the sample villages, was made in the fall of 1949. Data thus obtained will be valuable in connection with designing the sample of the parallel surveys. A statistician from India was employed by the Central Statistical Office from August to November in 1949. He designed the sample, using modern principles of probability sampling. An internal statistical analysis of the data from this survey yet to be made will show the comparative variance for households within villages and between villages, and this will make it possible to allocate survey resources much more efficiently than would otherwise be possible. For example, if the variance is high within villages and low between villages, a smaller sample of villages will be used with a higher rate of sampling of households within villages. But if the reverse is true, a larger sample of villages with a lower sampling rate within villages will be used.

During a 5-week stay in Turkey last fall the writer selected 10 qualified trainees to come to this country for intensive training of 6 to 9 months. Two of these were for work on agricultural census and crop and livestock estimating methods, 2 were for work on sampling, 1 each for work on the population census, the census of manufacturing and business, the collection of information on labor statistics and family budgets, and collection of information on national income, and 1 each to work on economic planning, and machine methods and sample expansions. Three of these trainees arrived last January. Incidentally, 3 of the 10 trainees are women.

At the request of the Director of the Central Statistical Office the writer also prepared, while in Turkey last fall, a report that analyzed briefly the needs of the Turkish economy for current and reliable agricultural statistics and that made specific recommendations regarding the organization and functions of a modern agricultural statistical service for Turkey. It is this service that will now be developed for that country.

Problems in Sampling a Heterogeneous Agriculture

By George Knutson and Floyd K. Harmston

Sampling for agricultural items having low frequencies of occurrence or a very sporadic geographical distribution, which is characteristic of the agriculture in the West, involves several special problems. One of these is the delineation of areas which will be useful as a basis for stratification for selecting samples and for analytical purposes. The authors give their views on the classification of agriculture with reference to Wyoming particularly.

IT HAS LONG BEEN the practice of agricultural statisticians to work with samples that were aimed at getting a cross-section of all farms in a State. Such a procedure is satisfactory when all farms in the universe are fairly similar with respect to the characteristics to be estimated from the sample. But when the agriculture in a State is heterogeneous a general-purpose sample of farms does not yield results of the required precision for sporadically distributed items, unless a prohibitively high sampling rate is used.

So far, the commonly used method for working with problems of heterogeneity has been the classification of areas by districts. Geographical districting has been used in the Department's work in agricultural estimates for a long time, in an attempt to bring "like" agricultural areas into the same subuniverse. These areas follow county lines. The method has a certain degree of merit. Recently, area interview surveys have utilized type-of-farming maps in allocating sampling areas; this amounts to districting into strata the parts of which are not necessarily geographically contiguous.

The problems of heterogeneity, however, are not completely solved by any such simple procedure. State statisticians, particularly those in the West, have lamented the lack of research on them. There seems to be a tendency to select the most homogeneous areas for use in sampling re-

search, thus relegating the nonhomogeneous to a background position, perhaps for future study. The establishment of the West of 100 Meridian Project gave hope, but this was discontinued before ground work was thoroughly laid.

What is there about agriculture in the less homogeneous parts of the country that poses such puzzling problems? Because we are familiar with it, the farming and ranching of Wyoming is here considered.

Agriculture is carried on in Wyoming at elevations ranging from 3,000 to 10,000 feet, or higher. This, in itself, is a problem. Abrupt and decided changes in elevation occur in many parts of the State, and they are responsible for similar changes in ecology. Crops are raised on elevations as high as 8,000 feet and pasture and meadows lie even higher. Rainfall varies from about 20 inches on plains and high mountains to 6 inches in the desert. Topography varies from rolling hills, through rough and broken country, to mountain crags. Stream valleys, some wide and some narrow, are numerous, with intermittent draws. The physical geography of Wyoming is probably the factor of the most heterogeneity.

The agriculture of this State should be classified into several universes and subuniverses. Some of this classification can be made on a geographical basis but most of it cannot. Four types of farming and ranching are carried on in some counties.

There are two major categories of cropland—irrigated and dry. Some land is subirrigated, and this requires special treatment and cropping practices. Yields derived are comparable with those from irrigated land, but for the sake of simplicity these two major categories are considered.

Irrigated land may be readily subclassified into (1) hay meadows and pastures of high elevation and (2) elevations that are relatively low, with diversified farming. The hay meadows are found in all parts of the State and are fairly homogeneous in character. Diversified farming is carried on in many parts of the State but there are wide differences between these parts.

For the sake of statistical analysis, it is always well to consider the following subdivisions by kind of projects when thinking about Wyoming's irrigated land: (*a*) North Platte River valley (Districts 4 and 5), (*b*) Laramie County, pump irrigation (District 5), (*c*) Wind River and Big Horn basin (District 1), (*d*) Sheridan and Johnson Counties (District 2), (*e*) Wheatland Flats (District 5), (*f*) Uinta County (District 3), (*g*) Star Valley (District 3), (*h*) Jackson Hole (District 3), (*i*) Eden (Sweetwater County—District 4), and (*j*) several very small and minor areas scattered throughout the State. Each subdivision has distinct characteristics that are not shared by any other. Each must have individual consideration and analysis in estimation procedure.

The dry-land areas may be subdivided into (*a*) hayland, (*b*) general cropland—wheat, barley, oats, corn, potatoes, beans, and other crops, and (*c*) range and pasture lands. The dry hayland, mostly limited to the Eastern Plains, is fairly homogeneous. The cropland occurs in two types of area—the eastern plains and the mountain foothills and mountain valleys. The crops grown in dry land may be categoried into those grown in all areas and those grown in specialized areas. The small grains predominate in all dry-land areas. Potatoes (commercially grown), beans, and safflower, are produced in certain small areas. Corn is grown in the plains area only.

There are four kinds of ranching enterprises: (*a*) cattle ranching, (*b*) sheep ranching, (*c*) cattle-and-sheep ranching, and (*d*) the dude ranches. Cattle ranchers operate on the plains and in the mountains. The plains rancher depends upon year-round grazing, with or without supplemental feed; the mountain rancher grazes his livestock on the forest reserves in summer, uses the pastures or the irrigated meadows in spring and fall, and feeds hay, oilmeal cake, or other concentrate in winter. The sheep rancher of western Wyoming usually has winter range in the Red Desert area (with some supplemental feeding), ranges his livestock in the foothills in fall and spring, and uses the high mountain pastures in summer. The combination cattle-and-sheep ranchers are found in all parts of the State and may have any combination of range, pasture, and feeding. The dude ranchers are in the mountain areas; they raise mostly horses, cattle, and hay. With so much diversity in the State the statistician is hard put to obtain any kind of sample that will contribute to a reasonable estimation of the truth.

Possible Approach

As a possible approach to a solution, a separation of the total cropland universe into dry land and

irrigated land has long been advocated. This would be a definite break with the theory of districting, since both types occur in the same areas and are widely dispersed. But the need is urgent. The statistician needs this break-down in his sampling and analysis and there is an insistent demand for the development of separate estimates on these two subuniverses in Wyoming, particularly. Such information is essential to the effectiveness of present crop estimation and crop experimental work, and to economic studies regarding the Missouri Basin and other conservation projects in Wyoming.

To treat irrigated and nonirrigated farming and ranching as two distinct universes is the pressing need in this field at present. It would require research to establish bench marks and these would require not only analysis but contact work to keep abreast of changes within these universes. Other such "type" classifications, which would strengthen the agricultural statistician's position and effectiveness, should be attempted. This is particularly true in regard to sampling for livestock numbers. Such factors as drought, prices, and wages, affect the different types of the ranching enterprise differently. Information regarding the shifting from cattle to sheep or vice versa, changes in sizes of ranches, and similar factors, is needed when agricultural estimates are made. As several types occur in the same area, districting does not bring the needed results.

Certain solutions are here suggested in the absence of research which might develop a method far superior to stratification as a solution to the problems of heterogeneity. We submit that these problems are not small and are in definite need of solution. Apparently, they cannot be solved with methods that are derived from work with regard to areas that have more homogeneous agriculture.

The Gist of It

Limiting our consideration of the problem to the Western States, we arrive at these conclusions:

1. Heterogeneity is the most complex of the problems within the region with which the statistician is faced.

A. Widely divergent elevations and phenological phenomena lead to equally divergent ecology and farming or ranching practices.

B. The presence or absence of irrigation water on cropland is responsible for widely differing practices, yields, etc. The source of water supply (reservoirs, direct flow, pump, and subirrigation) and the amount of water available affect areas differently.

C. The livestock ranching industry is not homogeneous but consists of several unlike types. Each type is fairly homogeneous within itself.

2. Present practices are inadequate to cope with the problem.

A. Districting is a help but is far from a solution because different types of farming and ranching often occur in the same area.

3. The use of "type" classification, without regard to political boundaries or geographical proximity, offers a possible solution to parts of the problem.

A. A break-down between irrigated and nonirrigated cropland is acutely needed. To establish and maintain this would require additional work and expense.

4. Research and experimentation dealing with problems of heterogeneity seem essential to future progress in the field of crop estimates.

With demands for greater precision and detail in agricultural statistics, solutions of these problems become absolutely necessary if we are to do the thoroughly effective sampling that is basic to satisfactory results.