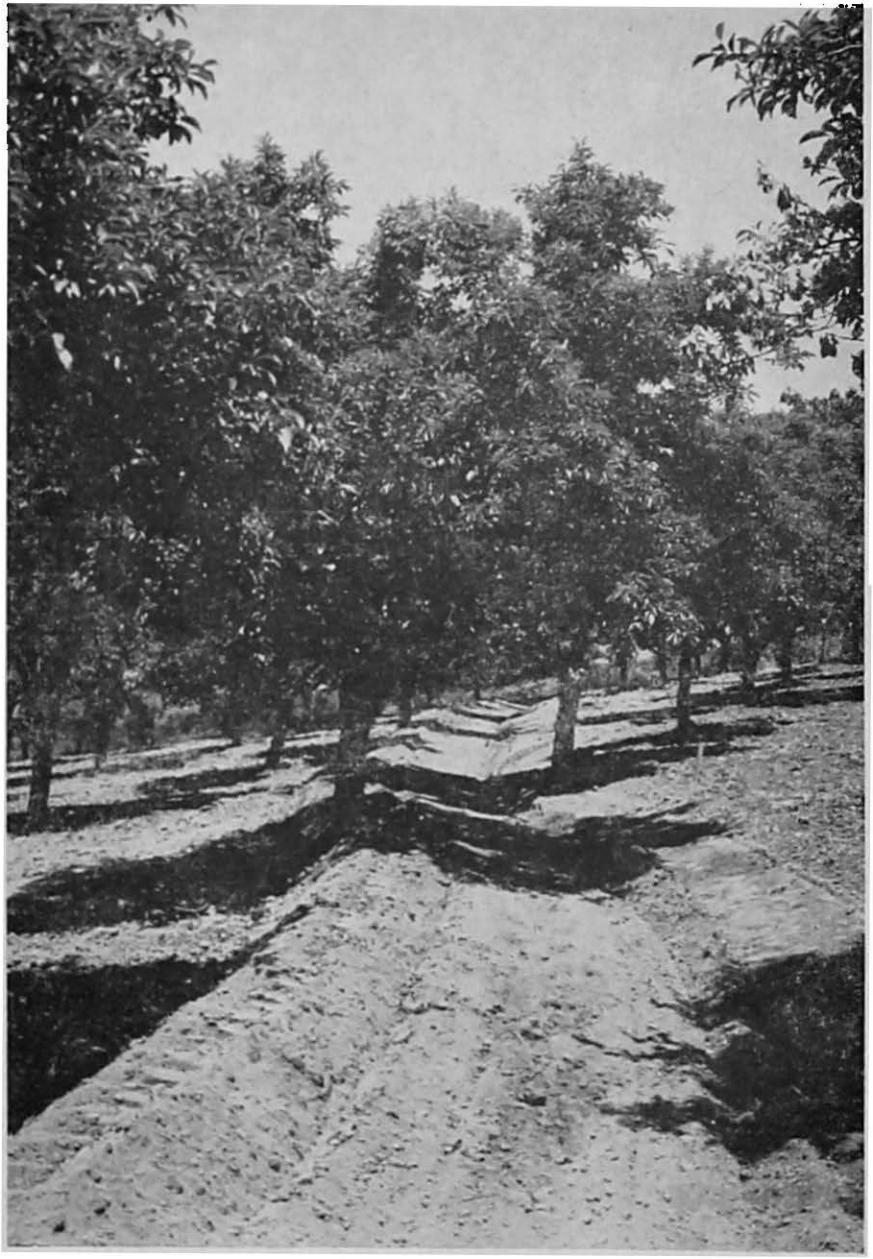
NATIVE AND WOODLAND PASTURE. The use of these areas should be rigidly limited to the seasonal carrying capacity, and managed with a view to maintaining ample protective ground cover and increasing the proportion of desirable grasses.

LIVESTOCK. The present operator of this farm is interested in increasing livestock production rather than expanding the size of enterprises he already has in his plan of operation (Table 10). By improving the permanent pastures and following the practice of rotating livestock before grazing too closely, the carrying capacity can be increased materially. While a small increase in numbers of livestock is recommended in the new plan, the chief aim is to provide better pasture over a long grazing season and keep steep land in grass.

EFFECT OF CHANGES ON INCOME. According to this analysis, the conservation plan increases net farm income about $176 per year without appreciably increasing the operator's own labor load (Table 11). As far as practicable, the new practices have been adopted without greatly disrupting the present routine. If changes are made gradually over several years, very little extra cash cost is involved.

Photograph by J. G. James, Soil Conservation Service, U. S. Department of Agriculture

Figure 8a. The grass strip is a low-cost method of preventing erosion, but it has not proved entirely satisfactory in this area.



Photograph by J. G. James, Soil Conservation Service, U. S. Department of Agriculture

Figure 8b. The contour terrace, used in conjunction with heavy cover crops, is usually more desirable than the grass strip.

For instance, the cash outlay for seeding perennial grasses is relatively high, but is comparable to the cumulative cost of seed required for grain over a 5-year period. It is therefore assumed that this farmer will not materially increase his capital costs. On the other hand, the plan unquestionably maintains farm income and stabilizes

Table 10. FEED-CROP AND LIVESTOCK BALANCE: EFFECT OF CHANGES IN CROPS AND IN NUMBERS OF LIVESTOCK KEPT ON A DIVERSIFIED FARM.

Kind of livestock	Number of livestock		Tons of feed required				A.U.M. pasture required	
			Concentrates		Hay			
	Before conservation	After conservation	Before conservation	After conservation	Before conservation	After conservation	Before conservation	After conservation
Horses	2	2	1	1	6	6	10	10
Ewes	50	60	1.25	1.5	5	6	100	120
FEED REQUIRED	....	....	2.25	2.5	11	12	110	130
Feed produced	....	....	5	2.7	34	16	94	136
Surplus	....	....	2.75	.2	23	4	−16*	6

* Deficit indicates that other feed was provided to supplement the pasture or that grazing was insufficient at times to maintain adequately the amount of livestock kept.

Table 11. MAJOR ITEMS OF CASH FARM RECEIPTS AND EXPENSE: ESTIMATED EFFECT ON INCOME OF CHANGES ATTRIBUTABLE TO THE CONSERVATION PLAN ON A DIVERSIFIED FARM.

Item	Before conservation		After conservation		Change
	Pounds produced	Total value	Pounds produced	Total value	
Cash receipts					
Grain sold @ 1.25¢ a pound	5,500	$ 69	400	$ 5	$ −64
Hay sold @ $10 a ton	46,000	230	8,000	40	−190
Prunes @ 5¢ a pound	12,400	620	9,600	480	−140
Walnuts @ 12¢ a pound	.....	.....	1,800	216	+216
Vetch seed @ 7¢ a pound	3,425	240	.....	.....	−240
Chewings fescue @ 25¢ a pound	.....	.....	1,250	312	+312
Tall fescue @ 20¢ a pound	.....	.....	1,500	300	+300
Lambs sold, 70 pounds @ 7¢	2,730	191	3,290	230	+39
Wool, 8 pounds @ 30¢	400	120	480	144	+24
Total major cash receipts	.....	$1,470	.....	$1,727	$+257
Cash expense					
Prunes, harvesting, etc. @ 2½¢ a pound	.....	$ 310	.....	$ 240	$ −70
Walnuts, harvesting, etc. @ 5¢ a pound	.....	.....	.....	90	+90
Cover crop and fertilizer	.....	.....	.....	62	+62
Seed	.....	80	.....	45	−35
Harvesting seed	.....	51	.....	100	+49
Taxes (exclusive of orchard)	.....	130	.....	130	.....
Miscellaneous livestock expense	.....	50	.....	60	+10
Miscellaneous hired labor	.....	75	.....	50	−25
Machinery repair	.....	100	.....	100	.....
Other miscellaneous items	.....	120	.....	120	.....
Total major cash expenses	.....	$ 916	.....	$ 997	$ +81
TOTAL NET INCOME	.....	$ 554	.....	$ 730	$ 176

the capital investment represented by land and particularly by the orchard.

Alternative farm management considerations

This operator had to decide whether to retain the 6.4 acres of prune orchard and improve its production, or discard it and use the land for hay and pasture production. Probably the major consideration was the expense that would have been involved for removing the trees and getting the land prepared for cropping. Since this orchard as previously operated could be valued no higher than the value inherent in the bare land less the cost of pulling out the trees, it is apparent that any net income from the orchard above operating expenses compares favorably with the income obtained if the land were used for pasture. In other words, prunes already established can compete with other uses of low-priced land as long as the product is of marketable quality and the yield is sufficient to pay all operating costs in addition to at least the equivalent of pasture rent.

The fact that this operator, because of age, lack of family labor, and residence in town, wanted a conservative farm plan, accounts for retention of the orchard as a source of immediate cash income, and for the selection of grass-seed crops and the sheep enterprise. Some increase in the size of business would be possible by having a small dairy herd, chickens, or turkeys if the concentrates were purchased. Such enterprises would give the operator more employment during the winter and thus afford him more nearly a full-time job.

Since prices of products such as the grass-seed crops are likely to change considerably, it is assumed that suitable substitutions will be made from time to time as circumstances warrant. Eventually the orchards will also need to be replaced.

FRUIT AND NUT FARMS

Many kinds of fruit are grown in the area—prunes, pears, peaches, and berries predominating, while walnuts and filberts are the commercial nut enterprises. Some of these farms are highly specialized, producing only one variety of fruit or nuts and having no other source of income on the farm.

An analysis of 34 fruit and nut farms studied shows their distribution according to size and the change in land use under the soil conservation program proposed (Table 12). All of these farms had more than 60 per cent of their harvested cropland in fruit or nuts. An average increase of 3 acres in orchard, 1 acre in berries, and 1 acre in grass and legumes is recommended as part of the soil con-

servation program. Some of this increase comes as a result of the renovation of orchards, but most of it is from a reduction in the acreage of small grains (see Table 2).

Table 12. FRUIT AND NUT FARMS: PRESENT LAND USE AND CHANGES IN ACREAGES PROPOSED IN THE SOIL CONSERVATION PROGRAM.

Land use	Acres per farm in crops and fruit production						All farms (34)
	12 farms with less than 20		11 farms with 20-40		11 farms with 40 or more		
	Before conservation	After conservation	Before conservation	After conservation	Before conservation	After conservation	After conservation
Cropland	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Orchard	12.5	14.1	23.0	26.3	43.2	46.3	28.5
Berries	1.4	1.8	1.6	1.6	4.1	6.3	2.9
Grasses and legumes	2.3	4.0	3.8	4.3	2.7	3.5	4.0
Grains	4.4	1.5	5.7	2.3	5.6	.2	1.3
Row and miscellaneous crops	1.2	.7	.8	.4	.3	.....	.3
Total cropland	21.8	22.1	34.9	34.9	55.9	56.3	37.0
Pasture	3.9	4.0	16.5	16.5	5.1	3.5	7.9
Woodland	6.3	6.3	1.3	1.2	21.1	22.5	10.0
Farmstead, waste, etc.	1.7	1.3	2.8	2.9	4.3	4.1	2.6
TOTAL FARM	33.7	33.7	55.5	55.5	86.4	86.4	57.5

A soil conservation plan for a 40-acre berry farm

This farm is located on the north slope of Chehalem Mountain, about 4½ miles north of Newberg in Washington County. About 24 acres have been in cultivation and farmstead, and 16 acres have been in timber and permanent pasture (Figure 9).

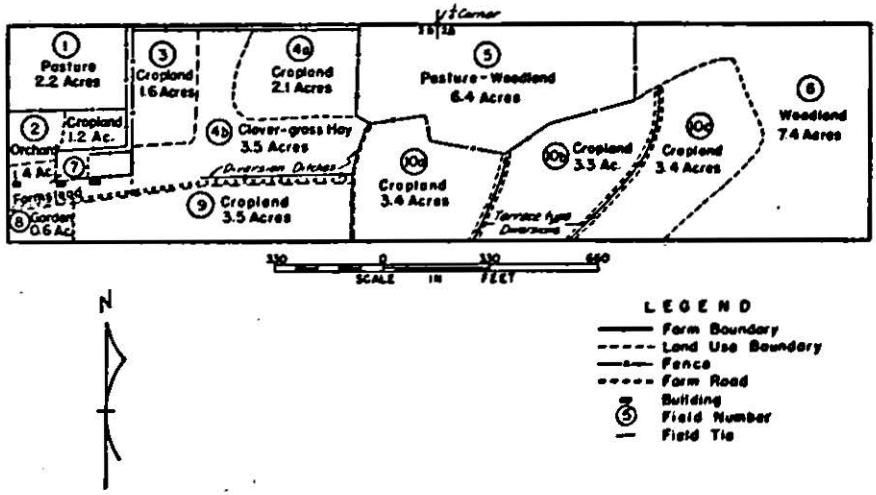


Figure 9. Map of a specialized berry farm.

The soil is Olympic clay loam, a residual soil derived from basalt. While it is not as erosible as some of the other hill soils, the cultivation of the steeper slopes leads to washing and gullying if precautionary measures are not taken in connection with farming practices. The erosion on this farm is described as slight to moderate, the latter indicating that from 25 to 50 per cent of the topsoil has been removed.

PROGRAM PROPOSED. The major recommendations for soil conservation on this farm include the following measures: (1) shifting from grain to perennial grass and legume hay on the steep cropland; (2) pasture improvement through clearing of brush and by proper grazing; (3) strip-cropping on very steep cropland; (4) terracing and planting new berry land on the contour to facilitate contour cultivation; (5) planting a legume cover crop between the rows of berries each fall, using a nitrogen-phosphate fertilizer to stimulate a heavy growth to be plowed under in late spring.

LAND USE. Operators of small farms such as this one always have the problem of how to obtain a sufficiently large size of business to maintain the farm family satisfactorily. This farmer is interested in the black raspberry (blackcap) enterprise as his chief and almost sole source of income (Table 13). Practically all of the acreage adaptable for cane fruit, consisting of about 17½ acres, is used in what may be termed the berry rotation system. The map of the farm indicates these various tracts as follows:

Field 3	1.6 acres
Field 4a	2.1 acres
Field 9	3.5 acres
Field 10a, b, c	10.1 acres
TOTAL	17.3 acres

Although some berry plantings have been kept in production over a prolonged period, a production program should provide for a systematic rotation of plantings over a definite period of years. In this case the proposed plan provides that half of the available berry land be in berry production 5 crop-years, one-tenth in new planting each year, and four-tenths in hay and corn (Figure 10).

Each year, to the extent that the topography of the land permits a division into units of uniform size, 8.65 acres are in bearing berries, 1.75 acres in new berry planting, and 6.9 acres in hay, corn, and green manure crops. After harvest, 1.75 acres of the oldest canes are plowed up, the soil reconditioned for 4 years while producing crops of corn and grass-legume hay, and then a new planting of berries set out.

Photographs by Albert Arnst, Soil Conservation Service, U. S. Department of Agriculture

Figure 10. *At top:* Black raspberries planted on the contour. *Below:* This steep slope formerly used for grain is now kept in grass and legumes for hay, thus eliminating difficult annual tillage operations and an erosion hazard.

The remainder of the farm consists of the steeper slopes. The 3.5 acres (Field 4b) of hillside cropland is retired from cultivation and sown to permanent grass for hay and pasture. The 2.2 acres (Field 1) of brush pasture is cleared and sown to permanent pasture. The 6.4 acres (Field 5) of brush pasture, and the 7.4 acres (Field 6) of woodland are retained but improved in their respective present uses. The hay and pasture furnish most of the feed requirements for 2 horses and 2 cows or their equivalent in other livestock (Table 14). Very little grain feed needs to be purchased if corn is produced as suggested. The farmstead, garden, and family orchard (Fields 2, 7, and 8) are capable of producing an abundance of fruit and vegetables for the household and some additional kale or mangels for the cows during the winter season. The woodland is useful as a source of fuel for the home and of building and fence materials for the farm.

TABLE 13. A 40-ACRE BERRY FARM: LAND USE AND ESTIMATED CROP PRODUCTION BEFORE AND AFTER ADOPTION OF THE CONSERVATION PRACTICES.

Land use	Before conservation			After conservation		
	Acres	Yield	Total	Acres	Yield	Total
Cropland		*Pounds*	*Pounds*		*Pounds*	*Pounds*
Berries (new)	.....	.....	.....	1.75	.....	.....
Berries (bearing)	4.5	2,500	11,250	8.65	3,000	26,000
Legume hay	3.4	5,000	17,000	5.15	5,000	26,000
Grass hay	.....	.....	.....	3.5	4,000	14,000
Grain	8.5	1,600	13,600	.....	.....	.....
Corn	4.4	1,800	7,920	1.75	2,000	3,500
Farmstead and garden	3.2	.....	.....	3.2	.....	.....
Total cropland	24.0	.....	.....	24.0	.....	.....
Woodland	7.4	.....	.....	7.4	.....	.....
*Pasture**		*A.U.M.*	*A.U.M.*		*A.U.M.*	*A.U.M.*
Brush	3.2	1.5	3.3	.....	.....	.....
Improved	.....	.....	.....	2.2	3	6.6
Wooded	6.4	.7	4.5	6.4	1	6.4
Aftermath (hay land)	.....	1.0	3.4	.....	1	9.0
Total pasture	8.6	.....	11.2	8.6	.....	22.0
TOTAL ACREAGE	40.0	.....	.....	40.0	.....	.....

* Measured in *animal unit months* (A.U.M.) or the pasturage that will carry one cow or equivalent 1 month.

EFFECT OF CHANGES ON INCOME. It is estimated conservatively that the yield of berries will increase 20 per cent or 500 pounds per acre because of the soil improvement program (Table 15). The income from berries was computed at 6 cents a pound and the cash expense of handling the crop at 3 cents a pound, leaving a net return of 3 cents to cover the operator's labor and investment. The cost of

the fertilizer was estimated at $60, and the cover-crop seed at $26 per year. Under the old system of farming this place about 9 tons of grain were sold annually, while under the new plan a part of the feed is purchased. The financial gain from the new program of management approximates $300 annually.

Considerations that are much more significant to the operator, however, include the fact that the plan relieves him of the necessity

Table 14. FEED-CROP AND LIVESTOCK BALANCE: EFFECT OF CHANGES IN CROPS AND IN NUMBER OF LIVESTOCK KEPT ON A BERRY FARM.

Kind of livestock	Number of livestock		Tons of feed required				A.U.M. pasture required	
			Concentrates		Hay			
	Before conservation	After conservation	Before conservation	After conservation	Before conservation	After conservation	Before conservation	After conservation*
Horses	2	2	1	1	6	6	10	10
Cows	1	2	0.5	1	3	6	6	12
FEED REQUIRED	....	....	1.5	2	9	12	16	22
Feed produced	....	....	10.8	1.75	8.5	20	11	22
Surplus	....	....	9.3	−0.25	−0.5	8	−5	....

* Succulent portion of the winter feed for dairy cows may consist of kale and root crops grown in the garden or of beet pulp purchased instead, particularly in late winter season after the farm supply of green feed crops is usually exhausted.

Table 15. MAJOR ITEMS OF CASH FARM RECEIPTS AND EXPENSE: ESTIMATED EFFECT OF CHANGES ATTRIBUTABLE TO THE PROPOSED MANAGEMENT PROGRAM ON A BERRY FARM.

Item	Before conservation		After conservation		Change
	Pounds produced	Total value	Pounds produced	Total value	
Cash receipts					
Berries, @ 6¢	11,250	$675	26,000	$1,560	$+885
Grain, @ 1.25¢	18,600	232	.....	.....	−232
Hay, @ $10 a ton	.....	.....	16,000	80	+80
Butterfat (or equivalent) @ 35¢	.....	.....	300	105	+105
Total major cash receipts	.....	$907	.....	$1,745	$+838
Cash expense					
Berries, picking, etc. @ 3¢ a pound	.....	$338	.....	$ 780	$+442
Cover-crop seed	.....	.....	.....	26	+26
Fertilizer, lime, etc.	.....	.....	.....	60	+60
Feed purchased	.....	.....	.....	10	+10
Farm repairs	.....	40	.....	40	.....
Taxes	.....	67	.....	67	.....
Miscellaneous hired labor	.....	80	.....	80	.....
Other miscellaneous items	.....	50	.....	50	.....
Total major cash expense	.....	$575	.....	$1,113	$+538
TOTAL NET INCOME	.....	$332	.....	$ 632	$+300

of plowing, sowing, and harvesting grain on the steep lands every year. Instead, this plan provides him with a convenient source of hay and with good pasture. It enables him to conserve the land and give more attention to his important berry enterprise during the critical periods.

The cost of long-time improvements required is estimated as follows:

Terraces	$24
Seed for permanent pasture (clover and grass)	37
TOTAL	$61

The farmer would ordinarily be able to finance such a small outlay directly. On the amortized basis the annual cost over a 10-year period at 4 per cent interest is only $8 a year.

In addition to being assured of a satisfactory annual farm income, the farmer is enabled to reestablish the highest possible productivity on his land and thereafter maintain the productivity continuously. Under the old system, on the other hand, erosion would gradually accelerate, yields would steadily decline, and the farm itself would suffer irreparable loss as a capital asset.

Alternative farm management considerations

The plan developed for this 40-acre farm is suitable from the standpoint of soil conservation and for using the land intensively, but some farmers would prefer somewhat more diversification. This could be provided by increasing the number of dairy cows to four or even more, particularly if a tractor replaced the horses and soiling crops were used for the cows. A farm flock of chickens could be kept in any case; for farmers who like chickens a small commercial flock would be desirable. Raising dairy calves for market offers possibilities without the work of milking. Marketing weanling pigs is another enterprise that involves a minimum of chore labor. Livestock enterprises, such as dairy and poultry, provide the farm family with winter work and some income throughout the year. This additional income from livestock, together with food furnished the household, serves to shield the farm family from some of the anxiety inherent in one-crop farming. Even where most of the feed must be purchased, the fact that manure has an unusually high value when conserved and applied to an intensive crop such as berries may justify the presence of more livestock on small, specialized crop farms.

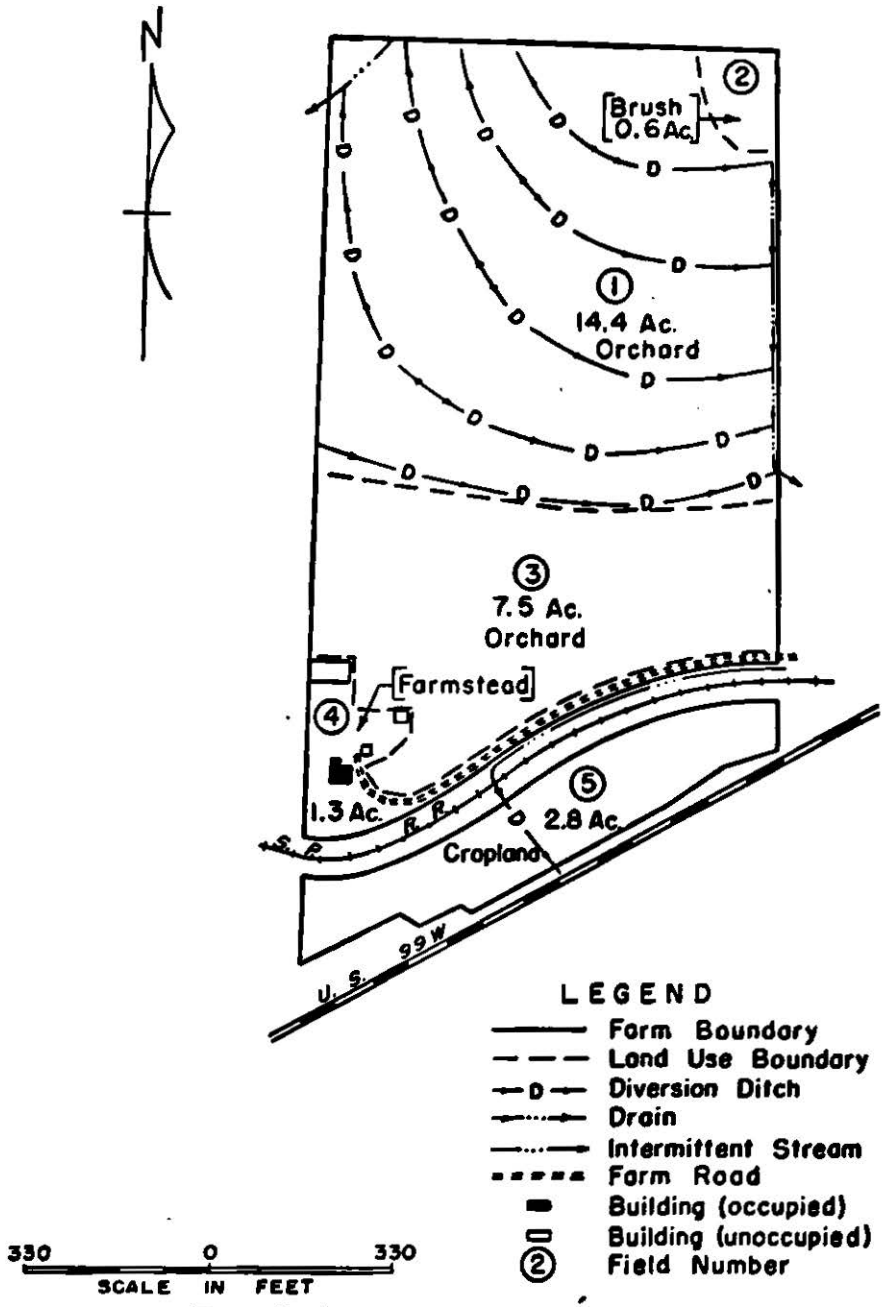


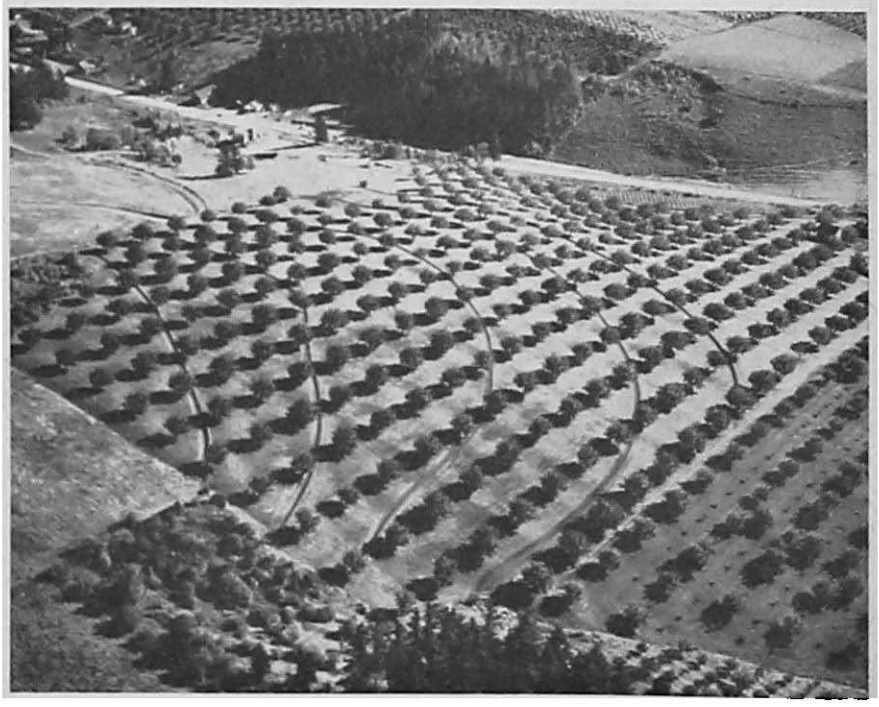
Figure 11. Map of a specialized walnut farm.

CONSERVATION NEEDS ON A 27-ACRE WALNUT FARM

The problem

The walnut farm is located about 3 miles northeast of Newberg, Oregon. Walnuts occupy 21.9 acres, berries 2.8 acres, and farmstead, brush, and roads 1.9 acres (Figure 11). A commercial nut processing plant has been operated in connection with the walnut orchard. The soil is classified as Aiken silty clay loam. The topography generally is rather steep. An area of approximately 19 acres has slopes of from 10 to 17 per cent and 3 acres average 28 per cent slope (Figure 12).

A survey made in 1936 showed that on 14 acres moderately severe sheet erosion had occurred and on 8 acres severe sheet erosion. It was estimated that more than half of the topsoil had been lost through sheet and gully erosion. Periodic observations made during the winter of 1936-37 revealed that the soil was seriously



Photograph by J. G. James, Soil Conservation Service, U. S. Department of Agriculture

Figure 12. Broad base terraces prevent erosion damage by carrying surplus water from hill orchards before it can begin removing soil.

depleted of organic matter and that the unfavorable soil conditions accompanying this state were becoming increasingly apparent. Few or no clods remained during the winter; the soil puddled, ran together, and packed. Rainfall penetration was very slow, and when the soil dried in the spring some cracking occurred as further evidence of poor physical condition (Figure 13).

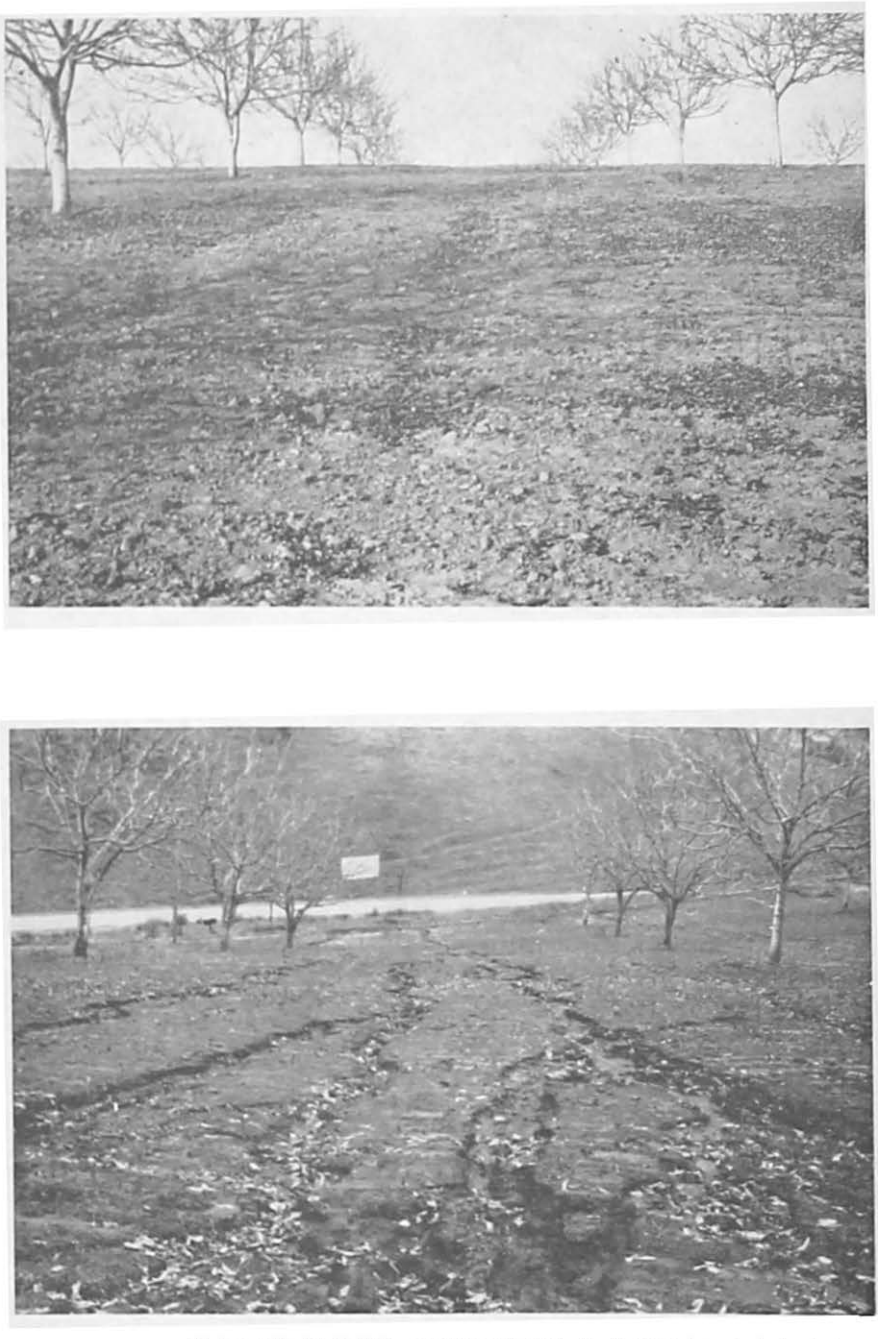
The farm owner reported that little if any erosion was apparent to him until about 1931 or 1932; after that it became progressively severe from year to year. In about 5 years the situation appeared so critical that he was willing to follow any measures that might stop soil losses. The farmer had realized that unless erosion was stopped his orchard investment, estimated at $800 per acre, would decline rapidly. At the age of 20 years the trees should have been only beginning their productive life. In addition to the damage to the orchard, considerable expense had been incurred in removing the soil washed across a road and railroad right-of-way below the lower edge of the orchard by an excessive rainfall in late spring.

The proposed soil conservation program

The soil conservation program on this farm embraces two major objectives. The first objective is to stop runoff and erosion damage immediately; the other is to rebuild the productivity of the soil and its resistance to erosion as rapidly as possible. In the summer of 1937, five large terrace-type diversions were constructed in the orchard. The purpose of these diversions is to remove excess water from the field before it runs far enough to start transporting the soil (Figure 14). All tillage operations, including sowing the cover crop, follow the contour, leaving no up-and-down-hill cultivation marks.

Since the low organic matter content of the soil was attributed to poor cover crops and excessive summer tillage, a combination of a winter hardy legume (hairy vetch) and winter barley or rye is sowed early each fall, fertilized with a nitrogen-phosphorus fertilizer to stimulate rapid growth, and worked down as late as feasible in the spring to produce the maximum tonnage of green manure for soil building. Subsequent summer tillage is limited chiefly to weed control. In addition to the use of cover crops and commercial fertilizer, a light top dressing of straw (1½ to 2 tons per acre) to provide additional protection to the soil is applied on the steeper slopes after the cover crop is sown (Figure 15).

During the two winters (1937-1939) the diversion system carried off large amounts of surplus water. The runoff through terraces was exceptionally heavy after the earlier part of January when

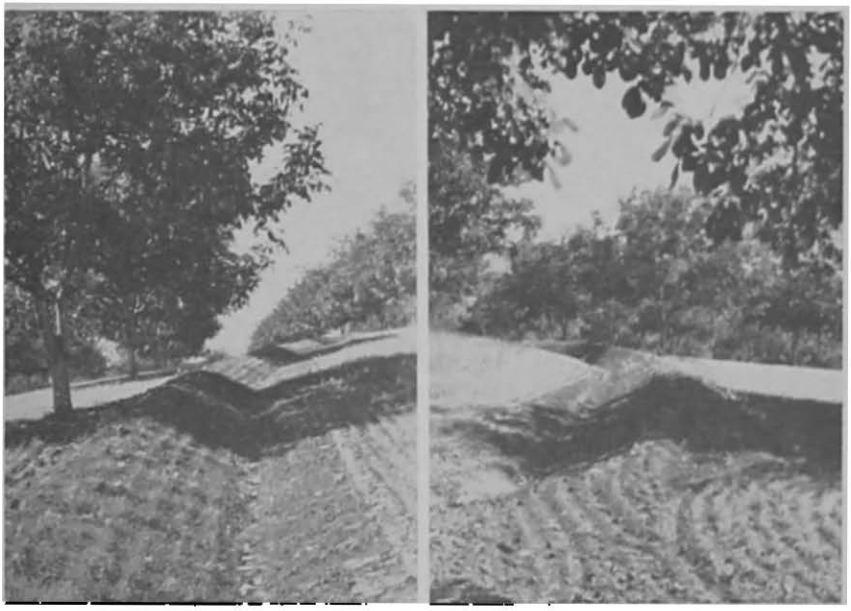


Photographs by Soil Conservation Service, U. S. Department of Agriculture

Figure 13. *Top:* This orchard soil is in poor tilth, crusting and preventing rainfall penetration. The bad soil condition accompanies poor stands of cover crop. *Bottom:* Damage from winter rains is severe.

the soil was well saturated with water, yet the conservation measures fully protected the orchard against erosion at all times.

By the end of this 2-year period the improvement in physical condition of the soil was very noticeable. The improvement appeared to be in direct proportion to the amount of organic matter



Photographs by Soil Conservation Service, U. S. Department of Agriculture

Figure 14. Structures like these are needed where surface runoff is too great to be controlled by contour cultivation and cover crops. These are diversion ditches in a walnut orchard on a 15 to 20 per cent slope of Olympic soil. The trees are spaced 60 feet apart. *Left:* Ditch is seeded. *Right:* Ditch is not seeded.

turned into the soil. The latter was friable and loamy, and much undecomposed cover-crop material was present. That winter (1939-40) there was no runoff from the terraces despite the fact that during February alone a rainfall of approximately 12 inches (twice the normal amount) was recorded at a gauge located at one corner of this orchard. The organic matter served to keep the soil open, permitting rapid penetration of the water and its retention (Figure 16).

After another year of observation showed that no runoff was occurring, 3 of the 5 terraces were removed. The soil had responded so fully to the other conservation practices used that the latter were considered sufficient to control erosion and maintain the soil without the aid of diversion terraces. In other words, the orchard re-

sponded to a system of contour tillage, winter cover cropping, fertilizing, and reduced summer cultivation. These measures are considered as minimum requirements for maintaining productivity of hill land soils of this character when in orchard.

Photograph by Soil Conservation Service, U. S. Department of Agriculture

Figure 15. A straw mulch may be necessary to prevent erosion on steep land. Applied after the cover crop is sowed, it is an added protection on critical areas.

The experience of the operator is a demonstration of how readily the adoption of approved practices for soil conservation can rejuvenate an orchard site that has been seriously depleted of organic matter. Three years after this operator first followed conservation recommendations he again estimated the value of his orchard at $800 per acre, whereas he felt that had erosion and improper soil management continued, the value would probably have decreased to $600 in that short period. The adoption of contour tillage, moreover, does not appreciably increase his farming costs. In fact, this operator professed becoming more satisfied with the contour method as he grew accustomed to its use.

COST OF PRACTICES. The cash expense incurred for constructing the 4,490 feet of terrace diversions is $166. Considered as a capital investment and amortized over a period of 10 years at 4 per cent

interest, the annual payment is $21. This item of $21 is then included with the cash operation expense connected with conservation practices in the orchard as shown in the following:

Payment on terrace cost	$ 21
Cover-crop seed	55
Fertilizer	66
Straw	16
Total cost per year	$158
Average cost per acre	$ 7

These results show that an additional annual cash outlay of about $7 per acre for conservation will maintain a hill orchard on a permanent producing basis justifying a capital value of $800,

Photograph by Soil Conservation Service, U. S. Department of Agriculture

Figure 16. Disking in a cover crop of 10 tons (rye and vetch) per acre helps correct the physical condition, thus conserving soil and moisture and increasing yield and profit.

whereas a lack of such provision for soil maintenance in a very few years resulted in a reduction of the orchard value by as much as one-fourth and progressively more and more. The capital valuation does not particularly affect the owner who does not contemplate selling the property, except insofar as the value of the orchard reflects the production. In other words, what the owner meant by

his estimate that the value of his orchard would probably have decreased from $800 to $600 in another 3 years of uncontrolled soil erosion was that the yield probably would have declined in that proportion.

What would such a change in yield mean in terms of production and income? Assuming that a yield of 800 pounds per acre would be obtained on this young orchard under good management, and that yields would drop to 600 pounds if erosion were not controlled, the effect on income per acre under the two systems of management would be approximately as follows:

With conservation:	
800 pounds walnuts @ 12¢	$96
No conservation:	
600 pounds walnuts @ 12¢	72
Gross gain per acre for conservation	$24
Cash expense on extra yield @ 40 per cent of receipts	$10
Yearly expense for conservation practices	7
Total added expense under conservation	$17
Net gain per acre for conservation	$ 7

Carrying this thought a step farther shows that the estimated net gain of $7 per acre in favor of conservation practices is a return of 3½ per cent on the extra $200 orchard valuation that the soil conservation system was able to establish and maintain. The orchards on this type of land similarly operated without regard to soil losses eventually become marginal in their capacity to produce. As yields decline and quality deteriorates economical production is, of course, impossible. The result is that the capital valuation of the orchard gradually decreases in line with the productivity represented.

COVER CROPS AND CONSERVATION

One of the most important methods of erosion control and soil improvement on orchard land is the planting of an adequate winter cover crop. The acreage of cover crops on the 65 farms in the project is increased 51 per cent under the proposed program (Table 16). A survey discloses, moreover, that already the quality of cover crops has materially improved from using more seed per acre, sowing at the proper time, and using a larger proportion of legume (vetch) in the seed mixture. The improved mixture not only assures a thicker cover during the winter, but also a heavier yield to turn under as green manure in the spring (Figure 17).

Photograph by J. G. James, Soil Conservation Service, U. S. Department of Agriculture

Figure 17. Winter cover crops in orchards serve the dual purpose of preventing erosion during the winter and increasing organic matter in the soil. The entire crop is turned under in the spring.

Table 16. COVER CROPPING: TOTAL NUMBER OF ACRES AND THE PER CENT OF INCREASE SUGGESTED IN THE SOIL CONSERVATION PROGRAM.

System of farming	Number of farms	Acreage of cover crops		Increase
		Before conservation	After conservation	
		Acres	*Acres*	*Per cent*
Dairy and fruit farming	11	36	97	170
Diversified farming	20	498	533	7
Fruit and nut farming	34	541	996	84
ALL FARMS	65	1,075	1,626	51

SOME GENERAL CONSIDERATIONS IN PLANNING FARMS FOR SOIL CONSERVATION

Soil conservation planning is designed to safeguard the resources and income of the farm as a whole. This planning involves the provision of definite recommendations for conserving the soil. It also involves the development of a carefully prepared plan for the organization and operation of the farm as a business enterprise. In

other words, farm planning is not only conservation but it is *profitable* conservation. It conserves or maintains the annual income of the farm family, and it also conserves the capital investment on a permanent basis.

Soil conservation planning should be accomplished with a minimum disruption of the farm organization and routine practices because farmers, more than most business operators, are very resistant to change, especially of well-established farming methods. A farmer whose proposed conservation program calls for elaborate erosion-control structures or radical changes in the arrangement of fields, crop rotations, and livestock programs will probably be hesitant about developing the plan or even adopting it at all.

Farm planners and farmers, therefore, are particularly concerned with proceeding in the most effective manner open to them. Wherever soil conservation is needed, every effort should be made to understand the problem thoroughly, not only to avoid making serious mistakes, but in order to make each recommendation proposed serve unmistakably as a demonstration of businesslike farming.

Such a program requires more than a knowledge and use of structures. It requires more than advice regarding soil conserving farm practices. It requires a thorough understanding of the farm management principles involved on every farm. The factors of production—land, equipment, labor, and management—must be thoroughly evaluated in formulating a basic plan for the farm as a whole. Such evaluation involves a comprehensive knowledge of the standards for the region. The planner must be familiar with the possibilities of yield, production, costs, and prices in order to advise intelligently regarding alternative methods and practices. The plan must fit the man as well as the farm. It must lend itself to some adaptation as, for example, to the farmer's advancing age, when he may want a less strenuous system of farming, or to the time when his sons are able to participate in the active management, requiring a larger size business.

Adoption of such a comprehensive long-time plan should embrace a system of adequate though simple farm records. Through the use of carefully prepared plans to direct the development of the farm organization in future years, and the annual records of performance to measure the year-by-year progress made toward the objectives, each farm unit operating under a soil conservation program becomes an invaluable source of information to the farm operator and the planners as well as an indisputable demonstration to the surrounding farmers and the community.