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AGRICULTURAL ECONOMICS RESEARCH

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New Approaches and Methods for the 1950 Census of Agriculture

By Ray Hurley and Richard K. Smith

The agricultural censuses are one of the basic foundations of not only our statistics relating to crops, livestock, and farms generally but also of large blocks of agricultural economics research. Agricultural statisticians and researchers necessarily have a keen interest in any new methods of obtaining or new developments in tabulating and publishing census data. As State and county materials from the 1950 Census of Agriculture are now being released, the following article is timely. Ray Hurley, Statistician in Charge of the Agricultural Census, Bureau of the Census, and R. K. Smith, Vice Chairman of the U. S. D. A.'s Crop Reporting Board, describe some of the new approaches used by the Census to assure a more complete coverage of farms, some of the new sampling techniques, and the use of State "economic areas" as the basis for publishing certain kinds of census data. The discussion of the techniques used to obtain a more adequate coverage of both farms and subject matter, is not an attempt to evaluate the internal accuracy of the answers obtained—that task is still in process. A note has been added, over the signature of Dr. Hagood, describing the new concept or definition of farm population used in the 1950 Population Census and briefly summarizing its effect.—O. V. Wells.

NEW APPROACHES and methods used for the 1950 Census of Agriculture may be divided into two general groups: (1) Those affecting primarily the enumeration and (2) those relating to office processing and publication.

Approaches and Methods Affecting Enumeration

Several new procedures were introduced to further the completeness of the coverage of the farm census.

For the first time questionnaires were sent to farm operators for filling in answers before the actual start of the enumeration. Through the cooperation of the Post Office Department a copy of the agriculture questionnaire was distributed to every rural box holder and to box holders in selected towns not having door-to-door mail delivery in all States—except North Carolina, South Carolina, Georgia, Alabama, Mississippi, and Louisiana and except 65 out of the 75 counties in Arkansas. Approximately 9 million agriculture questionnaires were so distributed between March 17 and April 1, 1950. Each questionnaire was accompanied by a letter stating specifically the kinds of places for which the agriculture questionnaire was to be filled and asking the person in charge to examine the questionnaire, fill in the answers to as many questions as possible, and give the questionnaire to the census enumerator when he called to take the census of agriculture, population, and housing, in April or later.

Accurate data regarding the extent to which farm operators filled the agriculture questionnaire before the arrival of the census enumerator are not available. Some records were kept in approximately

10 percent of the 450 supervisors' districts; they indicate that, in the areas in which the agricultural questionnaires were distributed through the mail, approximately 20 percent of the farmers had completely filled them out by the time the enumerator arrived and another 20 percent had partially done so.

In another move to improve coverage, the census enumerators were instructed to fill agricultural questionnaires for (1) all farms and (2) all places of 3 acres or more not considered as farms. In previous censuses, enumerators were instructed to complete questionnaires for all places containing 3 acres or more on which any agricultural products were produced and all places under 3 acres on which $250 or more of agricultural products had been produced, during the preceding year. Enumerators had difficulty in applying these instructions. In the first place, the determination of the value of agricultural products produced was difficult, particularly where a large part of the production was for consumption on the place. Second, even the determination of whether agricultural products were produced on places of 3 or more acres was influenced considerably by the enumerator's opinion as to whether he considered the place a farm and the scale of farming on the place.

The new procedure resulted in the taking of more than a million questionnaires that were not included in the final agricultural tabulations. Of these, 778,000 represented places on which there were no agricultural operations in 1949; and approximately 240,000 were places with agricultural production less than that required for retention of the questionnaire in the tabulations as a farm. The enumeration of places of 3 or more acres contributed to the completeness of the enumeration especially in areas where there were large numbers of marginal farms.

The procedure set up to insure a thorough check on the enumeration of large farms aided greatly in improving the coverage. In 1948, lists were prepared of the large farms enumerated in the 1945 Census of Agriculture.

These lists were sent to State statisticians of the Bureau of Agricultural Economics, who, as special agents of the Bureau of the Census, checked the lists against existing records and made field checks when possible. In this way, lists totaling 62,800 large farms were prepared for use by census crew leaders and enumerators. So far as possible, the enumeration of these large farms was checked in the field during the period of enumeration. During the editing process after the questionnaires were received in Washington, the enumeration of the large farms was completely checked. For the areas west of the Mississippi River, any large farms located in more than one county were checked to see that they were enumerated only once. Approximately 4,000 letters were written during the editing process to check on the enumeration of large farms, to obtain more information, or to insure the accuracy of the reports.

More accurate and complete coverage of the farm census in the South was insured by the use of a special supplementary questionnaire (Landlord-Tenant Operations). Its use was required when two or more agricultural questionnaires were necessary for an individual land holding. Its use aided in the enumeration of cropper and other tenant farms comprising plantations and the larger land holdings. Enumerators were instructed to list on this questionnaire the name of the landlord and each cropper and other tenant and to give, for each listing, certain items of information such as the acreage assigned, acres in cotton, acres in tobacco, and acres in other crops. This special questionnaire was filled out for approximately 400,000 land holdings located in the 900 counties in which it was used.

Supervision and Training

Greater supervision and more training of census enumerators constitute important changes in the approach to the 1950 Census as compared with prior censuses. Approximately one local supervisor was provided for every 14 enumerators in rural areas. These crew leaders were given a week of training by members of the Washington staff of the Bureau of the Census and personnel from State Agricultural Colleges and the U. S. Department of Agriculture. The crew leaders then conducted training sessions for the enumerators. Rural enumerators were given approximately 24 hours of training before they began their actual work. Detailed training on the census of agriculture represented more than one-third of the total training time for the 17th Census. The training was standardized through the use of training materials and film strips and recordings of mock interviews. A rigid time schedule was set up for the crew leaders to follow so that the training time would be proportioned among the various parts of the census enumerator's work. During the period of actual enumeration the crew leaders were expected to accompany each member of his crew during at least one farm visit. He also visited each enumerator when work got fully under way, inspecting his completed questionnaires on a systematic basis and answering his questions. At the completion of an enumeration district the crew leader checked the enumerator's map to see that the coverage of the district was satisfactory.

The use of State questionnaires represented one of the new approaches. In previous censuses separate questionnaires had been used for the different regions but the number of different questionnaires used in 1950 was almost five times as large. This permitted reducing the number of questions for many States and eliminated the need for farmers to read many questions that did not apply to the area. It also provided for the asking of separate questions regarding crops that were important only in that State. The questionnaire itself was of the interview type. Most of the questions were stated completely and exactly as the enumerator was expected to ask them. This was the first time that an interview-type schedule had actually been used in the census of agriculture.

Sampling was used to a greater extent in the 1950 Census of Agriculture than for prior censuses, thus reducing the time spent by the enumerator. In 1950, sampling was used for two purposes. First, data on farm facilities and equipment, farm labor, farm expenditures, distance to trading center, value of farm land and buildings, taxes, farm mortgage debt, etc., were enumerated only for a sample of farms. Second, a sample of farms, comprising all large farms and one-fifth of all other farms, was used for the tabulation of more than a third of the data to be published for the 1950 Census.

The farms for which some items of information were to be enumerated on a sample basis were selected during the enumeration. These farms were also used for the tabulation of data on a sample basis. Each agricultural questionnaire given to census enumerators, as well as each going to a farmer through the mail, had a serial number ranging from 1 through 5. Census enumerators were required to obtain sample information for farms if the questionnaire had a certain serial number. The determination of this serial number was made on the basis of the number assigned to the enumeration districts in which the enumerator performed the enumeration. For example, if the last digit of the number designating the enumerator's district was 5, then he was required to obtain the sample information for all questionnaires having a serial number of 5.

In a number of cases the enumerator did not follow perfectly the prescribed method of selecting the sample farms. In order to detect biases introduced into the sample because of this failure, it was necessary to check the selection of farms in the sample at the completion of the enumeration and during the processing of the questionnaire. During the enumeration or before the processing of the questionnaires, enumeration districts in approximately 65 counties were found in which the sampling procedure had not been followed fully. In these counties the sample was corrected by selecting the farms that should have been included and obtaining the missing information either by reenumeration or by mail.

To learn the extent of the sample bias, counts were obtained during the processing of the questionnaires for each county and for each State economic area, for all farms, by size of farm and by economic class. The counts obtained for the sample were compared with the expected number. Where there was a bias in the sample selection, adjustments were made before the tabulation by duplicating questionnaires at random in the sample when the expected number of farms was greater than the actual number of farms in the sample. Likewise, farms were eliminated from the tabulation when the count of farms in the sample exceeded the expected number of farms in the sample. In general, the enumerators introduced a bias into the sample by including the larger and better farms. In adjusting for this bias, 2.1 percent of the farms were duplicated and 3.0 percent of the farms were eliminated from the sample prior to the tabulation of data for the sample. For farms classified as commercial (that is, farms with a value of products sold of $1,200 or more plus farms with a value of products sold of $250-$1,199 and with operators working off the farm less than 100 days and obtaining the major part of this income from the sale of farm products), the percentage duplicated was 1.5 percent and the percent eliminated amounted to 3.7 percent. On the other hand, for noncommercial farms, the percentage of farms duplicated was 3.4 percent, and the percentage eliminated was 1.5 percent.

Methods Relating to Office Processing and Publications

A revision in the census definition of a farm was made for the 1950 Census. For 1950, places of 3 or more acres were included in the tabulation if the value of agricultural products in 1949, exclusive of home gardens, amounted to $150 or more. The agricultural products could have been either for home use or for sale. Places of less than 3 acres were counted as farms only if the value of agricultural products sold in 1949 totaled $150 or more. Places operated in 1949 for which the value of agricultural products was less than these quantities because of crop failure or other unusual situations, and places operated in 1950 for the first time, were counted as farms if normally they could be expected, on the basis of the livestock on hand or the amount of cropland and pasture land available, to produce these minimum quantities of farm products. Questionnaires to be included in the tabulations as farms were determined during the processing of the questionnaires in Washington, as the census enumerator was not given a definition for a farm.

For the 1945 and earlier censuses of agriculture, the definition of a farm was somewhat more inclusive. Census enumerators for prior censuses had been provided with the definition of a farm and instructed to fill questionnaires only for those places which met the criteria. From 1925 to 1945, farms for census purposes included places of 3 or more acres on which there were agricultural operations and places of less than 3 acres that had agricultural production for home use or for sale with a value of $250 or more. For places of 3 or more acres, no minimum quantity of agricultural production was required for purposes of enumeration; for places of under 3 acres all the agricultural products valued at $250 or more may have been for home use and not for sale. The only questionnaires excluded from the tabulations were those taken in error and a few with very limited agricultural production; as only a small home garden, a few fruit trees, a very small flock of chickens. In 1945, reports for 3 acres or more with limited agricultural operations were retained if there were 3 or more acres of cropland and pasture, or if the value of products in 1944 amounted to $150 or more when there was less than 3 acres of cropland and pasture.

The change in definition of a farm seems to have reduced the number of farms included in the tabulations for the 1950 Census as compared with 1945 by not more than 200,000. The eastern States were most affected by this change.

In the office processing of the 1950 Census of Agriculture there has been closer cooperation than ever before between the Bureau of Agricultural Economics and the Agriculture Division of the Bureau of the Census. At the time the tabulations for each State were being edited, summarized, and prepared for preliminary release, the BAE State Statistician for that State was called to Washington and detailed to the Census Bureau to give as much assistance as possible as a special agent of the census. Extensive use was made of his statistical experience and knowledge of agricultural conditions and operations in his State. Usually the detail covered about 2 weeks. Not only was the BAE State Statistician able to help the Census Bureau in its work but he also gained valuable experience with the census data which will be extremely helpful in using and interpreting the 1950 Census results in future BAE estimates and revisions.

The use of State economic areas or groupings of counties for the presentation of statistics represents a new development for the 1950 Census of Agriculture. Outside of metropolitan areas, State economic areas, in general, are the same as State type-of-farming areas. These economic areas were established by the Bureau of the Census in cooperation with the Bureau of Agricultural Economics, State Colleges, and other interested agencies. The counties comprising a State economic area have similar agricultural, demographic, climatic, physiographic, and cultural characteristics.

Basically, State economic areas have been established for the purpose of presenting statistics not only for the 1950 Census of Agriculture but also for the Censuses of Population and Housing and other types of Census data. The 48 States have been subdivided into 501 State economic areas. (For a description of State economic areas, see the Special Report of the 1950 Census entitled, "State Economic Areas: A Description of the Procedure used in Making a Functional Grouping of Counties in the United States.") For the purpose of presenting agricultural statistics, most metropolitan areas have been combined with adjacent economic areas when the number of farms and the agricultural production of the metropolitan area are of small importance. On the other hand, because of significant differences in the characteristics of the agriculture within State economic areas, some State economic areas have been subdivided when statistics are given for the 1950 Census of Agriculture. Figure 1 shows the economic areas to be used for agricultural data.

More than a third of the detailed data published for the 1950 Census of Agriculture will be for State economic areas. Data to be so published include frequency distributions of farms reporting specified items such as farm operators by age, corn by acreage harvested, cattle by number on hand; detailed statistics on farms classified by size of farm, by tenure of operator, type of farm, and economic class of farm; and tabulation of farms reporting: Potatoes by acreage harvested, milk production by size of herd, poultry items by size of flock, etc. The use of State economic areas as units for the publication of statistics made possible many tabulations that would not have been possible by county because the data on other bases would not have been reliable enough and because of the cost of tabulation, amount of clerical work required and cost of publication. These tabulations include cross tabulations by size of farm, tenure of farm operator, type of farm, and economic class of farm.

Note on change in definition of farm population.—Agricultural statisticians and economists will also be interested in the change in definition of the farm population that was introduced into the 1950 Population Census. In the 1940 Population Census and in the current population surveys made during the 1940-50 decade, all persons living on farms were classified as in the farm population. In 1950, two classes of such persons were not regarded as living on farms. The most important of these groups consisted of families living in houses on farms for which they pay cash rent, but who do not rent any farm land along with the house. Most of the workers in these families are employed in non-

FIGURE 1.

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.)

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[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.

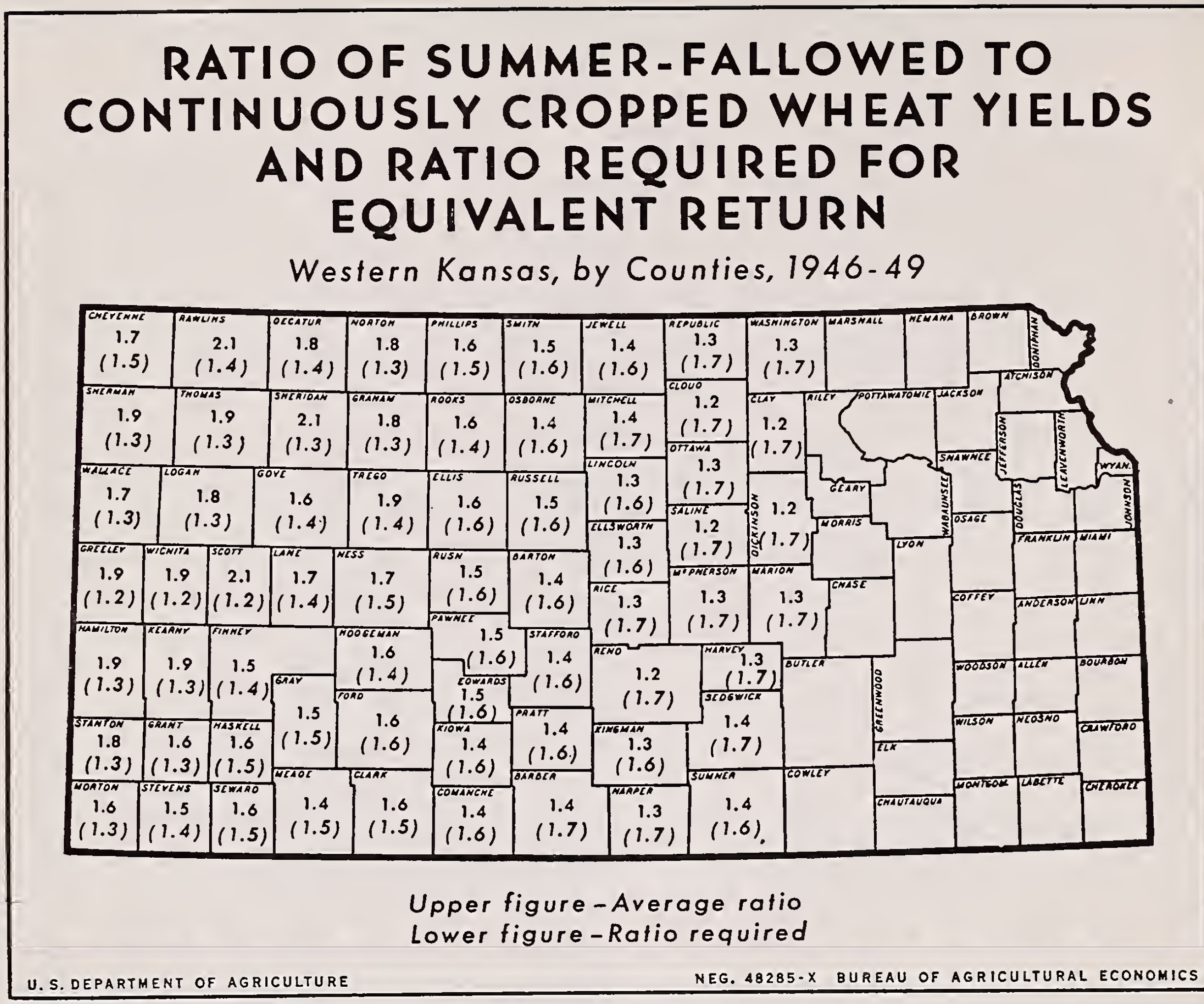

FIGURE 1.

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.

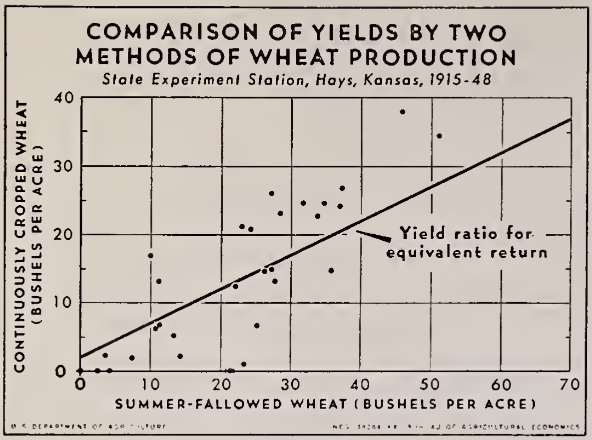

FIGURE 2.

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 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.

[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.

Use of the Ratio-Delay Method in Processing Plant Operations

By L. L. Sammet and J. B. Hassler[1]

Studies to increase the operating efficiency of packing and processing plants and other establishments that handle farm products have become increasingly important in the marketing research program. These studies have brought to the attention of marketing research people in this Department and the State agricultural experiment stations the techniques of engineering-methods study, a field that had been generally unfamiliar to economists. This paper describes the application of a relatively recent development in this field to a study of operations of pear and apple packing plants.

The ratio-delay method is used in analyzing the use of time in plant operations. Among its advantages are its economy and its susceptibility to statistical evaluation of the reliability of the results obtained.

STUDIES LEADING to greater operating efficiency in plants that pack and process agricultural products have become increasingly important in the marketing research program and are particularly pertinent in the present period of high demand for productive resources. In such studies, the traditional approach has tended to be in terms of average costs computed from the records of a representative sample of plants, but this method frequently yields inadequate or misleading results. Average costs derived from historical records often fail to account for the effects of seasonal variation in volume, excess plant capacity, differences in work methods, and other factors affecting the efficiency of plant operations (*1*).[2] This difficulty has led to a growing interest in the application of industrial engineering techniques to studies of plants.

Examples of the kind of analytical data obtainable with the aid of industrial engineering methods are: Standard unit-time requirements for the performance of essential tasks; estimates of the proportion of working time that is actually used in productive work—the converse of this measure is the proportion of "idle" or "delay" time; and the pattern of flow in handling materials. Such data are basic to an analysis of plant operations aimed at improving efficiency through better work methods and the elimination of bottlenecks in plant operations, or, more generally, through better integration of the plant processes.

The industrial engineering procedure most familiar to agricultural economists probably is the *time study* by which the amount of time required to perform a specific operation is measured by direct observation with a stop watch. This method is most applicable to work performed in repetitive cycles but, if observations are taken for a long enough period, it also will provide estimates of time required for irregular operations and for delays or idle time. If the task to be measured is divided, for purposes of observation, into a series of discrete elements and if performance times for each element are obtained, the time study will provide data for a detailed analysis which may lead to changes in the equipment or work methods that will increase efficiency.

A second industrial engineering method familiar to agricultural economists is the *production study* which consists of a continuous time log of each operation, delay, or other event associated with a particular task. The performance times are obtained by a series of continuous stop-watch readings, each reading being associated on the data sheet with a notation as to the nature of the particular event observed. By sorting these separate observations into appropriate categories, estimates of the average time per operation can be obtained for each category. This type of study is used to obtain unit-time requirements where the pattern of

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[1] Credit is due D. G. Malcom for assistance in designing field procedures described in this report; and acknowledgment is made to Herman M. Southworth, Glenn Burrows, and R. G. Bressler, Jr., for suggestions in its preparation.

[2] References in parentheses and italics refer to literature cited at end of paper.

operations is so irregular as to make a time study unsuitable. Or, the production study may be employed to estimate the distribution of the time of a worker who performs more than one task, or to obtain the proportion of his total work time that is spent in a "delay" or "idle" status.

A third method has been introduced more recently by a British statistician (*2*) and has come to be known by industrial engineers as the *ratio-delay method.* This method probably is less familiar to agricultural economists than the time-study or production-study methods; it appears to have excellent possibilities as a tool in marketing research. This paper presents some aspects of its application in a study of costs and efficiency in the operation of pear- and apple-packing houses in California. A question might be raised as to the aptness of the designation, ratio-delay, especially as the applications described in this article are to a much broader category of events than delays. It is suggested that the term, ratio-delay, be associated primarily with a method of procedure rather than a particular kind of event.

An important point is to be stressed with respect to each of these methods. Data obtained by them are based on past performance and each method yields only an estimate of expected or probable performance. Each method is subject to error in that the period observed is only a sample of the total performance.

Choice of Method

In a particular plant the operations often involve many different job classifications and many workers. To analyze the operations it may be necessary to obtain data as to the labor and equipment requirements in each job category. This may require an estimate of the time expended per work unit and of the proportion of time spent in productive work, in a delay or idle status, on work of another category, etc. It also may be essential to obtain the pattern of movement for materials transported by hand truck or fork truck—that is, the transport route for each type of material, the number of units moved per trip, and the number of times the material was moved. The most logical way to obtain this pattern is by observation of the workers involved.

For many jobs, the time requirements per work unit are most easily obtained by time study, but this method is not well adapted to tasks in which the job elements are not well defined—for example, checking packed boxes in a fruit-packing plant to ascertain the size and number of fruits per box. Moreover, the use of the time-study method to obtain data such as the proportion of delay time is unduly expensive if many jobs are to be studied. In fact, if the plant operations are seasonal, as is often the case for marketing facilities, there may be insufficient field time for obtaining these data by time study. Similar handicaps apply to the production-study method.

Thus, under suitable conditions, the ratio-delay method is useful in economizing on field time required for estimating delay proportions and in establishing unit-time requirements for the less well-defined jobs. A modification of the ratio-delay method also is applicable to the problem of defining the pattern of flow in materials handling.

Procedures in Ratio-Delay Studies[3]

The ratio-delay method is essentially a sampling process which involves: (1) a machine or worker whose activity is divided into several categories, (2) a large number of instantaneous and, for practical purposes, random and independent observations of the work, and (3) the theory that the ratio of the *number of observations* in any one category to the total number of observations will yield a reliable estimate of the ratio of *time expended* in that category to the total time. The process can be visualized more easily, perhaps, by first considering how observations are made in the field.

As a preliminary step, the work performed at each work station is studied and a written summary or job description of the operations is prepared. The observer thus familiarizes himself with the details of each job and is prepared to classify properly the events to be noted in the ratio-delay study. A schematic plant lay-out may be drawn to record the locations of the work stations (fig. 1) to be observed and for use in planning the route to be followed by the observer. Tours of the plant may be made over this route and on each tour the activity of the worker at each station may be classified.

To avoid bias in classifying the observations, they should be made on an instantaneous basis, with care to eliminate any tendency to anticipate what the work status should be or unconsciously to ex-

[3] For general discussions of ratio-delay procedures, see references (*5*), (*6*), and (*7*).

ercise a preference for recording the work status in one way or another. For example, a kindhearted observer might unconsciously prefer to record a worker as "working" rather than "idle." The kind of observation desired may be described as that resulting if the observer were to wear special goggles equipped with a camera shutter. If the shutter were operated the instant the work station was visible, an instantaneous observation of the work status would be obtained.

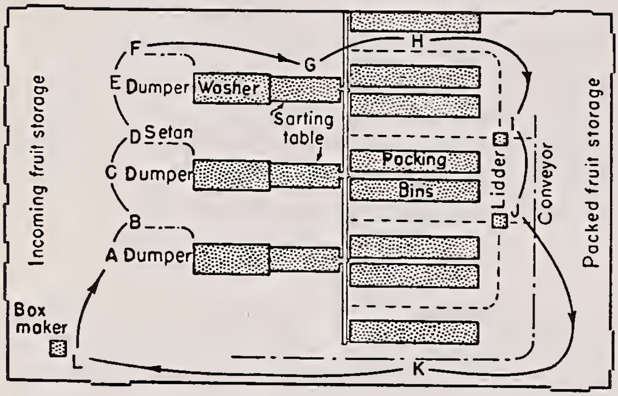

FIGURE 1.—Plant lay-out and ratio-delay observation route.

To assure consistent classification of the observations (both from the standpoint of consistency of one observation to another and from one observer to another) careful definitions must be drawn as to the character of each category of work status. Each observation should be recorded with a tally mark in the appropriate column of a data sheet. For example, the record for one job in a fruit-packing plant—the dumping of fruit from field lugs to a conveyor at three dumping stations—is illustrated in figure 2. A separate record should be made of the observations at each work station, although it may be desirable in later analysis of the data to aggregate the observations for several stations. For example, if identical operations are performed at several work stations, a ratio-delay proportion relating to the total work performed at the several stations may be wanted. In this event, observations on the individual stations may be aggregated to obtain an over-all proportion.

The ratio-delay method is statistically acceptable if the observations are random, independent, and unbiased, and if the number of observations is sufficiently large. These conditions require that all possible events have an equal chance of being included in the sample. As the ratio of delay observations to total observations is the basis for an estimate of the proportions in which the total time is divided, it is consistent with a random sampling procedure to record the same delay, if it is a long one, on successive trips.[4] A necessary precaution is that visits to a particular station not coincide with a cyclical delay, otherwise considerable bias may be introduced.

As the events observed in the ratio-delay study occur over a time period—and past events have no chance of being included in the sample—a truly random sample is not possible. But the desired conditions probably are approximated if a continuous round of observations are taken and if the starting time and the duration of each trip are arranged so as to avoid visiting the various work stations on a regular time cycle. The procedure of continuous sampling probably will approximate a random sample if applied to a situation in which the delays are random in distribution.[5]

RATIO-DELAY STUDY						
Plant: A Date: 7-14-50		No. of workers	WORKING	NOT WORKING		
Job	Sta.			Break for lots	Equip. failure	Other
Dumper	A	1	𝍸 𝍸 𝍸 𝍸	𝍸 𝍷		
Dumper	C	1	𝍸 𝍸 𝍸 𝍷𝍷	𝍸 𝍷	𝍷𝍷	𝍷
Dumper	E	1	𝍸 𝍸 𝍸 𝍸	𝍸 𝍷		

FIGURE 2.—Sample ratio-delay data sheet.

Applications in a Packing-House Study

To indicate how the ratio-delay method may be used in plant studies, several illustrations are given of its application in a current study of deciduous fruit-packing houses in California. This work has included an intensive study of operations in 22 plants in which the number of job classifications varied from about 12 to 45 and the total number of

[4] In the literature concerning the ratio-delay study, the usual instruction regarding long delays is either to schedule the observations so that each tour is slightly longer than the longest delay; or if the same delay extends into more than one observation trip, to count the delay only once. The procedure suggested in this paper will result in a more reliable estimate of the delay time.

[5] This sampling procedure becomes less appropriate the more the delays under observation deviate from random occurrence. If delays occur with regularity or are cyclical, the delay probably can best be measured directly, rather than by sampling. For example, sampling should be discontinued during lunch and rest periods.

workers per plant ranged from 25 to 180. The ratio-delay method was employed to obtain three types of data: (1) The proportion of ''delay'' (nonproductive time) in relation to total working time. (2) Time requirements per work unit for specific jobs. (3) The flow pattern in materials handling.

The Proportion of Delay Time.—In the simplest case, this involves a classification of the observations into only two categories. The data given in figure 2, for example, would be grouped into two classes, ''working'' — 57 observations — and ''not working''—21 observations—and the delay proportion computed as the ratio of delay observations to total observations. If the estimated delay proportion is represented by p, this ratio in the example is:

$$p = 21/78 = 0.269$$

As it may prove desirable to have information regarding the causes underlying the total delays observed, subgroups of delay observations might be obtained. Thus, in the data in figure 2, 18 observations were recorded under ''break for lots''[6] and the proportion of observations in this category is:

$$p = 18/78 = 0.231$$

The foregoing ratios of instantaneous observations are estimates of the proportions in which the total time was divided. Thus, we estimate that of the total time about 73 percent was actual working or productive time and 27 percent was total-delay time. Delay due to break for lots is estimated as 23 percent of the total time.

As the delay proportions are based on sampling data, the question of reliability of the estimates obtained is important. This problem is considered in detail later in this paper, but it is well at this point to note some empirical evidence as to the accuracy of the observed proportions. In several instances it was feasible to make concurrent ratio-delay and production studies of a particular job. These parallel studies make possible a comparison between delay proportions obtained by direct measurement in a production study and sample proportions obtained in a ratio-delay study (table 1). Although the two sets of proportions do not correspond exactly, they are reasonably consistent, particularly in view of the small number of ratio-delay observations.

[6] ''Break for lots'' refers to the suspension of the dumping operation while changing from the fruit of one grower to the fruit of another.

Time Requirements Per Work Unit for Specific Jobs

When time requirements per work unit are obtained by time study, the operations comprising the task usually are divided into work ''elements'' and the performance time determined separately for each element. The element times then are summed to obtain a cycle time. The element times are useful in a detailed analysis of work methods, but for some purposes it is sufficient to obtain only the average total cycle time. A simple way to ascertain such times is to divide the actual *productive time* in a given period by the number of work units completed during that period.

Obtaining an estimate of the productive time, as distinguished from the total time, is a simple matter if the delay proportion is available. Consider, for example, the task of dumping fruit from field lugs at the sorting table conveyor recorded in figure 2. For the 1-day period illustrated, the total delay proportion for the three dumpers was 0.269; for the complete study—over a 4-day period—their delay proportion was 0.321. Conversely, their proportion of *productive* work time was (1-0.321) = 0.679.

Their aggregate total working time per hour was 180 man-minutes. This total, when adjusted to allow for two 10-minute rest periods per 8 hours (not counted as a delay in the ratio-delay studies), reduces to 172.5 minutes of total available work time per plant-hour. A further adjustment by the proportion of productive work, p = 0.679, gives an estimate of 117.2 minutes of productive dumper time per hour.

During the 4-day period, the average rate at which field lugs were dumped (as reported in the plant records) was 837 lugs per hour of plant operation. The productive time per work unit (in this instance, dumping one field lug) then is: productive time = 117.2/837 = 0.140 minutes per lug.

Within the limits of accuracy of the ratio-delay proportion, this represents the average time required per work unit, excluding time lost through delays, equipment breakdown, rest period, and so on.

The foregoing computation leads to another comparison of results derived from ratio-delay proportions with data obtained by direct measurement. In nine of the packing houses the time required for

TABLE 1.—*Comparison of delay percentages observed by ratio-delay and production-study methods*

Plant	Type of delay	Job	Production study: delay proportion	Ratio-delay study: Delay proportion	Number of observations	Estimated standard error S_p
A	BFL[1]	Set-on	0.174	0.167	67	0.046
A	BFL	Dumper	.174	.167	67	.046
A	BFL	Sorter	.174	.197	67	.049
B	Conveyor stopped	Lidder	.157	.184	49	.055
B	BFL	Dumper	.031	.038	52	.026
C	BFL	Set-on	.269	.218	78	.047
C	BFL	Dumper	.269	.239	78	.051
C	BFL	Sorter	.269	.251	78	.049

[1] BFL = Break for lots.

dumping field lugs was obtained directly by time study. The average times thus estimated are compared (table 2) with average times derived from the ratio-delay proportion in the manner described above. The two sets of estimates of average dumping times are reasonably consistent but some qualifications must be noted. Neither estimate is, in any sense, an absolutely true value. The ratio-delay proportion is subject to sampling errors, as is the time-study average. If it is granted that reasonably consistent estimates were obtained by each method, it still must be recognized that the time-study observations were confined to an operating period of only 10 to 20 minutes and to a single dumper per plant. The ratio-delay observations, on the other hand, are the aggregate of observations made during a period of 3 or 4 days in each plant and, for the plants having more than one dumper, the summaries represent the aggregate of observations on all the dumpers.

In the above situation, considerable variation might be expected between the rates of operation—and, hence, the observed average times per work unit—existing during a 10- to 20-minute time study and the average for a 3- or 4-day period. One might also expect to find variation in the rate of operation by different dumpers in the same plant. The likelihood of such variation is greatly reduced by the circumstances applying to the dumping job. An essential requirement is to maintain an even flow of fruit to each sorting and packing line. This means that the dumper is "line paced" and that his rate of operation must be approximately uniform so long as the rate of line operation does not vary appreciably. A fairly uniform rate of operation per line over several days is not uncommon. In fact, in some packing plants a mechanical timer is employed to regulate the rate of work of the dumper.

MATERIALS-HANDLING PATTERN.—The objective in this application of the ratio-delay study was to obtain a quantitative description of how the fruit and packing materials were transported within the plant. The data desired were the proportion of total trips in a given category that occurred over each transport route, the number of units transported per trip, and the number of times each unit of material was moved before final disposition.

The application of ratio-delay procedures is illustrated by reference to the observations on the receiving of incoming fruit at a pear-packing plant. The work consists of unloading palletized lots of

TABLE 2.—*Comparison of unit-time requirements for dumping field lugs as ascertained from plant-output data and ratio-delay data*

Plant	Number of observations	Ratio-delay proportion	Estimated standard error of proportion S_p	Estimated average productive time per work unit: From ratio-delay	From time study
A	252	0.329	0.030	0.138	0.140
B	87	.103	.033	.082	.078
C	104	.077	.026	.162	.153
D	300	.010	.006	.155	.156
E	98	.041	.020	.163	.156
F	164	.143	.028	.245	.237
G	41	.122	.051	.094	.095
H	138	.109	.026	.251	.251
I	276	.119	.029	.165	.127
J	72	.111	.037	.143	.137

full field lugs, using fork-truck equipment, and transporting them to a sampling station, or to a temporary storage, or directly to the dumping station (fig. 3). The work area was divided into numbered zones for convenience in recording. Each fork truck was treated as a separate observation unit and a data sheet was prepared for each unit. Similar arrangements were made with respect to other trucking jobs in the plant and an observation route was laid out in the way described in discussing the general procedures in ratio-delay studies.

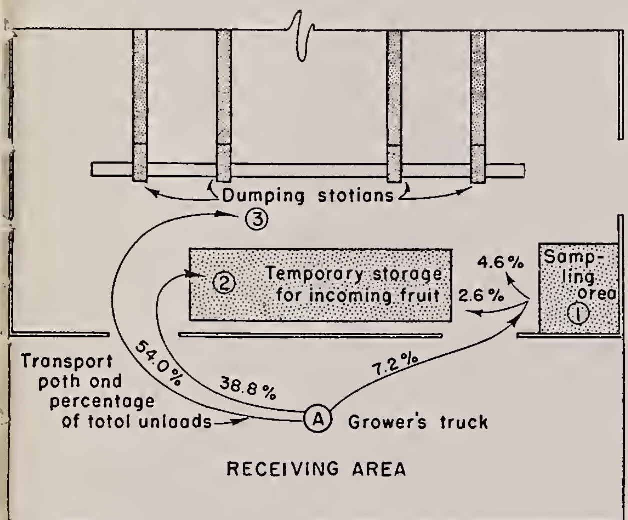

FIGURE 3.—Lay-out of packing-house receiving area, with transport paths for unloading growers' trucks and percentage of total unloads in each path.

On each tour of the observation route the observer made "instantaneous" ratio-delay observations by which each fork truck was classified as "working" or "not working." If a fork truck was working, the observer also noted the load being carried and the transport path followed. These data were recorded systematically by truck and by transport path (fig. 4). In this study 350 observations were made on the entire receiving operation. There were 324 of these in a "working" category; 126 of them applied to removing pallets from growers' trucks and transporting them to a sampling station, or to a temporary storage, or directly to a dumping station. The ratio of observations in each transport path to the total observations on removing pallets from the growers' trucks provides a description of the transport pattern. Thus, it is estimated that 7.2 percent of the total pallets unloaded were transported to the sampling station, 38.8 percent to the temporary storage, and 54.0 percent directly to the dumping station. All the pallets placed in temporary storage (38.8 percent of the total received) required two separate movements before reaching the dumping station.

Plant. A			Observer. ET			Date: 8-1-50			
Transport path		Material trans-ported	No of units per trip	OBSERVATIONS					
				WORKING	NOT WORKING			W'k'r not obs'v'd	W'k'r, other work
From	To				Waiting	Service truck			
A	1	Field lugs	36	IIII					
A	2	Field lugs	36	卌 卌 卌 III					
A	3	" "	36	卌 卌 卌 卌 卌					
—	—				卌 I	II			卌 II

FIGURE 4.—Data sheet for estimating materials-handling pattern from ratio-delay observations.

Sampling Procedures and Reliability of Estimates

The preceding illustrations from actual plant studies indicate that estimates can be based on ratio-delay proportions that are reasonably consistent with estimates based on direct measurement. But more rigorous tests as to reliability are needed. The objective of the ratio-delay procedure is to estimate the proportion of the elements in a population that possesses a given characteristic. This resolves into a statistical problem of sampling for attributes possessed by elements of the population, rather than for value measurements of these elements, and estimating the true proportion from the proportion observed in the sample.

Statistical Properties of a Sample Proportion

In samples of n random and independent observations drawn from a given population, the proportion, p, which possesses a certain attribute is a random variable which follows the binomial probability law. It can be shown that the average (expected) value of p for an indefinitely large number of random samples of size n is equal to π, the probability that a given observation will possess the attribute, and the variance of p is $\frac{\pi(1-\pi)}{n}$. For finite populations sampled with replacement, π would represent the proportion in the population possessing the attribute. Replacement restrictions can be eliminated without serious error if the population is absolutely large and the sample is relatively small.

Because the evaluation of the discrete probabilities of the binomial distribution is extremely tedious for large values of n, the distribution of p is frequently approximated. The normal distribution is appropriate when it can be assumed that $n\pi$ is greater than 5, (*3*). Or, in cases when $n\pi \leqq 5$ can be assumed and n is large, the Poisson distribution is a satisfactory approximation. The normal approximation has theoretical validity, since it is the limiting form of the binomial distribution as n becomes infinitely large. The limit is approached most rapidly when $\pi = 0.50$, and least rapidly when π is near zero or one. The use of the normal approximation for problems of the type considered in this paper generally results in oversampling. Much of what follows is based on the assumption that p is normally distributed with mean equal to π and variance equal to $\frac{\pi(1-\pi)}{n}$, that is, $E(p) = \pi$ and $\sigma_p^2 = \frac{\pi(1-\pi)}{n}$

Certain probability statements may be made about p for a given value of π and a given sample size n. For example, we may say that the probability that p differs from π by not more than $t_\alpha \sigma_p$ is equal to α. Symbolically, this is written as

$$P[-t_\alpha \sigma_p \leqq p - \pi \leqq t_\alpha \sigma_p] = \alpha \qquad (1)$$

in which t_α is found in a table of central areas under the normal curve for a given value of α. The use of $S_p = \sqrt{\frac{p(1-p)}{n}}$, as in tables 1 and 2, for σ_p gives fairly reasonable approximations to probability statements for testing the reliability of a proportion in a sample of a given size, provided n is large. A few of the commonly used values of α and the corresponding values of t_α are:

α	t_α
.68	1.000
.90	1.645
.95	1.960
.99	2.576

Suppose we are interested in knowing how large n should be, *for a given value of* π, such that $P[-\theta \leqq p-\pi \leqq \theta] = \alpha$ where θ is a preassigned admissible error and α is the desired probability level. From equation (1) it is evident that the value of n must be such that

$$\theta = t_\alpha \sigma_p = t_\alpha \sqrt{\frac{\pi(1-\pi)}{n}}$$

The solution for n is

$$n = \frac{t_\alpha^2 \, \pi(1-\pi)}{\theta^2} \qquad (2)$$

Note that n increases directly with the desired probability level (since t_α increases with α) and reaches a maximum when $\pi = 0.50$ for any given values of θ and α. The above expression for n assumes a knowledge of the value of π, but in any practical problem, π is unknown; hence a satisfactory basis for estimating the required sample size is not provided. A more valid approach follows.

Interval Estimation of π and Its Use in Formulating a Procedure for Sampling (*4*).—Our basic problem is to devise a procedure for sampling which will assure a sample size sufficient to satisfy the requirement $P[-\theta \leqq p-\pi \leqq \theta] \geqq \alpha$ for desired values of θ and α. This problem is solved by means of the concept of an interval estimate of π. The solution for the desired sample size is given by

$$n = \frac{t_\alpha^2 (\theta + p')(1 - \theta - p')}{\theta^2} \qquad (3)^7$$

with the details of the development in the Appendix (page 133).

Equation (3) permits us to compute the required value of n for possible alternative values of p. The (A) section of figure 5 shows the solutions of equation (3) in graphic form for $\theta = 0.05$ and selected values of α. The (B) section of figure 5 shows graphic results for $\alpha = .95$ and selected values of θ. These charts give the paired values of n and p necessary to satisfy conditions postulated by assigned values of θ and α.

Several procedures, varying as to details, may be followed in the use of figure 5 to draw samples which have the required paired values of n and p. In one method, the observer takes an initial sample of n_o observations, where n_o is the value of n when $p' = 0$, i.e., when $p = 0$ or 1. For example, if $\theta = 0.05$ and $\alpha = .95$, then n_o, from figure 5, is 73.[8] If this initial sample actually results in $p = 0$ or 1, no larger sample is required. If $p \neq 0$ or 1, the observer notes from figure 5 the sample size corresponding to the preliminary sample proportion and takes additional observations to obtain the total sample size indicated. This does not assure that the total sample size and the value of p obtained thereby will exactly satisfy the conditions set by θ and α, unless the final value of p is the same as

[7] $p' = p$ when $p \leqq \frac{1}{2}$, and $p' = 1 - p$ when $p \geqq \frac{1}{2}$.

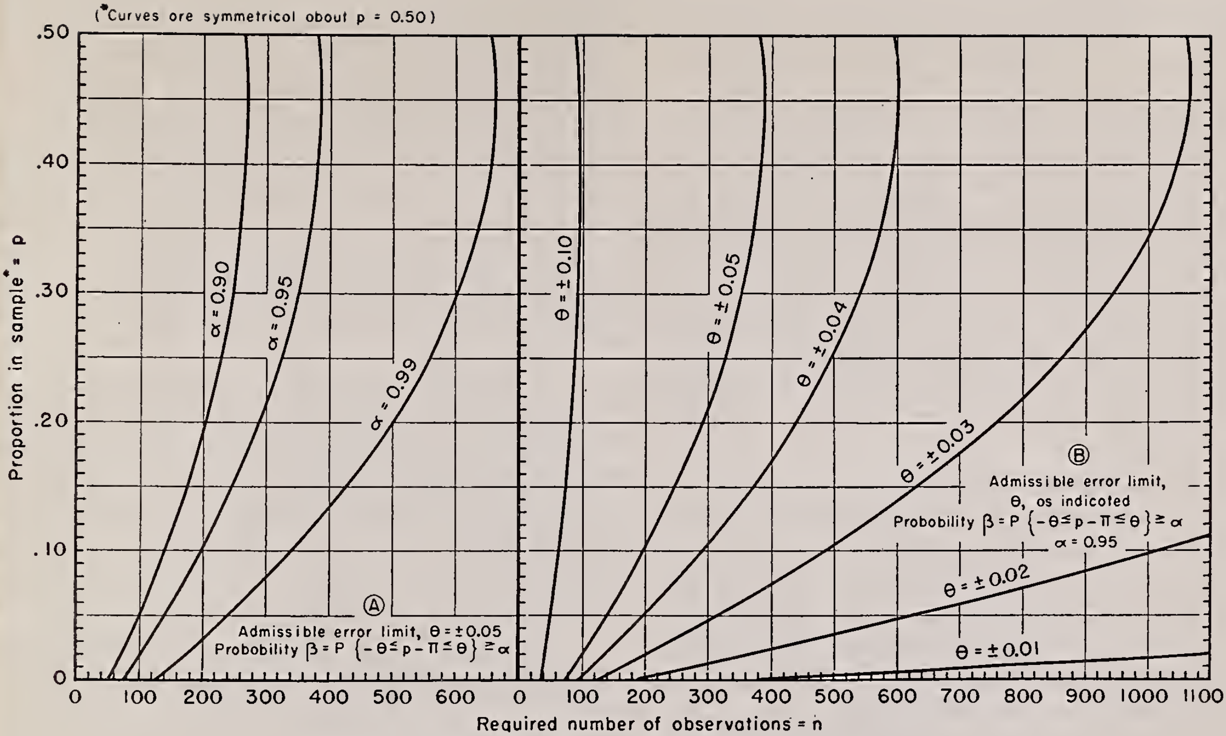

FIGURE 5.—Number of observations required to obtain ratio-delay proportions with given limits of error and stated probability.

the preliminary value obtained from the n_o observations. However, with n_o fairly large, as it usually will be, the final sample size which results will ordinarily be very near to the actual requirement, being over or under by a small number.

A second method may be followed which begins, as above, with the observer taking the required n_o observations and stopping at this point, if $p = 0$ or 1. If $p = 0$ or 1, he continues sampling and computing p until he obtains for the first time a sample proportion for which the required n, as given by figure 5, is less than the n actually supplied. In reaching this last observation a "one-by-one" sequence need not be followed throughout, but only in the neighborhood of the indicated final n. For earlier proportions of the sampling sequence, the computation of the sample proportion and a check of the required n need be made only at intervals. For example, if the initial sample indicated a need for 300 observations, a second check might be made after 50 or 100 additional observations—or a check might be made at the end of each day's study. The size of these increments of observations could be progressively decreased as the final n was approached.

ESTIMATING SUBCLASS PROPORTIONS.—The theoretical discussion thus far has been limited to the simple case of a proportion of one attribute relative to all the elements in a given population. This was the situation in our earlier example of estimating the delay proportion, π_d, at a dumping station, with respect to total time. But in some instances we are interested in a proportion relative to some subclass within the total population. This was true for our illustration of activity at the receiving station of a pear-packing plant where we were interested in proportions relative to the "working" subclass, or to the secondary subclass "unloading grower's trucks."

In a generalized form this situation is one in which a worker (or set of similar workers) has mutually exclusive jobs A, B, . . . , N which he does while actively working. We are interested in estimating π_{W_A}, the proportion of the "working" time

[8] Values of n_o for certain other levels of θ and α may be obtained from figure 5, or n_o may be computed from the equation,

$$n_o = \frac{t_\alpha^2 (1 - \theta)}{\theta}$$

spent in working on job A, and our sample estimate is $p_{w_A} = \frac{n_{w_A}}{n_w}$, where n_{w_A} and n_w are respectively the number of "working on A" and "working" observations in the sample.

The essentials of the sampling design for the subclass can be stated very simply. Proportions within the subclass will be defined in terms of the number of subclass observations rather than the total sample. The observer employs figure 5 to estimate n_w, the number of observations required in the subclass. As before, he will continue to sample until the indicated number of subclass observations is obtained.

In planning the sampling procedure for a subclass, a forecast of the probable size of the total sample may be wanted. A basis for making such an estimate is developed as follows. Since n_w is not a fixed number for samples of constant size, unless $\pi_d = 0$, we cannot be certain of the required size of our total sample if we desire $P\ [-\theta \leqq p_{w_A} - \pi_{w_A} \leqq \theta] \geqq \alpha$ for given values of θ and α.

The size of the initial sample necessary to secure n_{w_0} observations in the "working" category could be estimated from the sample when it grew to perhaps 100 observations in total size. At this point we could estimate π_w and its complement $\pi_d = 1 - \pi_w$, from the sample values of p_w and p_d. Without presenting the basis for the following, we could say that the expected size of the initial sample, n_o, required to reach the necessary value of n_{w_0} would be given approximately by[9]

$$n'_o = \frac{n_{w_0}}{p_w} \qquad (4)$$

with an approximate estimated standard deviation, s_{n_o}, of

$$s_{n_o} = \sqrt{\frac{n_{w_0} p_d}{p_w}} \qquad (5)$$

Assuming a normal distribution for the size of the initial sample, we could say that there was only about a 1-percent chance that the size of the initial sample would exceed

$$n''_o = \frac{n_{w_0}}{p_w} + 2.236 \sqrt{\frac{n_{w_0} p_d}{p_w}} \qquad (6)$$

When n_{w_0} was reached, we would proceed to determine the final size of n_w, as in the simple case.

[9] The negative binomial probability law is the basis for this development. Equations (4) and (5) are only sample estimates of $E\ (n_0)$ and σ_{n_0} formed by substituting p's for π's in the population expressions.

Also at this point we could recalculate p_w and p_d as estimates of π_w and π_d and proceed as above to estimate the expected size of our final total sample and its approximate practical upper limit. To do this we would use the new values of p_w and p_d, as well as the estimate of the desired final size of n_w, and by means of equations (4) and (5) estimate the expected size and standard deviation of the final sample size. The practical upper limit would be found by substituting these values in equation (6).

In conclusion, it might be stated that under conditions when π_w is smaller than 0.50, the final situation will require exceedingly large total samples as this proportion approaches zero. It can also be stated that the final sample size will become fairly large when π_{w_A} is near 0.50 even when π_w is greater than 0.50. Tables 3 and 4 illustrate these statements in an approximate way.

One might want to estimate a proportion relative to a category one stage below that just considered.

TABLE 3.—*Estimated average size and practical upper limit of the initial sample in a subclass proportion problem* ($\theta = \pm 0.05$, $\alpha = .95$)

p_{w_s}*	n_{w_0} required	Estimated average size	Estimated size with about 1% probability of being exceeded
.90	73	81	88
.50	73	146	174
.10	73	730	919

* p_{w_s} is proportion of "working" observations calculated when initial sample has become fairly large, prior to reaching $n_w = n_{w_0}$. Values given in table are only assumed for illustrative purposes.

TABLE 4.—*Estimated average size and practical upper limit of the total sample in a subclass proportion problem* ($\theta = \pm 0.05$, $\alpha = .95$)

p_{w_A}*	p_w**	Estimated final n_w required	Estimated average size	Estimated size with about 1% probability of being exceeded
.10 or .90	.822	196	238	255
.20 or .80	.822	289	352	373
.45 or .55	.822	385	469	495

* p_{w_A} is the proportion, *in the initial sample*, that the "working on A" observations are of the "working" observations.

** p_w is the proportion, *in the intitial sample*, that the "working" observations are of the total.

(Values given for both these proportions are assumed only for illustrative purposes.)

The procedures already given could be generalized to cover such cases. A total sample of exorbitant size would be required unless the subclass could be isolated and reduced to a simpler case. If this is not feasible, procedures other than the "ratio-delay" method could be used—that is, time or production studies.

Some Practical Considerations

In the application of the ratio-delay method to plant studies, there are numerous practical considerations. Some of these are noted below.

The effectiveness of the sampling design will depend on how fully it is possible to anticipate all categories in which estimates are wanted, including estimates relating to subclasses. The critical effect of these "anticipations" on the sampling design emphasizes the importance of the initial step in the ratio-delay study—the analysis of activity in each job category.

A sequential sampling procedure, or some adaptation of it, may be advantageous in conducting the observation tours of the plant, suggested earlier as a suitable field procedure. In regular tours of a plant, different delay proportions probably will be observed at each station and the total number of tours required will be determined by the station having the proportion requiring the largest n; also by the aggregate number of observations per tour that are obtained in a particular job category. It is probable that the necessary n will be attained at some stations sooner than at others. If such a station—or a group of stations—can be deleted from the observation route with appreciable saving in the observation time, the field time will be reduced, and it may be possible to obtain more complete data by focusing more quickly on operations that require greater accuracy or more detailed data.

In ascertaining delay proportions, the ratio-delay method usually will be less costly to apply than either the production-study or time-study method. In the plant studies here cited, for example, the field time required in the ratio-delay study is estimated to have required 80 percent less time than would have been necessary to obtain a one-day production study of each job. This estimate is greater than has been reported in other studies; estimated savings of 33 to 70 percent have been noted in other reports (*5*), (*6*), (*8*).

The ratio-delay sample may be more representative than a time study or a production study, for it may easily be composed of an aggregation of observations taken over a period of days or weeks (assuming no essential changes in the plant organization or working conditions during the period of observation) and thus may reflect typical conditions more accurately than would isolated time studies or a production study confined to one day.

If made on a department or plant-wide basis, the ratio-delay study can provide, in a sense, a simultaneous measure of delay at all points and so is an excellent device for indicating how effectively plant operations are integrated, and at what points improvements in work methods to eliminate delays would be most beneficial. These relationships would not be so clearly revealed by a succession of isolated production or time studies.

The ratio-delay data may be less biased than the production- or time-study data from the standpoint of the worker's reaction to observation, since the worker is under observation in the ratio-delay study for very short periods. Even so, in the particular study referred to in this paper, some worker reaction was noted in a few instances. The reaction usually was in the nature of a make-work tendency. An experienced observer, however, can offset abnormal worker reaction: For example, he can obtain a "flash" observation on entering the work place; he can make his observation after having passed the work place; or he can observe from across the plant.

The ratio-delay method shares a common handicap with the production- and time-study techniques—that is, the bias introduced by the rate at which a particular individual works. It is conceivable, and not unlikely, that delay time is observed for some individuals whose output is governed by a production line only because they work at an abnormally rapid rate and thus work themselves out of a job. Conversely, the bias for a slow worker would be in the other direction. Owing to the nature of the ratio-delay study, any such bias appears difficult to eliminate. But if observations on several workers are aggregated to obtain the ratio-delay proportion, the effect of rate-of-working by an individual would tend to average out.

Appendix

Sample Size Based on the Interval Estimate of π

An interval estimate of π can be made whenever we can find two functions of our sample observations which are independent of the specific value of π, and for which there is a pre-assigned probability α, that the interval formed by these two functions will include the unknown but fixed value of π. The length and position of such intervals will vary from sample to sample; but for an indefinitely large number of samples, α proportion of them will cover π.

Let $L_{1\alpha}$ and $L_{2\alpha}$ be the desired functions; then $(L_{1\alpha}, L_{2\alpha})$ will be the confidence interval for π. We shall now determine the general formulas for $L_{2\alpha}$ and $L_{1\alpha}$, under the normality assumption. Starting with the probability statement,

$$P\left[-t_\alpha \sqrt{\frac{\pi(1-\pi)}{n}} \leqq p-\pi \leqq t_\alpha \sqrt{\frac{\pi(1-\pi)}{n}}\right] = \alpha,$$

we can transform it to the equivalent statement,

$$P\left[n(p-\pi)^2 - t_\alpha \pi (1-\pi) \leqq 0\right] = \alpha. \quad (2)$$

Setting the expression inside the brackets in equation (2) equal to zero, we may solve for π in terms of n, p, and t_α to obtain,

$$\pi = \frac{(2np + t_\alpha^2) \pm t_\alpha\sqrt{t_\alpha^2 + 4np(1-p)}}{2(n + t_\alpha^2)}$$

In the above equation, let the value given with the positive and negative roots of the radical be respectively $\pi_{2\alpha}$ and $\pi_{1\alpha}$. For all values of π between $\pi_{1\alpha}$ and $\pi_{2\alpha}$, $n(p-\pi)^2 - t_\alpha \pi (1-\pi)$ is less than zero. Therefore, our original probability statement is equivalent to

$$P\left[\pi_{1\alpha} \leqq \pi \leqq \pi_{2\alpha}\right] = \alpha$$

and the interval $(\pi_{1\alpha}, \pi_{2\alpha})$ is our confidence interval for π with level of probability α. This proves that the functions $L_{2\alpha}$ and $L_{1\alpha}$ are given by $L_{2\alpha} = \pi_{2\alpha}$ and $L_{1\alpha} = \pi_{1\alpha}$.

In connection with our basic problem, if we set $L_{2\alpha} - p = \theta$ or $p - L_{1\alpha} = \theta$ depending on whether $p < \frac{1}{2}$ or $p > \frac{1}{2}$, and solve the resulting expression for n, we will secure the sample size which will satisfy the requirement of

$$P\left[-\theta \leqq p-\pi \leqq \theta\right] \geqq \alpha.$$

It can be shown that p will always be contained in the interval $(L_{1\alpha}, L_{2\alpha})$, or in cases when $p = 0$ or 1 it will be one of the end points. For $p < \frac{1}{2}$, $L_{2\alpha}$ is farther from p than $L_{1\alpha}$ for a given value of n and α, and vice versa for $p > \frac{1}{2}$. Because of symmetry, $L_{2\alpha} - p'$ is equal to $(1-p') - L_{1\alpha}$ for $p' \leqq \frac{1}{2}$ where $L_{2\alpha}$ is computed for $p = p'$ and $L_{1\alpha}$ is computed for $p = 1 - p'$, for fixed values of n and α. The expression for $L_{2\alpha} - p'$ is given by

$$\frac{t_\alpha^2(1-2p') + t_\alpha\sqrt{t_\alpha^2 + 4np'(1-p')}}{2(n + t_\alpha^2)}$$

The solution for n is,

$$n = \frac{t_\alpha^2(\theta + p')(1 - \theta - p')}{\theta^2}$$

References

(1) Bressler, R. G., Jr.
1945 RESEARCH DETERMINATION OF ECONOMIES OF SCALE. Jour. Farm Econ. v. 27, no. 3.

(2) Tippett, L. H. C.
1935 STATISTICAL METHODS IN TEXTILE RESEARCH, USES OF BINOMIAL AND POISSON DISTRIBUTION, A SNAP READING METHOD OF MAKING TIME STUDIES OF MACHINES AND OPERATIVES IN FACTORY SURVEYS. Textile Inst. Trans. Jour. v. 26.

(3) Hoel, Paul G.
1945 INTRODUCTION TO MATHEMATICAL STATISTICS. New York, John Wiley and Sons.

(4) Wilks, S. S.
1949 ELEMENTARY STATISTICAL ANALYSIS. Princeton, N. J., Princeton University Press.

(5) Schaeffer, E. H.
1941 OBSERVATION RATIOS. Factory Management and Maintenance. v. 99, no. 7.

(6) Barnes, Ralph M.
1949 MOTION AND TIME STUDY. New York, John Wiley and Sons.

(7) Morrow, R. L.
1946 TIME STUDY AND MOTION ECONOMY. New York, Ronald Press.

(8) Correll, Donald S., and Barnes, Ralph M.
1950 INDUSTRIAL APPLICATION OF THE RATIO-DELAY METHOD. Advanced Management. v. 15, nos. 8 and 9.

Rural Zoning in Transition

By Erling D. Solberg

Rural zoning is in a period of rapid growth and development. New types of regulations and zoning techniques are emerging to cope with the new problems and goals stemming from the impacts of change in our rural communities. A study was made to find out the nature and extent of rural zoning and the probable trends. The extensive results of this research, on which this article is based, will be published later as a Department publication.

ZONING ORIGINATED and developed in crowded cities. Its basic regulations were designed for urban ends. Pioneers in the field of rural zoning took these basic raw materials and shaped them to serve the rural community. In the early twenties, in Wisconsin and in a few other States, rural communities began to adopt zoning techniques for protecting rural values on that day's more restricted urban fringe. During the following decade, they established forestry and recreational districts to help bring order out of land-use chaos in the cut-over areas of the North Central States. More recently, in the open country and on an expanded urban fringe, which sometimes extends 30 to 50 miles beyond city limits and often overlaps fringe areas of neighboring cities, many rural communities are exercising zoning powers to guide residential growth, to assign commercial and industrial activities to designated areas, and to preserve the safety and carrying capacity of their highways.

The process continues. Rural zoning is in a period of transition. From today's zoning laboratories—the State legislatures and local zoning agencies—through a process of adaptation and innovation, new types of rural zoning regulations and techniques are emerging to cope with problems of our changing rural communities. The very number and diversity of these experimental agencies alone foreshadows further change.

Rural people in increasing numbers are recognizing the value of rural zoning as one available regulatory measure for protecting their community and for guiding its growth. They have been asking for information on how zoning can be helpful in coping with new problems. They want to know how rural zoning has been used in other States and counties.

Enabling Laws

The future value of rural zoning to our changing rural communities may depend as much, or more, upon the development and use of new zoning devices as upon the exercise of conventional regulations. For that reason, a library study was made of all enabling laws authorizing zoning outside the limits of incorporated municipalities. In total, 175 such laws in 38 States were found. Of these, 102 in 31 States empowered a total of 1,165 counties to zone; 50 in 12 States authorized towns or townships to adopt ordinances; and 23 pertained to other units of local government (fig. 1).

The main provisions and powers conferred by each enabling law were summarized and tabulated for ready comparison. Tabulation was facilitated because two model enabling laws were found to have materially influenced the drafting of most of the statutes. The legislatures, using these standard acts as a base, selected provisions at will. They accepted some, rejected others, and added a host of their own. New adaptations and innovations, the mutations of zoning, were carefully noted and are discussed later.

Local governments get their power to zone from their respective State legislatures. This power is conferred in zoning enabling laws, which merely empower the counties, towns, or other units of local government, to adopt zoning ordinances. These governments, at their discretion, may exercise the powers granted or they may decline to act. If a community decides to zone, the ordinance must come within the framework of its enabling law which governs the areas that may be zoned and the types of regulations that may be imposed. In this respect the enabling laws vary considerably.

Before proceeding further, it will be helpful to define zoning and to examine briefly the types of

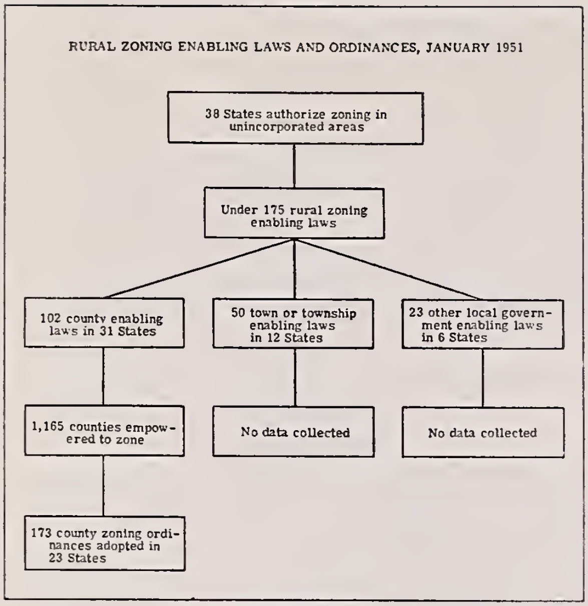

Figure 1.

regulatory powers embraced by that term. Zoning is the regulation by districts of the height, bulk, and use of buildings, the use of land, and the density of population. The term embraces a bundle of differing but related types of controls. It involves four major types of directives—use, site-area, building-dimension, and density of population. Each of the four is composed of several separable parts. For example, use regulations are sometimes imposed only in suburban-type districts—residential, commercial, and industrial — or only in open-country zones—agricultural, forestry, and recreational. Or, as is often the case, they are imposed in districts of both types. There may be multiple variations of permitted or prohibited uses in such districts.

Similarly, site-area regulations may control the minimum size of lots or tracts, the percentage of the tract that may be occupied by buildings, the size of side or rear yards, and the set-back of buildings from roads. Building-dimension restrictions may control the height, size, bulk, kind, and number of stories, and design of buildings, or only some of these. Density-of-population regulations may limit the number of families permitted per tract, or prescribe in square feet the minimum areas of ground or floor space required per family.

Zoning measures that are exercised in the interest of public health, safety, morals, and the general welfare, have been held a valid use of the communities' police powers in a long line of decisions in both Federal and State courts. But the validity of a proposed zoning regulation in each jurisdiction must be considered in light of enabling authority conferred, and of Federal and State constitutional limitations.

County Zoning Ordinances

Only county zoning ordinances were examined, and a complete coverage of these was not feasible. Zoning officials in counties that had zoned were communicated with and a copy of their ordinances was requested. Responses from counties in California, in the Northern Lake States, and in a half-dozen other States, were gratifying. A number of ordinances were obtained from libraries of Federal agencies. In all, copies of zoning ordinances were obtained for one or more counties in 17 of the 23 States that had zoned at the time of the study. These comprised slightly more than 40 percent of the 173 ordinances then in effect.

The character of zoning powers exercised in the county zoning ordinances that were examined varies materially. Four main types of ordinances were found. These were rural comprehensive, suburban comprehensive, rural use, and open-country use. The first two of these types of ordinances embody regulations of all four of the classes previously mentioned—use, site-area, building-dimension, and population-density. Rural comprehensive ordinances were the most numerous and comprised 35 of the 71 ordinances diagrammed in figure 2. Four ordinances were of the suburban comprehensive type. Only use regulations are effected by the 19 open-country use ordinances examined. The same is also true of some of the 13 ordinances of the rural-use type, but a few in this class add site-area regulations, or they impose set-back lines.

The most important function of zoning — the regulation of the use of land, buildings, and structures—is effected by dividing the areas to be zoned into use districts in which certain uses are permitted, sometimes conditionally; and in which others are prohibited. Use districts established by the ordinances examined are of six main classes: Residential, commercial, industrial, agricultural, forestry-recreational, and residual. Each main class embraces several subclasses. The agricultural class includes general agricultural, residential-agricultural, and country-home districts. Fifty percent

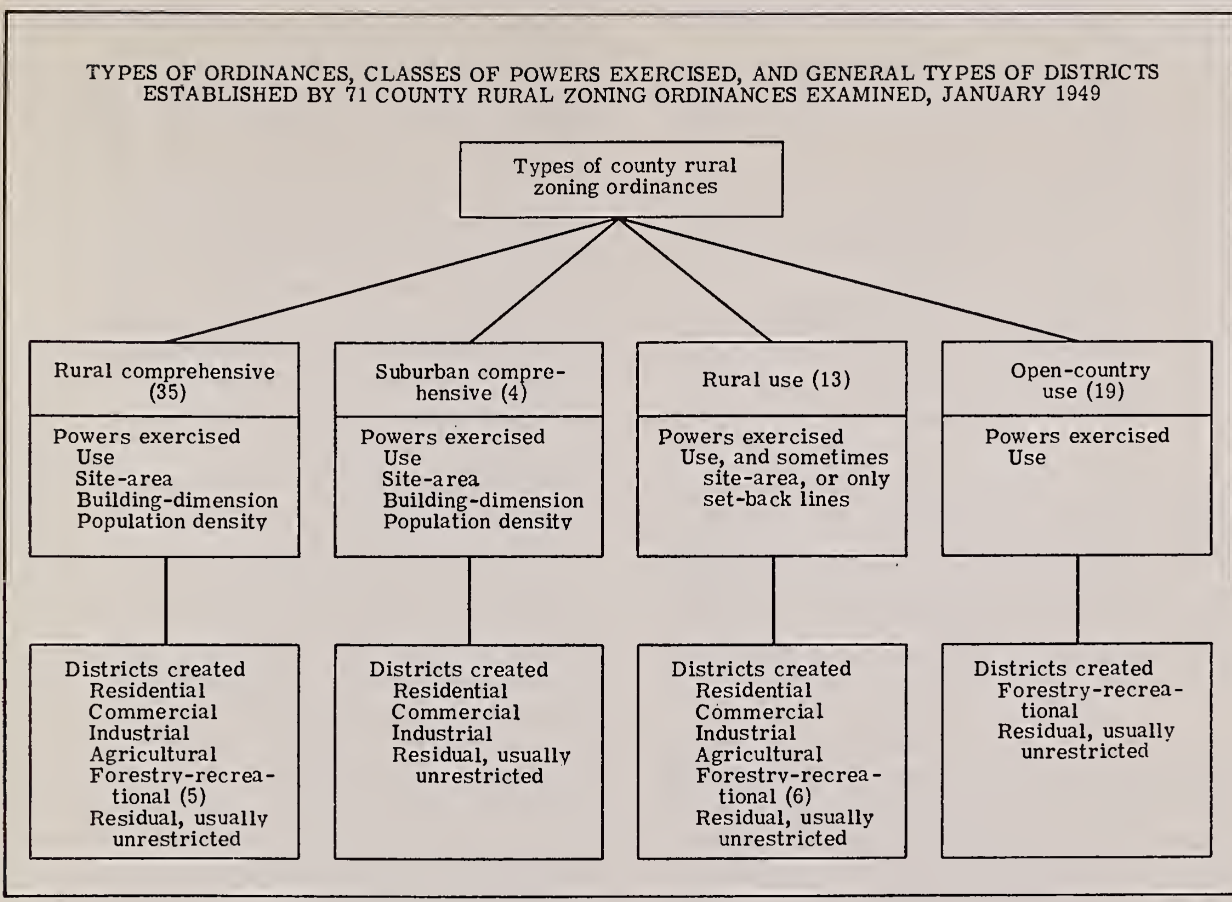

Figure 2.

of the ordinances examined provide for general agricultural districts.

Ordinances classified as rural comprehensive and as rural use, usually create types of zoning districts embraced by five of the six main classes of districts. The exception is the forestry-recreational type districts, which type was established by only 5 of the rural comprehensive ordinances examined and by 6 of the 13 rural-use ordinances. Four main classes of districts were created by the suburban comprehensive ordinances. The open-country-use ordinances established only forestry or recreational districts, or both.

Readers are cautioned that the name given a particular type of district in an ordinance is not always indicative of all the classes of uses permitted in such district. Rather, it generally is descriptive of the least restricted class of use in the entire array permitted in such zone. Under many ordinances, districts of less restricted uses admit the uses of the more restricted zones. Uses permitted in each succeeding district in the array from the most to the least restricted are cumulated. For example, in the residential districts having highest restrictions, only homes and accessory uses are permitted; in the agricultural districts, homes plus farming; in the commercial districts, homes plus farming, plus trade; and so on (fig. 3).

Each zoning ordinance, in addition to dividing the areas zoned into districts, usually lists the general kinds and the specific uses that are permitted, conditionally permitted, or prohibited, in each type of district. Multiple variations are found. Such uses that are enumerated in the county ordinances we examined that pertain to the three classes of agricultural zoning districts are of nine types: Residential, agricultural, agricultural-industries, recreational, commercial, public and semipublic, public utility, mining and related activities, and general industrial uses. Very few zoning restrictions on farming activities in general agricultural districts are found, except for those that apply to gar-

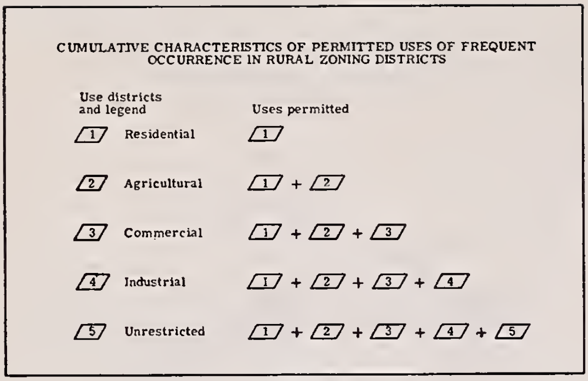

Figure 3.

bage-feeding farms, to hog ranches, and to livestock-feeding and sales yards. One or more enabling laws in each of 17 States exempt agricultural activities from zoning regulations. As interpreted in a few States, such exemptions do not apply to tracts that contain 5 to 10 acres or less.

Future of Rural Zoning

What does the future hold for rural zoning? The answer will depend upon several considerations. Rural zoning will be furthered by a fuller appreciation of the the fact that the basic raw materials of zoning—the types of permissible regulations—were urban-created; that such urban-created devices cannot be transplanted, without reshaping, to a rural setting and be expected to flourish. Instead, they may wilt and die. The future of rural zoning will be advanced by apprising rural people that zoning is not a single package that must be acepted or rejected as a unit, but that zoning embraces differing but related types of controls; that these controls may be exercised individually or in groups; and that they may, and preferably should, be modified and reshaped so as to best serve the rural community.

The growth of rural zoning will be promoted by a widespread realization that the benefits from some types of zoning regulations are primarily local, while from others the benefits accrue to the locality as a whole or to society generally, with lesser or even no advantage to landowners or occupants in the zoning unit. Moreover, rural zoning would be furthered by a general recognition of the limitations of local government for administering types of zoning regulations whose benefits are largely nonlocal. In such cases, administration by higher levels of government would be more effective. Finally, and most of all, the future of rural zoning will depend on the adequacy of prezoning research and on the ingenuity of zoning officials in reshaping urban-created legal devices and in designing new zoning regulations and administrative techniques to cope with new rural zoning problems. To be effective, types of zoning regulations and agencies selected must be suitable and adequate to achieve the desired goals.

The task of devising new zoning directives and techniques is largely one of adapting and expanding what is authorized or has been done under existing enabling laws or ordinances to new and wider zoning ends. In the remaining paragraphs a few avenues of adaptation are suggested. Others may occur to readers.

Roadside Zoning.—Roadside-zoning regulations aim to preserve the safety and traffic-carrying capacity of the highways. Typical regulations include restrictions or prohibitions on commercial uses and outdoor advertising, and off-street parking, set-back, and access controls. Their benefits accrue primarily to the general public. In fact, the interest of an owner of land adjoining the road often conflicts with the interest of the traveling public. In contrast to the incidence of benefits, authority to impose roadside-zoning regulations is usually vested in local units of government. The exercise of roadside-zoning powers, when granted, is often limited functionally by restrictive enabling laws; is necessarily limited geographically by the community's boundaries; and is frequently limited administratively by meager budgets and in response to individual and group pressures stemming from a divergence of interest between landowners.

Problems growing out of the absence of roadside zoning or from inadequate regulations are evident in many rural communities. Merely to empower counties or towns to zone apparently is not enough. The result too often on Federal and State highways is good zoning in a few communities, inadequate controls in others, and none in many; although the needs are the same in all. Examples are also common of the attrition of local interests causing a gradual break-down of locally imposed zoning regulations, particularly along new arterials. The larger public interest suffers. Greater uniformity of roadside-zoning regulations, both geographically and chronologically, is sorely needed.

The problem and challenge is one of redesigning traditionally local zoning regulations and techniques so as to achieve a workable compromise between local and State-wide interests. Ways need to be found to reconcile this conflict of interest and to make administration more responsive to the structure of zoning benefits.

In this field there is a need for both research and education. Certainly, attention must be paid to local desires and needs, and at the same time wider public ends must be served. Some legislative experimentation directed toward these goals has occurred. In addition to the usual provision in enabling laws that requires zoning regulations to be preceded by and based on comprehensive planning, a few statutes are found that prescribe minimum set-back lines along roads, if the community zones; require local governments to adopt regulations of a specified character; or authorize State agencies to veto local roadside ordinances. In 1949, the legislature of one State considered a bill to grant its State Highway Department power to zone areas along certain roads. It has been suggested that grants and aids for highway purposes should be predicated on the existence of adequate roadside zoning. And, moreover, since the benefits from such zoning accrue primarily to the community at large, that highway aid funds should be made available to zoning agencies to defray at least partially the cost of administering roadside ordinances.

Zoning in River Basins.—Rural zoning both on the watershed and on the flood-plain is a useful regulatory device that is not to be overlooked when planning development of river basins. Conventional zoning regulations and techniques no doubt will play a useful part, but such regulations have some obvious limitations. New types of regulations, reshaping of old types to attain new goals, and rural zoning by other levels of government, offer greater possibilities. Zoning techniques and agencies proposed for river basins need to be designed with a cognizance of the nature, scope, and interrelationship of the over-all problem, and with the aim of integrating zoning with other remedial measures. Inspired research is needed in this field.

Programs in a river basin looking toward stabilization of water supply and reduction of siltation and flood crests must begin upstream on agricultural, grazing, and forest lands. Unwise land use on the highlands often accentuates problems in the valleys below. Conversely, upstream remedial programs may confer both local and downstream benefits. Problems of a river basin call for the integration of remedial programs of all the areas within the basin.

One means of reserving upper watersheds for purposes of stream regulation is by purchase for public forests; another is by zoning such areas to forestry and recreational uses, or to both of these uses. The incidence of benefits from this type of zoning, however, if regulations are to be imposed by the usual local units of government, may preclude tapping their full potentials. There are both local and regional benefits. Those accruing to the locality are ascribed primarily to improved recreational conditions, to lessened forest-fire hazards, and to lower taxes on forest lands resulting from the need for fewer public services. Other benefits resulting from forest zoning are the stabilization of water supply, and the reduction of flood crests and silt flows. These benefits may accrue primarily to people living outside of the forest zone.

Although the incidence of the benefits from forestry and recreational zoning may be both local and regional, these benefits will be realized only if local governments on the upper watersheds decide to zone. This they may decline to do, or neglect to do; or they may initiate an inadequate program. Forest zoning might be strengthened by regulations imposed at higher levels of government or at a combination of levels. Furthermore, the establishment of adequate forest areas on the watershed might be assured by the allocation of river-development funds for the purchase or condemnation of nonconforming tracts, to be resold for forestry and recreational uses. Also, public recreational values might be protected by zoning regulations that require forest land to remain open to public hunting and fishing, as is required by two county zoning ordinances in Michigan.

Flood-plain zoning regulations, to be stable and most effective, need to be imposed at a level of government higher than the local level. Attainment of the full benefits calls for regulations that prohibit certain uses of land in all areas subject to periodic damaging inundation, irrespective of local political boundaries. Annual flood losses might be greatly reduced by excluding or removing dwellings and other uses that are subject to aggravated flood losses from hazardous lowlands; by restricting such areas to farming; and by restricting the more critical areas to grazing. Benefit-cost analysis might be used in making a choice between flood-plain zoning and alternative remedial measures, and for deciding upon the character of zoning regulations to be adopted.

FARM ZONING DISTRICTS.—Rural zoning is a flexible tool that can be readily shaped to serve the needs of rural people. Realization of its full potentials awaits the touch of adaptative imagination. Perhaps zoning regulations could be designed to prevent the unplanned, haphazard, and often premature, suburban development on good agricultural land located on the urban fringe. The destruction of the agricultural character of these communities often begins by sale of a few small tracts for nonfarm residential uses. The process continues bringing with it higher taxes stemming from school, sanitation, and other public-service problems, and, finally, the economic and political submergence of the rural community. Such parcellation and nonfarm uses are permitted by prevailing cumulative zoning district regulations (fig. 3).

Instead, regulations designed for agricultural zones might prohibit nonfarm residences and impose large-tract minimums. These would tend to retard parcellation. A comparable growing practice in industrial districts is the exclusion of all nonindustrial uses. Moreover, there are already county zoning ordinances that prescribe minimums of 5-, 10-, and even 20-acre tracts. A further step might be the establishment of greenbelts around our cities.

In closing, it is emphasized that the legal raw materials of zoning—the basic types of regulations—were urban created; that in the past these raw materials have been reshaped in an effort to serve the rural community. Today, in our changing rural economy, new problems and goals call for new zoning techniques. It is probable that rural zoning will again prove to be a flexible community tool.

Changes in Corn Acreage and Production After the Early Indications

By Malcolm Clough

Early-season indications of corn acreage and production are important to farmers, to processors, and to the Government. This article compares the earliest indication of corn acreage and production each season with the actual outcome of the crop as estimated in December. During the last two or three decades, more than 80 percent of the year-to-year variation in corn acreage has been reflected in the March 1 intentions, and about 60 percent of the variation in corn production has been reflected in the July 1 indications. But 40 percent of the variation in corn production has been determined after July 1, and decisions based on July indications must allow for this remaining uncertainty. In general, the range of uncertainty is reduced substantially by the August and September crop reports. The September estimates have differed from the December estimates by less than 100 million bushels in 20 of the last 32 years.

BECAUSE of the prominent place of corn in the agriculture of our country, prospects for an oncoming crop are of interest and concern, not only to Corn Belt farmers, but to the public generally. Prospects for the crop are basic to the outlook for livestock production and to prospective supplies of meat, milk, and eggs. Changes in prospects for the crop are under continual observation, from the first indications of farmers' planting intentions, as reported in March, to the time of harvest in the fall.

The purpose of this paper is to compare the earliest indication of acreage and production in each year with the actual outcome of the crop as estimated in the December crop report each year. The estimates of acreage and production made currently each year in December are used in making these comparisons, since they are the latest official estimates for the preceding year available at the time the prospective acreages and the July 1 indicated production figures are reported. The final estimates made in later years include revisions based on Census data. Data on early indications of acreage and production are not revised later to reflect general changes in level based on the Census.

Most farmers probably begin making plans for the next corn crop soon after the current crop is harvested. The first official indication of prospective corn acreage, made by the Department of Agriculture, is released in March, based on a survey of farmers' planting intentions as of March 1. The first official figures on indicated production are released in July on the basis of the July estimated acreage for harvest, the condition of the crop at that time, and assuming normal growing weather during the remainder of the season. It is recognized at the time of the release of these reports that weather and other factors may change the final acreage or production substantially from early indications.

It is generally known that corn production, influenced by the effect of weather on yields, varies much more from one year to the next than does the acreage of corn.[1] This fact is brought out in the comparisons that follow. Changes from farmers' intentions as to acreage, which are largely under the control of the farmer, are much less pronounced than changes in estimates of production from July to December, which are influenced by weather and other factors mostly outside of his control.

March 1 Acreage Intentions
A Fairly Reliable Indicator of Planted Acreage

Farmers have been reporting their plans for planting corn and other major farm crops since late in the 1920's. Their reports as of March 1 are summarized by the Crop Reporting Board each year to give the first indications of prospective changes from the preceding year in acreages to be planted. Historical comparisons show that the March intentions as to corn acreage have been fairly reliable as indicators of planted (or harvested) acreages. Farmers generally follow through reasonably close to their March plans.

The primary purpose of these reports is to provide information to assist growers in making such further changes in their acreage plans as may appear desirable. The acreage actually planted or harvested in the year is influenced by weather conditions at planting time, price changes, agricultural programs, or other conditions which affect planting after March 1. Furthermore, farmers take advantage of the Prospective Plantings report itself as a guide in changing their acreage plans for various crops.

A comparison of the March 1 indicated acreages of corn and the actual acreages planted (or harvested) as reported in December is made here for the years 1929-50. It will be noted that the comparisons for the first 9 years of the period (1929-37) differ from those for the years 1938-50 in that the intentions in the earlier period were reported on the basis of prospective acreage for harvest. From 1938 to date the March 1 intentions were reported on the basis of prospective plantings. For this reason the March intentions are compared with harvested acreage from 1929 through 1937, and with planted acreages from 1938 to date.

For the entire period the intended or prospective acreages were fairly close to the estimated actual acreages. In some of the years before 1937 sizable deviations from the intentions reflect greater than average abandonment of acreage after planting, as farmers in that period reported prospective acreage *for harvest.* The heavy abandonment in 1934 and 1936, as a result of the severe droughts, resulted in a considerably smaller acreage actually harvested than was indicated in March. Weather also appears to have been an important factor in some more recent years, when acreages planted deviated considerably from the intentions. In 1945, for example, and to some extent in 1947, wet planting seasons prevented farmers from planting the full acreage intended earlier in the year. In 1949, on the other hand, wet weather during the planting time for oats and other small grains apparently meant that farmers diverted land to corn that they originally planned to put into small grains.

[1] Comparisons of year-to-year changes in corn acreage, yield, and production were published in the *Feed Situation,* December 1948. These comparisons revealed that the average change in corn yields from one year to the next was about 15 percent of the average yield during 1919-48, whereas the average change in corn acreage was only about 3 percent of the average acreage.

These comparisons indicate that farmers generally have planted slightly less corn than they planned in March, or that they have not realized fully their planting intentions. In the earlier years, however, the difference between prospective and actual acreages (harvested) is exaggerated by the heavy abandonment in some of these years. For the years 1938-50 planted acreage averaged about 425,000 acres, or 0.5 percent, below the March 1 intentions. For the entire period (including 1929-37 when farmers reported prospective acreage for harvest), the acreages realized averaged about 1.1 million acres below the intentions. If the two drought years, 1934 and 1936, are omitted, the acreage realized averaged only 700,000 acres, or less than 1 percent, below the intended acreages.

Comparisons of acreage intentions and the acreage planted (or harvested) are shown in table 1, both on the basis of total acreages and in terms of change from the preceding year. The change from the preceding year for the March 1 intentions is the change from the previous acreage harvested for the years 1929-37, and from the previous acreage planted for the years 1938 to date. This comparison reveals that the intentions indicated the direction of change in 17 of the 21 yearly comparisons.

Statistical measurements of the association between the prospective and the actual change in acreage from the preceding year are summarized in table 2. Based on the estimating equations the acreages planted (or harvested) by farmers averaged a little below those indicated by the March 1 intentions reports. The magnitude of the prospective change after adjustment for level, as indicated by the regression coefficients .976 and .912, also was a little less than the actual change. The coefficient of correlation between prospective and actual acreage changes for the entire period was .90, and the standard error of estimate 2.1 million

TABLE 1.—*Corn: March 1 intentions as compared with planted or harvested acreage, United States, 1929-50*

Year	March 1 intentions[1]	Planted or harvested acreage[2]	Difference	Change from preceding year: March 1 intentions[3]	Change from preceding year: Planted or harvested acreage	Acreage planted but not harvested
	Million acres	*Million acres*	*Million acres*	*Million acres*	*Million acres*	*Million acres*
Harvested						
1929	100.2	98.0	—2.2			
1930	100.8	100.8	0	2.8	2.8	2.4
1931	105.8	105.0	— .8	5.0	4.2	2.5
1932	107.3	107.7	.4	2.3	2.7	2.4
1933	103.9	102.2	—1.7	—3.8	—5.5	3.9
1934	92.1	87.5	—4.6	—10.1	—14.7	8.4
1935	95.7	92.7	—3.0	8.2	5.2	4.0
1936	98.8	92.4	—6.4	6.1	— .3	8.8
1937	94.8	93.8	—1.0	2.4	1.4	3.2
Planted						
1938	94.6	93.3	—1.3	[4]—1.9	[4]—3.2	2.3
1939	92.1	91.5	— .6	—1.2	—1.8	3.4
1940	87.8	88.1	.3	—3.7	—3.4	2.3
1941	87.7	87.2	— .5	—.4	— .9	1.5
1942	91.3	91.0	— .3	4.1	3.8	1.5
1943	96.8	97.1	.3	5.8	6.1	2.3
1944	99.6	98.7	— .9	2.5	1.6	1.5
1945	95.8	92.9	—2.9	—2.9	—5.8	1.6
1946	93.0	90.0	—3.0	.1	—2.9	1.3
1947	87.6	86.2	—1.4	—2.4	—3.8	2.2
1948	86.1	86.2	.1	— .1	0	.8
1949	84.8	87.9	3.1	—1.4	1.7	1.2
1950	82.8	84.4	1.6	—5.1	—3.5	1.1
Average 1929-50	94.5	93.4	—1.1	---	---	2.8
Average (excld. 1934 and 1936)	94.4	93.7	— .7	---	---	2.2

[1] Prospective acreage for harvest 1929-37; prospective plantings 1938-50.
[2] Preliminary estimates of acreage harvested, 1929-37, and planted, 1938-50, as reported in the December crop report of each year.
[3] Change from the acreage harvested the preceding year, 1930-37, and from acreage planted the preceding year, 1938-50.
[4] Change from planted acreage in 1937 of 96.5 million acres.

acres. When the severe drought years 1934 and 1936 are adjusted to reflect about the average abandonment for the entire period, the coefficient of correlation is increased and the standard error reduced.

The relationships computed after making adjustments for the years of drought appear to be more applicable to the association between acreage intentions and acreages planted, as currently reported, since abandonment of planted acreage no longer affects the relationships. The planted acreage has been within 1.5 million acres of the intended acreage in 10 of the last 13 years (1938-50) in which prospective plantings have been reported.

TABLE 2.—*Measurements of the relation between the prospective and the actual change in corn acreage from the preceding year*[1]

Period	Regression equation	r	r^2	Standard error of estimate
				Million acres
1929-50	$X_1 = -1.06 + .976\ X_2$	.900	.809	2.1
1929-50[2]	$X_1 = -\ .49 + .912\ X_2$	.941	.885	1.5

[1] The actual acreage is the dependent variable (X_1) and the prospective acreage (March 1 intentions) is the independent variable (X_2).

[2] With acreages in the drought years 1934 and 1936 adjusted to reflect the average abandonment for the entire period.

July Indications of Corn Production

Within 3 Percent of the December Estimate in 2 Years out of 5; Differ by More than 15 Percent in One-fifth of Years

Corn production as indicated in July and the actual production as estimated in December also are compared for the years 1919-50. As discussed previously, the July indications are based on the condition of the crop in July, assuming average weather during the remainder of the growing season. In years when the remainder of the growing season was near normal, the size of the crop as estimated in December did not differ greatly from the July 1 indications. In 13 of the 32 years the December estimate was within 88 million bushels, or about 3 percent of the July indicated production.

In years when unusually favorable or adverse conditions prevailed after July 1, the final outcome of the crop varied substantially from the indicated production as of July 1. In 3 of the years when droughts occurred during the growing season, 1930, 1934, and 1936, the final outcome of the crop was more than 700 million bushels below July 1 indications. In 6 of the 32 years the December estimate of production differed from the July figure by 15 percent or more.

Indicated production as of July is compared with the December estimates (in table 3) in the same way that the comparisons between prospective and actual acreages were made previously. The year to year comparisons show that corn production varies much more than corn acreage, and there is no advantage in using last year's production as a starting point for estimating the current crop. Hence attention is focused on the differences between the early indications themselves and the December estimates.

It is of interest that the December estimate was below the July indications about as many times as above it—15 years out of the 32. But the frequency distribution of these differences, shown in table 4, differs considerably from a normal frequency pattern. Years in which production was moderately above that indicated in July occurred much more frequently than those in which it turned out moderately below. The distribution of the observations below 0 was particularly skewed, with 3 of the 15 years falling in the extreme class interval of —900 to —700 million bushels. There were no years, however, when production exceeded the July indication by 700 million bushels. This brings out the fact that there is greater likelihood of having production turn out much lower than indicated in July than much higher. On the other hand, there were more years when actual production turned out moderately higher than indicated in July than moderately lower. There were 10 years when actual production was 100 to 500 million bushels above that indicated in July and only 4 years when it was 100 to 500 million bushels below.

The average difference between July 1 indicated production and the December estimates, shown in table 3, was 227 million bushels, or about 8 percent of the average production. The standard deviation of the differences was 314 million bushels. There were 22 years (69 percent) when the difference was not greater than the 314 million bushels. Of the 10 years when differences exceeded 314 million, there were 6 years when the December estimates were above the July indications and 4 years when they were below. In 3 of these 4 years, however,

TABLE 3.—*Corn: July indications and December estimates of production, 1919-50*

Year	July (Indicated)[1]	December (Estimate)[2]	Difference	Change from preceding year[3]	
				July (Indicated)	December (Estimate)
	Million bushels	*Million bushels*	*Million bushels*	*Million bushels*	*Million bushels*
1919	2,815	2,917	102		
1920	2,779	3,232	453	—138	315
1921	3,123	3,080	— 43	—109	—152
1922	2,860	2,891	31	—220	—189
1923	2,877	3,054	177	— 14	163
1924	2,515	2,437	— 78	—539	—617
1925	3,095	2,901	—194	658	464
1926	2,661	2,645	— 16	—240	—256
1927	2,274	2,786	512	—371	141
1928	2,736	2,840	104	— 50	54
1929	2,662	2,622	— 40	—178	—218
1930	2,802	2,081	—721	180	—541
1931	2,968	2,557	—411	887	476
1932	2,996	2,908	— 88	439	351
1933	2,384	2,330	— 54	—524	—578
1934	2,113	1,381	—732	—217	—949
1935	2,045	2,203	158	664	822
1936	2,245	1,524	—721	42	—679
1937	2,572	2,645	73	1,048	1,121
1938	2,482	2,542	60	—163	—103
1939	2,571	2,619	48	29	77
1940	2,416	2,449	33	—203	—170
1941	2,549	2,673	124	100	224
1942	2,628	3,175	547	— 45	502
1943	2,707	3,076	369	—468	— 99
1944	2,980	3,228	248	— 96	152
1945	2,685	3,018	333	—543	—210
1946	3,342	3,288	— 54	324	270
1947	2,613	2,401	—212	—675	—887
1948	3,329	3,651	322	928	1,250
1949	3,530	3,378	—152	—121	—273
1950	3,176	3,131	— 45	—202	—247
Average	2,735	2,739	[4]±227	[4]±336	[4]±405

[1] Indicated production, based on conditions July 1, assuming normal weather during the remainder of the growing season.
[2] Production as estimated in the annual summary of each year.
[3] Change from production the preceding year as estimated in December.
[4] Disregarding direction of difference.

the December estimates were more than 2 standard deviations below the production indicated in July, while none of the 6 years was above the July indications by as much as 2 standard deviations.

In considering the comparisons in terms of change from the preceding year, it will be noted that the July indications reflected the direction of the change in 23 of the 31 observations. The 8 years in which the July indications did not reflect the direction of change were generally years in which the condition of the crop changed materially after July 1. In 1930 and 1936, for example, small increases from the preceding year were indicated on the basis of July 1 conditions, but the droughts which came after July 1 caused a marked deterioration of the crops. On the other hand, 1942 was

TABLE 4.—*Corn: Frequency distribution of differences between July indications and December estimates of production, 1919-50*

Class interval	Class mid-point	Frequency	
		Years	Percentage of total years
Million bushels	*Million bushels*	*Number*	*Percent*
—900 to —700	—800	3	9.4
—700 to —500	—600	0	0.0
—500 to —300	—400	1	3.1
—300 to —100	—200	3	9.4
—100 to 100	0	13	40.6
100 to 300	200	6	18.8
300 to 500	400	4	12.5
500 to 700	600	2	6.2
700 to 900	800	0	0.0
Total		32	100.0

TABLE 5.—*Corn: Differences between the December estimate of production and estimates made in earlier months, United States, 1919-50*

Year	July	Aug.	Sept.	Oct.	Nov.
	Mil. bu.	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*	*Mil. bu.*
1919	102	129	60	17	7
1920	453	229	101	16	33
1921	− 43	48	−106	− 83	− 71
1922	31	−126	16	37	− 5
1923	177	73	− 21	33	25
1924	− 78	−140	− 76	− 22	− 41
1925	−194	− 50	15	− 17	−113
1926	− 16	68	− 53	− 35	− 49
1927	512	401	330	183	33
1928	104	−190	− 91	− 63	− 55
1929	− 40	−118	166	94	1
1930	−721	−131	98	34	− 13
1931	−411	−218	−158	−146	−118
1932	− 88	88	54	23	− 13
1933	− 54	57	45	39	41
1934	−732	−226	−104	− 36	9
1935	158	− 69	19	− 10	− 8
1936	−721	85	66	15	− 2
1937	73	− 14	96	83	− 6
1938	60	− 24	88	83	61
1939	48	159	96	87	28
1940	33	201	152	97	16
1941	124	85	149	47	− 3
1942	547	421	159	43	− 10
1943	369	201	91	21	− 9
1944	248	299	127	31	− 30
1945	333	174	− 51	− 60	− 56
1946	− 54	−209	− 84	− 87	− 93
1947	−212	−259	− 3	− 58	− 46
1948	322	144	122	83	1
1949	−152	−160	−148	− 99	20
1950	− 45	− 37	− 32	13	26
Average[1]	±227	±151	± 93	± 56	± 33
Standard deviation	314	178	107	68	43

[1] Disregarding direction of difference.

a year when very favorable weather after July 1 brought a marked improvement in crop prospects. The 1942 crop turned out 500 million bushels larger than in 1941, whereas a slightly smaller production was indicated on the basis of July 1 conditions.

Simple regression equations were computed to measure the association between (1) July indications and the December estimates of production and (2) the year to year changes in these two series from the December estimates of the preceding year.[2] The coefficients of determination (r^2) associated with the two equations are 0.582 and 0.619, respectively. The second coefficient implies that about 62 percent of the change in corn production from the preceding year has been reflected in the July indications. The remaining 38 percent of the variation in corn production reflects factors which operated after July 1, or factors which were not accounted for until after that date. The first coefficient may be given a similar interpretation in terms of variations of corn production about the 1919-50 average.

While the July 1 indication of the corn crop is the first report on production each year, the size of the crop is reappraised each month from July to December on the basis of conditions at the beginning of the month. The estimates made as the crop

[2] The first regression equation is $X_1 = -179.4 + 1.07 X_2$, where X_1 is the December estimate and X_2 is the July 1 indicated production. The standard error of estimate is 324 million bushels. The second regression equation is $X_1 = 1.5 + .919 X_2$, where X_1 is the change in production as estimated in December from the December estimate for the preceding year, and X_2 is the change in indicated production as of July 1 from the December estimate for the preceding year. The standard error of estimate is 328 million bushels.

These regression equations prove to be of no practical value for re-estimating corn production from the July indications, since the standard errors of estimate in each case are slightly greater than the standard deviation of the differences between the July indications and the December estimates of production (314 million bushels). This is to be expected, since the equations do not contain factors that adjust for abnormal weather subsequent to July 1.

develops would be expected to become progressively nearer to the December estimate made at the close of the growing season. This is borne out by table 5, which shows the differences between the monthly estimates made each year and the December estimate.

Since July and August are the critical growing months for corn, the estimates adjust rapidly toward the December figure from July 1 to September 1. Whereas the mean difference between the July and the December estimates of production was 227 and the standard deviation of the differences was 314, by September the mean difference was reduced to 93 and the standard deviation to 107. Further reductions were made in September and October, so that the October 1 and November 1 estimates in most years were fairly close to the December estimates. For the 32 years considered, the September estimates differed from the December estimates by more than 100 million bushels (about 3 percent) in only 12 years. The October and the November estimates differed by more than that amount in only 2 years.

The convergence of the earlier monthly estimates and the December estimate as the corn-growing season progresses is illustrated graphically by figure 1, based on the standard deviations of the differences shown in table 5. The production indications used for March are based on the March prospective acreages, assuming yields about the same as the average for the previous 5 years, after allowance for abnormal years. These projected production figures have been published in the March Prospective Plantings report over the past several years to provide a general guide as to the level of production, pending the issuance of the first official production estimate in July. The marked drop in the standard deviation from 314 million bushels for July 1 to 107 million for September 1 reflects the increased reliability of the monthly estimates as the crop nears maturity.

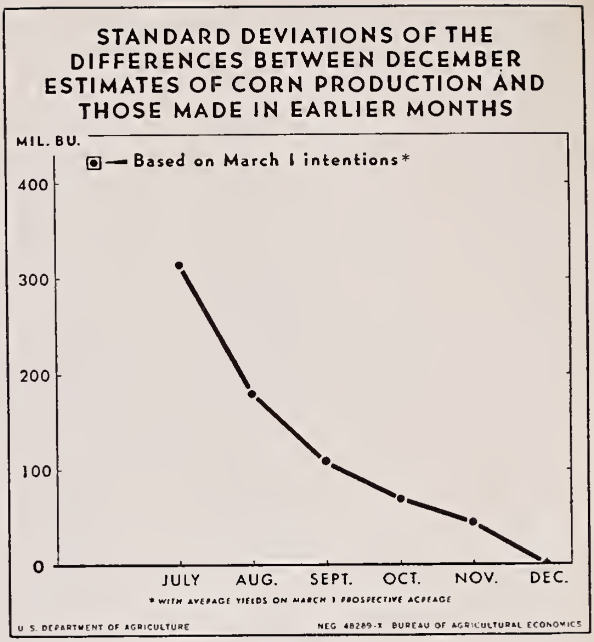

FIGURE 1.

Book Reviews

Interregional Competition in Agriculture. By Ronald L. Mighell and John D. Black. Harvard University Press, Cambridge, Mass., 320 pages. 1951.

As THOSE who have followed the interregional competition project in BAE will recognize, the empirical investigations summarized and interpreted here represent some 15 years of cumulative research results beginning in the middle of the 1930's. An influential reason for the choice of dairying in New England and the Lake States as the subject for intensive study was the practical problem of the long-run competitive position of dairying in these two regions. The results of the several supply-response studies developed in that project are presented both for their substantive content and for their bearing on the general problem of research methodology applicable to empirical studies of interregional competition.

In the development of supply schedules for dairy products, principal reliance is placed on the budget technique as applied to individual farms. Budgets are developed on the basis of alternative assumptions as to the relation of dairy prices to prices of other farm products. Price and production developments in the 10 years following 1936 provided an opportunity to test the analytical devices against the record; and the authors conclude that the results are reasonably good when allowance is made for the special circumstances of World War II. The demand schedules used in the study are developed mainly from the work of other research workers in the field of dairy marketing.

The authors recognize that the analysis developed during the 1930's is not applicable directly to the problem of the present competitive position of the two dairy areas. It does provide a test of the feasibility of estimating production responses to different assumed situations as to price. To the extent that the authors attempt a long-run evaluation of the competitive positions of the two areas, it depends heavily on the relative strength of influences that are difficult to fit neatly into individual farm budgets, such as technological changes, population growth, and governmental programs. But the earlier type of analysis developed in the basic studies provides a starting point from which an appraisal of the probable influence of these "unknowns" can be made.

Although there is an attempt to appeal to a broad group of readers by including additional materials, it seems likely that those interested in research methodology will benefit most from this study. It should be especially valuable to those engaged in research based on the economics of the firm. The probable supply response of the individual farm firm is basic in the analysis. The authors recognize that in retrospect a better job of sampling could have been done. A further difficulty in the use of the method is the need for background research in basic relationships as a prerequisite for the exercise of judgment in developing farm budgets. It is a little difficult, therefore, to reconcile the authors' enthusiasm for this research technique with their somewhat disparaging remarks on research on basic relationships. The budget technique is no substitute for analysis of basic economic relationships. One of its main advantages is that it forces the researcher to be explicit on relationships that might be overlooked.

The reviewer has considerable sympathy with the emphasis placed in the final chapter on using a rifle rather than a shotgun in the collection of basic economic statistics for use in research of the kind outlined in that chapter. But the cost of separate collection of partially duplicating statistics for a large number of purposes in addition to the study of interregional competition cannot be ignored. The ingenuity of research workers in the use of general-purpose data may have to continue to substitute in part for specialized data tailored to particular research programs.

This book is not easy reading, but this is not necessarily an adverse criticism. Distilling a little truth out of imperfect data is a laborious process, and the reader cannot be spared a share in this process. The authors have chosen wisely in not attempting to make the study easy to read at the expense of leaving out pertinent details.

Donald C. Horton

Economics of American Agriculture. By WALTER W. WILCOX and WILLARD W. COCHRANE. Prentice-Hall, Inc., New York. 594 pages, illus. 1951.

THE AUTHORS of this book set out a difficult task for themselves. But it has been done well. They have written a book which (1) gives the reader a broad picture of the major developments in American agriculture in recent decades, (2) points up the problems that face the industry, (3) indicates and analyzes causes for such problems, (4) appraises attempts to cope with these problems, and (5) indicates the nature of the economic principles or analytical tools that are applicable to problems of American agriculture. At the same time, even the elementary reader should find nearly all of the text easy to comprehend.

The six parts of the book cover the entire field of agriculture. The parts are: Developing efficiency in the production of farm products; Problems in acquiring and managing land; Marketing farm products in an interdependent economy; Toward an understanding of farm prices; Farmers in the national and world economy; and What Government aids do farmers need?

The first part is one of the best from the viewpoint of indicating the nature of developments in agriculture and interpreting the significance of various economic principles as they apply to agriculture. However, it tends to indicate the answers to a large number of production questions without the benefit of full analysis. For the beginning student it may tend to create the illusion that anwers are easy to find, while being of insufficient help in developing a method of approaching problematic situations. But in most cases, later chapters give a fuller treatment of the analytical tools applicable to problems discussed in these early chapters.

The second part, which covers problems of acquiring and managing land, is heavily descriptive. But, woven in among the discussions of tenancy, size of farm, taxation, land valuation, etc., are pointed analyses of the manner in which prevailing practices affect farm output and farm people. The nature of these discussions should make a lasting impression on even the beginning student.

The chapters on marketing point out the nature of the marketing problem as conceived by marketing analysts, very clearly. Any criticism that one may have of these discussions in no way reflects on the book itself. The book reflects the obsession of the present-day marketing analyst with the pictorial presentation of marketing channels and the arithmetical calculation of marketing margins.

Perhaps the best chapters as a group are those dealing with farm prices. They not only spell out the role which prices play in American agriculture but also present a relatively simple and straightforward explanation of how prices are determined. The beginning student who is without a knowledge of the principles of economics may find these chapters somewhat difficult to master.

The discussion of the nature and significance of the relation of the American farmer to both the nonagricultural sectors of the American economy and the world markets is well handled. Any person whose study of agricultural economics is based solely on this book will be well exposed to the major problems facing agriculture when he reads these chapters. At the same time, the student who intends to continue his study of agricultural economics will find stimulation here.

Although entitled What Government Aids do Farmers Need?, the last three chapters are devoted mainly to relating and analyzing various Government programs that have been in operation during the last two decades. As should be true in a book of this sort, the reader is left to draw his own conclusions about the kind of program that is needed.

The authors draw heavily on BAE statistical material. Wherever possible, the descriptive portions include the available facts. This heavy dependence on statistical information plus the discussions of current policy problems may date the book so that its usefulness will extend over a relatively few years. But it is the kind of book that has been needed for some time; it should be widely read and used by students of agricultural economics; and it will probably become one of the most widely known books of its kind.

Howard L. Parsons

Agricultural Marketing. By FREDERICK L. THOMSEN. McGraw-Hill Company, Inc. 483 pages. 1951.

Introduction to Agricultural Prices. By WARREN C. WAITE and HARRY C. TRELOGAN. John Wiley & Sons, Inc., New York. 440 pages. 1951.

A GOOD TEXTBOOK is the most reliable tool of a teacher. It often becomes the blueprint for a course, and in many instances the success or failure of a teacher working under the pressures of a heavy teaching load is dependent on the thoroughness of organization and presentation in the text material.

The utter inadequacy of teaching materials in agricultural marketing has caused many prominent teachers to look forward hopefully to the time when satisfactory textbooks in agricultural marketing would become available. For this reason, if no other, I am certain Dr. Thomsen's new book will receive a thorough review by the teaching profession. The basic question is what they will expect of the author. Very few are seeking new marketing ideas. They know such a course is designed as a general course for students from many departments of school of agriculture. Therefore, what is considered good or bad in the book will depend on the answers to the following questions:

1. Is the subject-matter well organized?

2. Does the text cover adequately the subject-matter deemed most essential to informing the students of basic facts and developments in the area of study?

3. Is the material well written for an introductory course, especially does it include a sufficient number of illustrations to clarify obscure ideas and encourage further reading?

4. Does the author deal with controversial subjects in an objective manner or has he chosen to become the advocate of a particular pattern of economic and social thinking?

The essence of the foregoing questions can be summed up by the usual query of a teacher who asks "Is it teachable?"

Dr. Thomsen has done an outstanding job of weaving together a discussion of the marketing system for farm products, how it operates, the tasks to be performed, who performs them, the problems encountered in moving farm products and the title to such products from the farm to the consumer. He recognizes thoroughly the importance of the consumer in the scheme of things and the degree to which consumer reactions to goods and services and ability to pay mean high prices or low prices on farm products. The subject-matter covered is adequate. The wealth of his experience in marketing research and teaching shows up in the discussions of the Marketing System, Prices and Margins, Potential Improvements in Marketing, and Means of Effective Improvement. His years with the U. S. Department of Agriculture enabled him to draw heavily on the factual and graphic materials of the Bureau of Agricultural Economics to buttress his own ideas. The effective use made of the Bureau's work added greatly to the value of the text.

There is no doubt in my mind about this author's alibity to deal objectively with controversial subjects in marketing. This is clearly demonstrated in his treatment of prices and margins, orderly marketing and controlled distribution, and government action to improve marketing. He states "I have tried to be a professional sponge, soaking up as many new concepts as possible through contact with different schools of thought and individuals of extraordinary proficiency in specialized fields." He has succeeded.

THE SECOND BOOK is a revision of the original text published in a limited number by the Burgess Publishing Company, Minneapolis, in 1948, and reviewed in this magazine in January 1949. The major changes in organization and presentation consisted of expanding and transferring to an appendix the materials on "Methods of Price Analysis." This simple and brief treatment of the tools and techniques for analyzing economic data is an obvious compromise between including such a discussion or leaving it entirely out of the elementary text. Waite and Trelogan have done an excellent job in adapting their material to students interested in an introduction to a broad and complicated field of study.

D. B. DeLoach

Psychological Analysis of Economic Behavior. By GEORGE KATONA. McGraw-Hill Book Company, Inc. New York. Edition 1, 347 pages. 1951.

IN A SUBSTANTIAL number of fields in economics both theory and empirical research have reached, if not a dead end, at least the area of sharply diminishing returns. An attempt at radical departure from traditional forms of analysis should be welcome in such fields as the derivation of demand curves and the study of duopoly or of the importance of profit maximization, if the departure is likely to shed some new light on an old subject. One promising source for new approaches to economic problems lies in the insights developed by the psychologists and especially the social psychologists.

Before the findings of one discipline can become the tools of another, it often proves necessary to overcome a certain disciplinary chauvinism which seems to be particularly prevalent in the social sciences. Since we are generally unable to formulate our results with the same mathematical precision as the natural scientists, we seem to take particular delight in pointing out the shortcomings of our sister disciplines in this respect and to consider this as reason enough to reject their possible contribution to our area of the social sciences. Any book can make a major contribution to the solution of economic problems if it helps to break down these barriers between fields by demonstrating not only the interrelationship in the social sciences, but also the applicability of the techniques and results of another discipline to the problems of economics. This, in my opinion, is the major contribution of *Psychological Analysis of Economic Behavior.*

It is the author's thesis "that economic processes stem directly from human behavior and that this simple but important fact has not received its due in modern economic analysis." He attempts "the task of describing a psychological approach to economic analysis and the current research in the field of economic behavior." He succeeds admirably in meeting this rather limited goal.

The central part of the book involves an examination of some consumer, business, and governmental decisions. The psychological assumptions underlying much of the traditional economic analysis of these decisions are brought out and the justification for the assumptions is examined. The book makes a worth-while contribution in pointing out that some of the psychological assumptions on which economists base a considerable body of theory and investigation are not necessarily tenable or a full explanation. Katona then proceeds to discuss the psychological evidence available on the bases for economic decisions and the conclusions applicable to economics which can be derived therefrom. Many of his data come from the admirable Surveys of Consumer Finances undertaken for the Federal Reserve Board by the Division of Program Surveys in the Bureau of Agricultural Economics and continued by the Survey Research Center of the University of Michigan.

It is in the discussion of the contributions of psychology actually available for the solution of economic problems that the book may be most disappointing to economists. Katona repeatedly points out that the psychological analysis of economic behavior is in its very beginning. The book provides no clear-cut and simple answers on motivations which economists could substitute for the equally simple and clear-cut assumptions underlying some of our theories. That the book fails to do so is, however, not only a function of the relatively undeveloped state of this inter-disciplinary discipline, but also of the complexity of the motives with which it deals. It is good to be reminded of this fact and to be introduced to one possible approach which, with fuller exploration by a new breed of psycho-economists or economic psychologists, may provide new insights as well as new facts that will be useful in solving some of the old problems of economics.

Gustav F. Papanek

Agricultural Marketing. By ADLOWE L. LARSON. Prentice-Hall, Inc., New York. 519 pages. 1951.

THE AUTHOR states that the major purpose of his book "is to help the reader to think critically and to act constructively on agricultural marketing problems." If he means by the term "reader" the beginning student in agricultural economics and marketing, the reviewer feels that, on the whole, a good job has been done.

The book is divided into six major parts: Agricultural Marketing in Our Economy, Agencies in Marketing, Marketing Functions, Marketing Commodities, Pricing, and Problem Areas. In Part III, the author is to be commended for his discussion of buying and selling as a marketing function since the importance of managerial decisions to the efficiency of a business organization frequently is neglected or minimized by writers. Pricing touches on the conventional concepts of price making and price analysis and includes a chapter on monopolistic tendencies in agricultural marketing. Problem Areas includes chapters on interregional and international trade barriers, cost of marketing, marketing information, futures trading, agricultural cooperation, marketing research, and marketing policy.

Throughout, the author makes generous use of statistical data and chart materials of the Department of Agriculture, particularly the Outlook charts and information on margins and costs prepared in the Bureau of Agricultural Economics.

An author of a textbook must strive to achieve comprehensiveness and at the same time must keep his text within a manageable length. He is faced with serious problems as to what subject matter to include, how to treat it, and where to place it within the general framework of a book. This author has succeeded in recognizing and outlining the wide array of topics which is embraced by the marketing field. But it appears to the reviewer that, to some extent, concreteness and general adequacy of treatment have been sacrificed to brevity. For instance, in the chapter on Marketing Research, there are good brief statements dealing with objectives, scope, and problems and procedures in marketing research, but the treatment is limited and extremely general. In view of the increasing emphasis on marketing research, to which the author devotes only two short paragraphs, one feels that both the student and the general reader would have benefited from some concrete account of the evolution of marketing research, particularly of that being carried on in the Department of Agriculture and in the State Experiment Stations, together with recognition of some of the problems that are under study and some description of how the Department, the Experiment Stations, and other agencies are organized to carry forward marketing research projects. To this might have been added some evaluation of the results of marketing research, a recognition of the historical unevenness in public support of agricultural marketing research, and a brief treatment of the forces which underlay the enactment of the Research and Marketing Act of 1946.

Similarly, in the concluding chapter, which deals with agricultural marketing policy, there are brief and general statements relating to production controls, marketing agreements, and the parity concept. If agricultural production and marketing programs, the parity concept, and related aspects of policy are to be considered a part of the agricultural marketing field, it would seem that the student should be given some insight into the part that parity and programs aimed at achieving parity have played in the struggle farmers and their representatives have made to achieve higher income levels for agriculture. He should also be given an indication of what the parity concept, means for measuring it, and programs designed to achieve it, have meant to the problem of general economic stabilization in different periods, including the present.

More emphasis might have been placed on the evolution of marketing methods and organization, changes in marketing technology, the declining relative importance of central markets, and the increase of chains, supermarkets, and self-service in the field of retailing. The term prepackaging is not even listed in the index. However, this is not to say that the author does not have a good grasp of his subject. The book is well annotated and the footnotes provide references to publications which furnish fuller treatment of subjects referred to. With adequate supplementation by lectures and other source materials, this should prove to be a useful textbook.

Bennett S. White, Jr.

Selected Recent Research Publications in Agricultural Economics Issued by the Bureau of Agricultural Economics and Cooperatively by the State Colleges[1]

ALLEGER, DANIEL E., and THARP, MAX M. CURRENT FARM LEASING PRACTICES IN FLORIDA. Fla. Agr. Expt. Sta. Bul. 13, Southern Cooperative Series, 28 pp., illus. June 1951. (BAE cooperating.)

Describes current practices and lists items to be considered in making a farm lease.

BRODELL, ALBERT P., and KENDALL, ALBERT R. FARM CONSUMPTION OF LIQUEFIED PETROLEUM GASES. 7 pp. Washington, D. C. July 1951. (Processed.)

Total farm consumption of liquid petroleum gases was estimated at more than a half-billion gallons in 1949. Sales in 1950 were more than 25 percent above 1949 sales.

BRODELL, ALBERT P., and SCHOLL, JOHN C. PLANTING AND FERTILIZING CORN. U. S. Bur. Agr. Econ. F.M. 84, 8 pp. June 1951. (Processed.)

Material obtained from voluntary crop reporters on methods and rate of planting, distance between rows, and use of commercial fertilizers.

BRODELL, ALBERT P., and BURKHEAD, CHARLES E. SPRAYING AND DUSTING THE MAJOR FIELD CROPS. 6 pp. Washington, D. C. July 1951. (Processed.)

Contains estimates of the 1949 acreage of field corn and small-grain crops harvested that were sprayed or dusted for insects.

CHRISTENSEN, RAYMOND P., and MIGHELL, RONALD L. INTERREGIONAL COMPETITION IN THE PRODUCTION OF CHICKENS AND EGGS. U. S. Dept. Agr. Tech. Bul. 1031, 71 pp., illus. July 1951.

Concerned with such questions as, Why is production of chickens and eggs so widely distributed in this country? Why do prices received by farmers differ so much between regions and between areas? Why has production increased much more in some places than in others? How have changes in supply from competing regions affected prices in each region? What important factors are likely to affect regional changes in production the next few years?

CONNER, MAYNARD C. THE MILK MARKET CONTROL LAW IN VIRGINIA. Va. Agr. Expt. Sta. Bul. 444, 49 pp., illus. June 1951. (RMA)

Weighs current methods of regulating the dairy industry against alternative approaches.

DAVIS, G. B. QUALITY LOSS IN MARKETING OREGON EARLY-CROP POTATOES. Oreg. Agr. Expt. Sta. Bul. 468, 32 pp., illus. October 1949. (RMA)

Quality can be improved through (1) an increase in maturity; (2) a reduction in mechanical injuries including cuts and bruises; and (3) a decrease in the decay.

ELLICKSON, JOHN C. HAIL INSURANCE ON GROWING CROPS. U. S. Dept. Agr. Agr. Inform. Bul. 56, 20 pp., illus. June 1951.

Deals with types of insurance that may be obtained, settlement of losses, and other provisions of the contracts.

GALLOWAY, ROBERT E., HOUSER, PAUL M., and HOFFSOMMER, HAROLD. COMMUNITY ASPECTS OF LIBRARY PLANNING. Md. Agr. Expt. Sta. Bul. A-56, 32 pp., illus. March 1951.

Has twofold purpose: (1) to serve as a basis for planning expansion of public library facilities in Prince Georges County; (2) to set up a pattern of study and research procedure that will be useful to other counties with similar problems of social organization.

GIBSON, W. L., JR., and HANSING, F. D. FATHER-SON FARM AGREEMENTS. Va. Agr. Expt. Sta. Bul. 9 (Southern Cooperative Series) 35 pp. April 1951.

Major objective is to learn whether father-son farm agreements can be used successfully to establish young men in farming, and to assist aging farmers to keep their farms highly productive.

HAY, DONALD G., and POLSON, ROBERT A. RURAL ORGANIZATIONS IN ONEIDA COUNTY, NEW YORK. N. Y. (Cornell) Agr. Expt. Sta. Bul. 871, 56 pp., illus. May 1951.

Rural areas of the county are characterized by intermingling of farm and nonfarm families. Five types of organizations were examined—spatial groups; institutionalized, formal, and informal organizations, and agencies.

IBACH, DONALD B., and MARX, ROBERT E. FERTILIZER AND LIME USED ON CROPS AND PASTURE, 1947. 31 pp. Bur. Agr. Econ. Washington, D. C. June 1951.

Gives estimates of acreages of different crops fertilized, quantities of plant nutrients used, and distribution of this use among crops by farmers.

[1] Printed reports are indicated as such. All others are processed. State publications may be obtained from the issuing agencies of the respective States.

KRISTJANSON, KRIS. DEVELOPMENT OF IRRIGATED FARMS ON THE MIRAGE FLATS PROJECT. Nebr. Agr. Expt. Sta. Bul. 410, 28 pp. Brookings. June 1951.

Analyzes the planning and settlement of Mirage Flats Project in northwestern Nebraska, which has an average annual rainfall of about 20 inches.

LIMMER, EZEKIEL. CHIEF FACTORS UNDERLYING GENERAL CHANGES IN RAIL FREIGHT RATES, WITH SPECIAL REFERENCE TO FARM PRODUCTS, 1910-51. 58 pp., illus. Bur. Agr. Econ. May 1951. (RMA) (Processed.)

Analyzes, with special reference to agriculture the principal rate-level cases decided by the Interstate Commerce Commission.

LIMMER, EZEKIEL. TRANSPORTATION OF SELECTED AGRICULTURAL COMMODITIES TO LEADING MARKETS BY RAIL AND MOTORTRUCK, 1939-50. 42 pp., illus. Bur. Agr. Econ. June 1951. (RMA) (Processed.)

Presents, for ready reference, selected available statistics relating to the relative share of the total volume of agricultural products moved by the several modes of transportation.

MARX, ROBERT E., and BIRKHEAD, JAMES W. HAY HARVESTING METHODS AND COST. U. S. Dept. Agr. Cir. 868, 122 pp., illus. June 1951.

Discusses investment in machinery, annual cost of using the machinery, labor crews and their costs, and total costs per acre and per ton for each of 15 methods of harvesting.

MULLINS, TROY, and SLUSHER, M. W. COMPARISON OF FARMING SYSTEMS FOR LARGE RICE FARMS IN ARKANSAS. Ark. Agr. Expt. Sta. Bul. 509, 37 pp., illus. June 1951.

Discusses changes in production techniques in Arkansas in the 1940's. The shift from binder-thresher to the combine for harvesting rice and use of artificial driers to dry the combined rice were particularly notable.

NORTH CAROLINA AGRICULTURAL EXTENSION SERVICE. FATHER-SON FARM AGREEMENTS. Southern Farm Mangt. Ext. Pub. 1, 23 pp., illus. (1951) Ext. Services of Ala., Ark., Fla., Ga., La., Miss., N. C., Okla., S. C., Tenn., Tex., and Va., the Farm Found., and U. S. Ext. Serv. cooperating.)

REUSS, LAWRENCE A., and BLANCH, GEORGE T. UTAH'S LAND RESOURCES. Utah Agr. Expt. Sta. Special Rept. 4, 66 pp., illus. June 1951. (BAE cooperating.)

Reseeding of range lands, use of fertilizers, and adoption of improved management practices have aided the expansion of farm production in Utah.

ROBINSON, R. WAYNE. COTTON PRODUCTION PRACTICES IN THE LIMESTONE VALLEY AREAS OF ALABAMA. Ala. Agr. Expt. Sta. Cir. 100, 32 pp., illus. June 1951. (BAE cooperating.)

Extent to which machinery should be substituted for man labor on these farms will depend upon the topography of cotton land on individual farms, future Government-control programs; and relative costs of machinery and labor.

STIPPLER, H. H., and MARTIN, J. W. TRACTOR POWER ON IRRIGATED FARMS IN SOUTHERN IDAHO. U. S. Bur. Agr. Econ. F.M. 81, 116 pp. July 1951.

Somewhat more than 23 percent of all farms in the State reported tractors in use in 1940 and 42 percent so reported in 1945.

UNITED STATES BUREAU OF AGRICULTURAL ECONOMICS. CONSUMER PREFERENCES FOR SELECTED FROZEN CONCENTRATED APPLE JUICE. 21 pp., illus. Washington, D. C. June 1951. (Processed.)

Reaction to three frozen concentrated apple juices was favorable. Most preferred was a blend of several varieties with 0.4 percent acidity.

UNITED STATES BUREAU OF AGRICULTURAL ECONOMICS. USE OF FRUITS BY CHICAGO BAKERS. U. S. Dept. Agr. Agr. Inform. Bul. 42, 87 pp. June 1951. (RMA, PMA, BAIC, and BHNHE cooperating.)

A consumer preference study which attempts to present the conditions that limit the use of various fruits by bakers, the circumstances under which their consumption could be increased.

Statistical Compilations

HICKS, JOHN A., and WILLIS, CLYDE Z. STATISTICS ON COMMERCIAL PEANUTS, BY SEASONS, 1938-39 TO 1949-50; MONTHS, 1945-46 TO 1949-50. 25 pp. Bur. Agr. Econ. Washington, D. C. June 1951. (Processed.)

UNITED STATES BUREAU OF AGRICULTURAL ECONOMICS. DAIRY STATISTICS AND RELATED SERIES. U. S. Dept. Agr. Statis. Bul. 100, 87 pp. June 1951.

UNITED STATES BUREAU OF AGRICULTURAL ECONOMICS. FLUCTUATIONS IN CROPS AND WEATHER, 1866-1948. U. S. Dept. Agr. Statis. Bul. 101, 193 pp., illus. June 1951. (RMA)

UNITED STATES BUREAU OF AGRICULTURAL ECONOMICS. STATISTICAL HANDBOOK OF AGRICULTURE IN THE UNITED STATES. 94 pp., illus. June 1951. (Processed.)

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