agricultural occupations. This excluded group includes families living in tourist cabins, in second or third houses on farms formerly used for tenants or hired workers, and, where farm consolidation has taken place, in houses formerly occupied by farm-operator families. About 2.1 million persons in such houses were classified as nonfarm residents in 1950 who presumably would have been classified as farm residents under the 1940 definitions. The second class excluded from the farm population under the new definition consisted of persons in institutions located on farms, such as jails, poorhouses, and mental hospitals. About 150,000 persons were affected by this shift.

Both of these changes are regarded as improvements in definition of the farm population, as the very great majority of the persons excluded have no connection with agriculture.

Annual estimates of the farm population for years prior to 1950 have been revised to be comparable with the 1950 definitions, and issued in the Census-BAE Series, No. 16A. On the basis of the 1950 definitions, farm population in the United States decreased from 29,047,000 in 1940 to 24,335,000 in 1950. The revised figure for 1940 compares with the old estimate of 30,269,000 based on the definition used by the Census for 1940.

It should be noted that the change in definition of farm population in the 1950 Population Census is entirely independent of the change in definition of a farm in the 1950 Census of Agriculture. The only instruction relating to the identification of a farm given to the enumerators of the Population Census was to let the respondent decide whether his house was on a farm, except in the case of houses or cabins rented separately and in the case of the institutions mentioned above.

Margaret Jarman Hagood

Summerfallowing to Meet Weather Risks in Wheat Farming

By E. Lloyd Barber

Summerfallowing is one of the principal methods used by farmers in the Great Plains to reduce the risk of crop failure. This paper gives some of the results of a study aimed at measuring the extent of the protection afforded by, and the cost of, summerfallow in terms of reducing the frequency with which gross returns per acre fail to cover the direct crop costs. (*The research on which this article is based was made under authority provided by the Research and Marketing Act of 1946.*)

SUMMERFALLOWING is one of the principal methods that has been used by farmers in the Great Plains to reduce the risk of crop failure. As a cultural practice, fallowing allows the storing up of a reserve of moisture, provides an effective means of weed control, and facilitates early seeding. During years of inadequate rainfall, a much better yield can be expected from wheat sown on fallow than from second crop or "continuous" wheat. In this respect, fallowing affords at least some degree of insurance against crop failure.

How much protection does summerfallow give, in terms of reducing the frequency with which the gross return per acre fails to cover the direct crop costs, and at what cost is the protection obtained? The answer obviously varies with the local situation with respect to yields and costs throughout the Great Plains. It is the purpose of this discussion to suggest a basis for an answer to this problem.

In appraising the effectiveness of summerfallowing as a device for meeting weather risks, two situations should be distinguished. In the drier areas of the Great Plains, the difference in yield between summerfallow and continuous wheat is large enough to make summerfallowing the more profitable practice. In other areas the difference in yield does not offset the additional cost of fallowing, but there is a gain in the stability of yields. In the latter situation, fallowing can be regarded as an alternative that reduces the risk of crop failure, but at a cost in terms of a lower average net income over a period of years.

Effect of Summerfallowing on Level of Farm Income

To evaluate the effect of summerfallowing it is necessary to have a basis for comparing summerfallow with continuous crop yields. Summerfallowing reduces the acreage that can be planted, and each acre of wheat in fallow involves costs over a 2-year period. To have as large a net return from wheat on fallow as from continuous cropping, the difference in yield must offset the reduction in acreage after adjustment has been made for difference in costs.

The relationship can be readily stated if we adopt the following notation:

Let X = gross returns (yield × price) per acre harvested with continuous wheat,
E = direct costs per acre harvested, with continuous wheat,
r_1 = ratio of the summerfallow yield to the continuous crop yield per harvested acre,
r_2 = ratio of the direct cost of summerfallow wheat to continuous wheat per harvested acre.

Then, the yield ratio necessary to make fallowing *more* profitable than continuous cropping is:[1]

$$r_1 > \frac{2(X - E) + E(r_2)}{X}$$

In the winter-wheat area of western Kansas, the direct operating costs per harvested acre in 1950 were estimated as \$9.78 with continuous cropping and \$12.40 with wheat on fallow (hence E = \$9.78, $r_2 = 1.268$).[2] The average farm price of wheat in this area was \$1.86 per bushel. Thus when a yield of 10 bushels per acre can be expected from continuous wheat (X = \$18.60), the yield ratio (r_1) must be 1.615, if fallow is to be as remunerative as continuous cropping.

It should be noted that changes either in the price of wheat or in the level of operating costs that widen the margin between gross returns and operating costs have the effect of making summerfallowing *less* profitable, relative to continuous cropping. For example, with costs as in the situation above, if the price of wheat were \$1 a bushel, a yield ratio of 1.3 would make summerfallowing as profitable as continuous wheat, whereas at a price of \$2.50 a bushel, the required yield ratio would be 1.7.

Another relationship should be noted: The lower the expected level of yield from continuous wheat, the smaller is the ratio of summerfallow to the continuous crop yields that are needed to make summerfallow wheat the superior alternative.[3] Both relationships are evident in table 1, which indicates the yield ratio at which wheat on fallow provides a return equivalent to continuous wheat, over a considerable range of yields and under two situations with respect to levels of prices and costs. The levels of prices are: (1) The level of prices received and prices paid in the winter-wheat area of western Kansas in 1950 and (2) a projected level of prices for this area based on an index of prices paid that is 175 percent, and an index of prices received that is 150 percent, of the period 1910-14.[4]

What is the actual yield ratio of summerfallow to continuous wheat in this part of Kansas? Separate estimates of yields under each of these practices are available only for the years since 1946. In table 2, this ratio is shown for counties in Kansas for the period 1946-49 together with the average percentage of wheat sown on fallow during this period, and the theoretical ratio required to make wheat on fallow as profitable as continuous wheat. (See also fig. 1.)

[1] The return from an acre of wheat with continuous cropping is (X − E). When all wheat is sown on fallow, the return per acre harvested would be $0.5(X.r_1 - E.r_2)$. Given E, X, and r_2, in order that summerfallowing give a greater return than continuous cropping, $0.5(X.r_1 - E.r_2)$ must exceed (X − E). This can be reduced to the formula that is shown.

[2] Direct crop costs include labor, seed, and tractor and machine expense; they do not include indirect costs against the farm enterprise as a whole or a charge for land. Only the direct costs are relevant in evaluating summerfallowing and continuous cropping as economic alternatives.

[3] At very low yields, summerfallow is the better alternative even when the yield from summerfallowed wheat is less than the yield from continuous cropping. This is a situation in which the yield is so low that total returns fail to cover costs at the prices assumed, and in which the same yield leads to a smaller net loss on fallow than on continuous cropping.

[4] This is the level that was projected for "intermediate employment conditions" in the report prepared in 1948 for the Committee on Agriculture of the House of Representatives, *A Study of Selected Trends and Factors Related to the Long-Range Prospect for American Agriculture.*

TABLE 1.—*Ratio of summerfallow-continuous crop yield of wheat required if the return from wheat on fallow is to be equivalent to the return from continuously cropped wheat under two levels of prices for the winter-wheat area of western Kansas*

Yield expected from continuous wheat per harvested acre	1950 prices received and prices paid		Prices received 150 percent and prices paid 175 percent of 1910-14	
	Required yield ratio (r_1)	Required yield for wheat on fallow (1) x (2)	Required yield ratio (r_1)	Required yield for wheat on fallow (1) x (4)
(1)	(2)	(3)	(4)	(5)
Bushels		Bushels		Bushels
1	—	0		0
2	0.075	.2	—	0
3	.717	2.2	0.532	1.6
4	1.038	4.2	.899	3.6
5	1.230	6.2	1.119	5.6
6	1.358	8.2	1.266	7.6
7	1.450	10.2	1.371	9.6
8	1.519	12.2	1.450	11.6
9	1.572	14.2	1.511	13.6
10	1.615	16.2	1.560	15.6
11	1.650	18.2	1.600	17.6
12	1.679	20.2	1.633	19.6
13	1.704	22.2	1.661	21.6
14	1.725	24.2	1.685	23.6
15	1.743	26.2	1.706	25.6
16	1.759	28.2	1.725	27.6
17	1.774	30.2	1.741	29.6
18	1.786	32.2	1.755	31.6
19	1.797	34.2	1.768	33.6
20	1.808	36.2	1.780	35.6

For 30 counties in the western part of the State, wheat on summerfallow yields a greater net return than does wheat continuously cropped. For the other counties, summerfallow does not appear to lead to maximum net income at the levels of yield experienced in 1946-49, in terms of which the actual summerfallow-continuous crop-yield ratio was calculated, was one in which the average county yields were almost 30 percent above long-time average yields. Therefore these calculations probably understate the advantage of summerfallowing. In terms of the lower level of yield several additional counties should be included in the group of which summerfallowing would lead to the highest average net income.[5]

When the expected yield ratio of fallow to continuous wheat is equal to or less than the ratio required to make summerfallowing the more profitable practice, fallowing might be considered as a conservative policy that could maximize net income in those years when the yield level and the margin between prices and costs, or both, turned out to be lower than expected. But the possible gains that could be made in ths way would be more than offset by failure to maximize income whenever the level of yield or the price-cost margin were greater than expected. Unless anticipations were unduly optimistic, such a policy would fail to maximize long-time average net income, although it could very well serve to reduce losses in unfavorable years.

Summerfallowing to Reduce Risk

In areas in which summerfallowing provides a smaller net return than does continuous wheat, wheat may be grown on fallow in order to reduce the risk of crop failure. To the farm operator, the problem of weather risk is principally one of avoiding situations in which total returns fail to provide a sufficient surplus above expenses to cover essential expenditures for family living. When at least a part of the wheat crop is sown on fallow, there is less likelihood that the yield will fall to a

[5] In computing the "required yield ratio" (shown in table 2) the county average yield for continuous wheat, 1946-49, was corrected for the percentage it was estimated to exceed the long-time average. But it was not possible to make a similar correction in the "actual yield ratio." A ratio more favorable to summerfallowing than that shown in table 2 should be expected as a long-time average.

TABLE 2.—*Summerfallow-continuous crop-yield ratio and percentage of wheat sown on fallow 1946-49, compared with the theoretical ratio necessary to make fallow wheat as remunerative as continuous wheat (with prices received 150 percent and prices paid 175 percent of 1910-14), Kansas*

Western counties	Yield ratio 1946-49	Percentage of wheat on fallow 1946-49	Required yield ratio	Other counties	Yield ratio 1946-49	Percentage of wheat on fallow 1946-49	Required yield ratio
		Percent				*Percent*	
Cheyenne	1.7	75	1.5	Barber	1.4	4	1.7
Clark	1.6	15	1.5	Barton	1.4	9	1.6
Decatur	1.8	50	1.4	Clay	1.2	3	1.7
Finney	1.5	37	1.4	Cloud	1.2	4	1.7
Ford	1.6	14	1.6	Comanche	1.4	11	1.6
Gove	1.6	47	1.4	Dickinson	1.2	1	1.7
Graham	1.8	46	1.3	Edwards	1.5	11	1.6
Grant	1.6	62	1.3	Ellis	1.6	14	1.6
Gray	1.5	18	1.5	Ellsworth	1.3	11	1.6
Greeley	1.9	64	1.2	Harper	1.3	1	1.7
Hamilton	1.9	66	1.3	Harvey	1.3	1	1.7
Haskell	1.6	27	1.5	Jewell	1.4	7	1.6
Hodgeman	1.6	17	1.4	Kingman	1.3	3	1.6
Kearny	1.9	64	1.3	Kiowa	1.4	17	1.6
Lane	1.7	49	1.4	Lincoln	1.3	6	1.6
Logan	1.8	50	1.3	McPherson	1.3	2	1.7
Meade	1.4	27	1.5	Marion	1.3	2	1.7
Morton	1.6	37	1.3	Mitchell	1.4	7	1.7
Ness	1.7	22	1.5	Osborne	1.4	12	1.6
Norton	1.8	63	1.3	Ottawa	1.3	3	1.7
Rawlins	2.1	64	1.4	Pawnee	1.5	12	1.6
Scott	2.1	71	1.2	Phillips	1.6	32	1.5
Seward	1.6	24	1.5	Pratt	1.4	13	1.6
Sheridan	2.1	42	1.3	Reno	1.2	4	1.7
Sherman	1.9	60	1.3	Republic	1.3	3	1.7
Stanton	1.8	70	1.3	Rice	1.3	8	1.7
Stevens	1.5	33	1.4	Rooks	1.6	26	1.4
Thomas	1.9	58	1.3	Rush	1.5	12	1.6
Trego	1.9	28	1.4	Russell	1.5	12	1.6
Wallace	1.7	53	1.3	Saline	1.2	3	1.7
Wichita	1.9	67	1.2	Sedgwick	1.4	1	1.7
				Smith	1.5	21	1.6
				Stafford	1.4	14	1.6
				Sumner	1.4	1	1.6
				Washington	1.3	3	1.7

level that causes hardship to the family. The cost of summerfallowing, as a protective device, can be estimated directly by comparing the expected summerfallow-continuous crop-yield ratio to the ratio required to make fallowing profitable.[6]

The benefits to be realized from summerfallowing, as a method of meeting risks in yields, can be illustrated by the long-time records of summerfallow and continuous crop yields at the State Agricultural Experiment Station at Hays, Kans. Over the period 1915-48, average yields of 23.9 bushels per acre for summerfallow wheat and 14.8 bushels per acre for continuously cropped wheat were obtained. This is a yield ratio of 1.61. But the ratio required to make summerfallow wheat as profitable as continuous wheat would be 1.74 with the prices of 1950, or 1.70 with the alternative price assumption (a level of prices paid 175 percent, and a level of prices received 150 percent of 1910-14). As this is a situation in which summerfallow wheat on the average (and under the price assumptions we have made) yields a smaller return than continuous wheat, it will serve to illustrate the benefits that can be attributed to fallowing as a means of reducing risk.

The summerfallow yield and the corresponding continuous crop yield of wheat each year of the period 1915-48 are shown in a scatter diagram in figure 2. A straight line has been drawn to show for any continuous crop yield the summerfallow

[6] For example, when the expected summerfallow and continuous crop yields are 15 and 10 bushels per acre, respectively, and a ratio of 1.7 is required to make fallowing profitable, the probable average cost of summerfallowing would be equivalent to the value of 2 bushels of wheat.

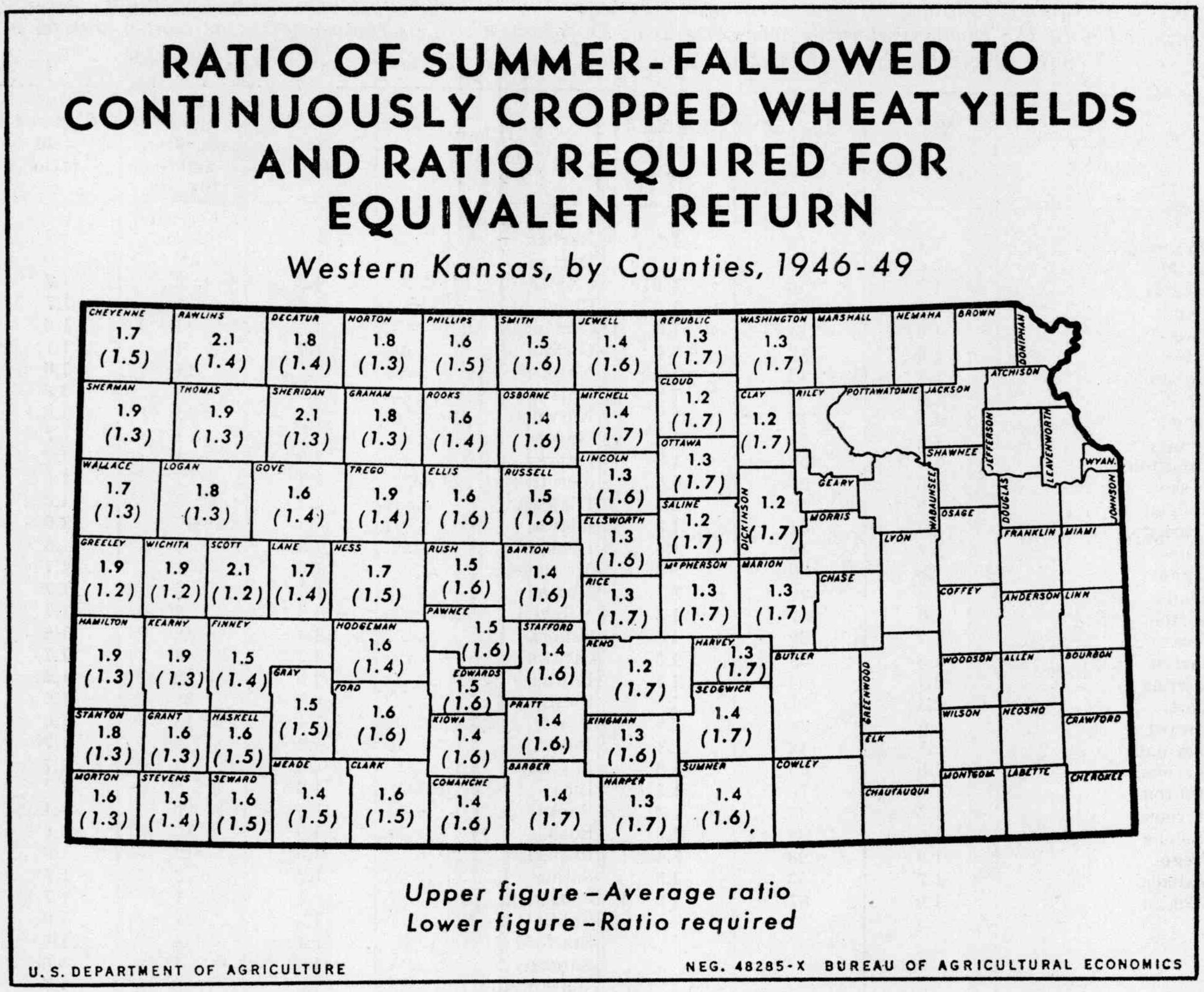

FIGURE 1.

yield that would give an equivalent return.[7] In years for which the plotted yield observations lie above this line, continuous cropping is more profitable than summerfallow wheat; for those observations that lie below the line, summerfallowing is the more profitable.

There were 17 years in which the yield of summerfallow wheat was less than the average of 23.9 bushels per acre. In 13 of these years, the corresponding continuous crop yield would have given a smaller net return than fallow. In the 17 years when the summerfallow yield was above average, there were 12 in which the corresponding continuous crop yield would have given a substantially greater return. In this example, the benefits of summerfallowing are realized largely in years in which yields were below average. By increasing the net return (or reducing losses) in unfavorable years, summerfallowing does serve to reduce risks in yields. The gains in this case, however, are more than offset by the income sacrificed during years when the yields were relatively favorable.

The value of summerfallow as a means of reducing risk may be seen more readily when the two yield series are expressed in terms of their comparative effect on the net income of an average farm in the winter-wheat area of Kansas. In table 3, the net income of a 600-acre farm is shown over a 34-year period (1) with 148 acres of wheat on fallow and (2) with 296 acres of continuously cropped wheat. In each case it is assumed that yields each year were as reported by the State Ex-

[7] With a level of prices received 150 percent and a level of prices paid 175 percent, of 1910-14.

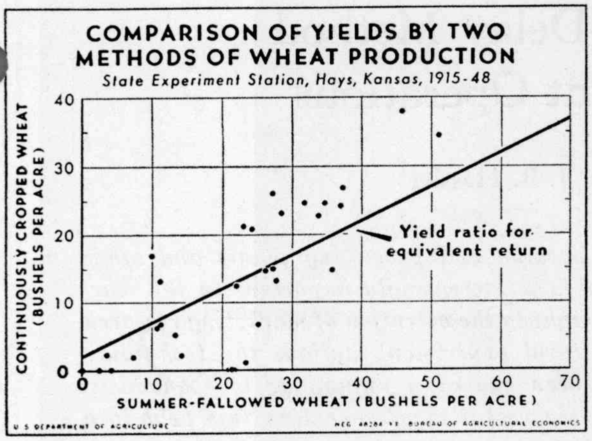

FIGURE 2.

periment Station at Hays, Kans. for summerfallow and continuous wheat over the period from 1915-48.[8]

In this illustration, net income with summerfallow wheat is, on the average, $231 smaller, but is more evenly distributed from year to year. There are no years with an income deficit when all wheat is on fallow, whereas with continuous wheat the income deficits are found in 5 of the 34 years. Thus summerfallowing provides some protection at a cost. Cost, here, is mainly in terms of the large incomes that could be realized in a few years with a larger acreage of non-fallow wheat.

It might seem that the most profitable policy would be an extremely flexible one which would tend to maximize the acreage of wheat on summerfallow when prospects were for a poor yield, with a return to a large nonfallow acreage when moisture conditions were better than average. But as the decision to allow acreage to remain in fallow is made in terms of a wheat crop that is planted one year later, it would be difficult in practice to follow this policy with any degree of success.

By growing part rather than all of the crop on fallow, a lesser degree of protection could be provided at lower cost. One-half or some other fraction of wheat on fallow could be chosen, depending upon the protection desired. Fallowing can be

[8] It is assumed that the farm has approximately 400 acres of cropland with 12 acres of barley, 33 acres of grain sorghums, 10 acres of sweet sorghums, and 7 acres of alfalfa. Net income includes income from livestock and livestock products—on the average, $2,260. A level of prices received 150 percent of 1910-14 and a level of prices paid 175 percent of 1910-14 have been used in determining net income.

TABLE 3.—*Net income of an average wheat farm in the winter-wheat area of Kansas (1) with 148 acres of wheat on fallow, and (2) with 296 acres of continuously cropped wheat with the yields reported by the Experiment Station at Hays, Kans., for summerfallow and continuous wheat from 1915-48*[1]

Year	Net income		
	(1) 148 acres of summerfallow wheat	(2) 296 acres of continuous wheat	(1) − (2)
	Dollars	*Dollars*	*Dollars*
1915	4,873	6,413	—1,540
1916	6,140	7,343	—1,203
1917	1,350	160	1,190
1918	6,399	4,739	1,660
1919	3,278	6,237	—2,959
1920	8,595	9,722	—1,127
1921	7,973	9,910	—1,937
1922	5,132	2,744	2,388
1923	1,206	494	712
1924	8,864	13,083	—4,219
1925	4,997	1,368	3,629
1926	4,533	4,415	118
1927	2,374	2,006	368
1928	10,457	15,124	—4,667
1929	5,202	7,664	—2,462
1930	5,619	9,004	—3,385
1931	7,256	8,907	—1,651
1932	10,922	13,026	—2,104
1933	4,059	3,863	196
1934	3,606	−637	4,243
1935	828	—544	1,372
1936	4,861	4,616	245
1937	3,892	−335	4,227
1938	5,105	4,251	854
1939	586	−541	1,127
1940	2,618	353	2,265
1941	5,862	7,974	—2,112
1942	3,642	2,664	978
1943	2,294	2,017	277
1944	8,044	10,164	—2,120
1945	1,329	870	459
1946	3,805	−313	4,118
1947	8,985	13,656	—4,671
1948	6,743	8,876	—2,133
Av.	5,042	5,273	—231

[1] Prices are assumed constant at the following levels: Prices paid, 175 percent of 1910-14; prices received, 150 percent of 1910-14.

adapted in each situation to the need for stability and to the price one is willing to pay.

As a method of risk-bearing, summerfallow is one alternative among several. The maintenance of cash reserves, or diversification with a livestock enterprise, or a crop-insurance policy, may be more effective in many situations as methods of meeting weather risks. In many areas, summerfallowing brings substantial benefits in terms of more stable income. The measure of its effectiveness involves a comparison with alternative risk-bearing methods as to the costs and benefits that may be expected. This is a matter on which individual farmers may be expected to exercise wide differences in choice.