age yield for the 8 years is 17.8 bushels per acre.

Two of the hard red spring varieties, Ceres and Marquis, and the two durum varieties, Kubanka and Mindum, grown for the entire period shown, yielded significantly lower than Thatcher.

The varieties Komar, Marquillo, Reliance, Hope, Supreme and Comet were discarded before 1938 because they yielded definitely lower than Thatcher. Monad durum was dropped from the trials because it is inferior in semolina quality to Kubanka or Mindum.

Other varieties previously omitted from plots because they were susceptible to stem rust, and therefore not included in Table 1, were Kota, Red Bobs, Preston, Power, Hard Federation, Ruby, Quality, Garnet and Bluestem. These have been grown in single nursery rows during the years 1930 to 1940.

Only three varieties averaged higher in yield than Thatcher in the years grown. These are Vesta, Rival and Premier. Some of the others are not significantly lower in yield than Thatcher. Pilot and Rival, which have been released to farmers, are more resistant to leaf rust than Thatcher and may be expected to outyield Thatcher under some conditions. Vesta, Premier and Merit have been increased under control pending more complete information from tests for flour quality. If released, information will be given out.

Eight new varieties grown for the first time in 1940 are omitted from the table because results for one year are not considered sufficient indication of the value of a variety. Six of these varieties yielded higher than Thatcher, indicating that progress is being made in developing varieties better than Thatcher.

An Investigation of Micro Methods in Comparison with the Standard Method of Determining the Test Weight of Hard Red Spring Wheat

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Importance of Test Weight

THE term "test weight" is a grading designation used in the official grain standards established by the United States Department of Agriculture. It is the weight of the volume of grain necessary to fill level full a Winchester bushel of 2150.42 cubic inches capacity. Test weight is a very important factor in wheat grading. Definite limits in test weight differentiate between the various numerical grades in sound and unmixed wheats. As grade in turn regulates the price this factor is highly significant to the wheat grower and is therefore of interest to the agronomist and the cereal technologist when evaluating varietal and cultural effects upon wheat quality.

Test weight is also a factor of importance to the flour manufacturer as it is highly correlated with the quantity of flour which may be obtained from a given lot of wheat. Sound wheats of high test weights produce more flour per bushel than low test weight wheats and are accordingly sought after by the miller. This desirability is reflected in the Federal grading system.

Test Weight Measurements

Standard equipment for finding the test weight of wheat is described in the Handbook of Official Grain Standards, published by the Agricultural Marketing Service, United States Department of Agriculture—1939 edition. An integral part of this equipment is the quart measure or kettle which contains exactly 1/32 of a bushel. By means of suitable standardized techniques described in the Handbook, the weight of grain contained in the kettle is ascertained, and the corresponding weight per bushel read off from the graduated beam of the apparatus or weighed on an accurate balance. Test weight depends upon the volume occupied and the actual density of the wheat. Plump-kerneled grain usually has a higher test weight than grain containing a large proportion of shrunken, shriveled kernels, which follow drouth and heavy rust damage.

Wheat varieties differ in test weight, even when grown under comparable conditions of soil and moisture. It is necessary to measure these varietal differences when testing wheats grown on experimental plots.

Limitations of the Standard Method

The standard method of test weight determination is satisfactory when several pounds of wheat are available for testing purposes, as is the case when working with wheat varieties grown on experimental plots. In the instance of the plant breeders' samples where new hybrids and selections are being grown in limited quantities the amount of wheat produced may be much too small for this method unless the test is allowed to wait until more grain can be produced. By doing this, valuable time is lost in securing information in respect to the quality of new rust-resistant varieties which may be eminently suitable for production in the State. The same is true of wheats grown in greenhouse tanks or sand cultures in nutrition studies where the cost of space and chemical nutrients preclude the production of wheat sufficient in quantity to fill a quart kettle. Other circumstances also may arise as in the carrying out of a pre-harvest survey of the wheat crop, where it is desirable to make test weight measurements on a relatively small wheat sample. Surveys of this nature were made by the Agricultural Marketing Service in the hard red spring wheat region in 1939 and in the hard red winter wheat area in 1939 and 1940 when a micro test was used to determine bushel weight.

Micro Methods of Measuring Test Weight

Aamodt and Torrie (1934) reported a study on Canadian wheat dealing with the relationships between the weight in grams of a 4 cc. sample multiplied by 20 and test weight as determined by a one pint measure. A high positive correlation (.947) was obtained with 184 samples of spring wheat, and a slightly lower correlation (.834) with 59 samples of winter wheat. It was shown that the 4 cc. method tended to give slightly higher results than the standard, but this difference was considered by the authors to be of negligible importance.

It was thought advisable to apply a modified form of Aamodt and Torrie's micro technique to an investigation of the reliability and precision of this method in comparison with the official standard United States procedure when testing North Dakota hard red spring wheat. This investigation was carried out in the following manner.

Two separate micro determinations were used in this study. These methods will be designated as the 16 cc. and the 4 cc. test respectively. One cubic inch in customary units is approximately equal to 16.4 cc. and therefore 4 cc. equals slightly less than one quarter of a cubic inch. On the average 30 grams of wheat were required for the 16 cc. test and 8 grams for the 4 cc. test. These weights compare with 1100 grams needed in the standard test.

The standard equipment for determining test weight is shown in Figure 1. This equipment includes the quart kettle, funnel and stand for filling the measure, and stroker for leveling off the surface of the wheat after the kettle has been filled to overflowing. A balance for weighing the kettle's contents as well as weights for the balance are shown at the right of the picture.

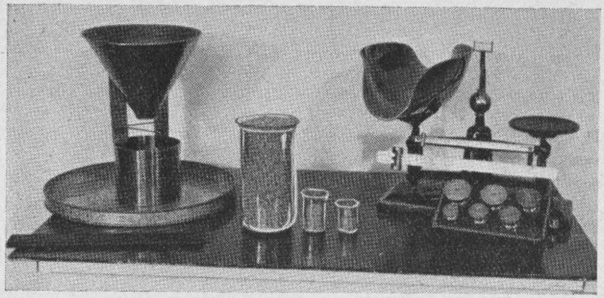

Figure 1. STANDARD EQUIPMENT FOR DETERMINING TEST WEIGHT.

Quart kettle with funnel at left of picture. Balance and weights for determining weight of a standard quart of grain shown at right. Quantities of wheat required for each of the three methods in centre.

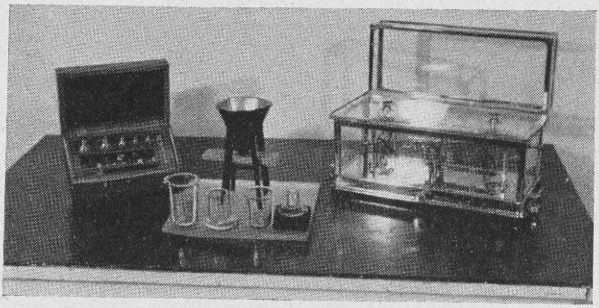

Figure 2. EQUIPMENT USED IN DETERMINING MICRO TEST WEIGHTS.

Funnel fitted with slide or shutter and 16 and 4 cc. measures are shown in centre, with quantities of wheat required for a test. Weighing balance at right, weights in box at left.

In Figure 2 the apparatus used in determining the micro test weight is shown. The small funnel at the left has an opening one half inch in diameter at the small end. The delivery end of the funnel is held exactly one inch above the center of the measure by means of a small stand, which precludes any possibility of the apparatus altering in position during or between tests. The glass measures were made from standard graduated cylinders by cutting off the lower base end at the proper height, and grinding the cut edges down to the correct volume. This procedure produced a smooth, level edge on the measure. A cylindrical hard wood stroker three eighths inch in diameter was used to strike off the superfluous grain in order to secure a level surface. This stroker is shown in the center of the figure. A grain testing balance with a sensitivity of 0.01 gram is shown at the right in the photograph with metric weights used in weighing the wheat after measuring. This equipment must be used on a rigid level base.

The method used in the determinations was essentially the same for both micro methods. The wheat to be tested is placed in the funnel with the slide or shutter closed. The measure is centered exactly under the funnel and the slide opened quickly. All the grain contained in the funnel is allowed to run through, overflowing the measure. The stroker is then placed lightly on the edge of the measure, care being taken not to jar or disturb the cylinder. The wheat is now leveled off with a zig zag motion of the stroker. The quantity of wheat remaining in the measure is then accurately weighed on the balance and the weight recorded to 0.01 gram. This weight is multiplied by the requisite factor to give the test weight per bushel.

Discussion of Results

The test weights obtained by the three methods on ten samples of hard red spring wheat are shown in Table I. In the instance of the 16 and 4 cc. technique the appropriate factor was calculated for multiplying the weight obtained in grams to obtain the test weight in pounds per Winchester bushel. Some discrepancy is noticeable in the results obtained, especially with the 4 cc. measurements, and from the data yielded by these ten samples the factor 20.7 rather than 20.0 appeared to give more consistent results when compared with the standard quart method. Differences in the dimensions of the various measuring containers no doubt are reflected in the degree of packing of the wheat kernels with consequent effect upon the relative volume occupied. The size of sample appeared to exert an effect upon the relative variability of the results, variability varying inversely as sample size.

The discrepancy between the relationship of the 4 cc. micro and standard methods found in the present investigation and those reported

Table 1. TEST WEIGHTS AS OBTAINED BY THREE METHODS

Sample number		Standard weight		16 cc. (Weight x 5.0)		4 cc. (Weight x 20.0)		(Weight x 20.7)	
1		56.2		56.85		53.60		55.48	
		56.2		56.75		54.60		56.51	
		56.3		56.30		54.60		56.51	
	Average		56.23		56.63		54.27		56.17
2		59.6		60.05		55.60		57.55	
		59.8		59.95		57.20		59.20	
		59.7		60.15		56.60		58.58	
	Average		59.70		60.05		56.47		58.44
3		60.4		60.25		56.60		58.58	
		60.5		60.60		57.60		59.62	
		60.5		60.35		57.60		59.62	
	Average		60.46		60.40		57.27		59.27
4		59.1		60.55		56.80		58.79	
		59.3		60.25		56.00		57.96	
		59.3		60.00		56.40		58.37	
	Average		59.23		60.27		56.40		58.37
5		63.5		63.35		59.20		61.27	
		63.5		63.70		59.20		61.27	
		63.6		63.35		60.00		62.10	
	Average		63.53		63.47		59.47		61.55
6		60.0		60.10		56.60		58.58	
		60.1		60.10		57.20		59.20	
		60.2		60.15		56.80		58.79	
	Average		60.10		60.12		56.87		58.86
7		62.6		63.50		58.80		60.86	
		62.4		63.30		59.80		61.89	
		62.6		63.85		58.60		60.65	
	Average		62.53		63.55		59.07		61.13
8		60.6		60.80		57.20		59.20	
		60.7		61.45		57.80		59.82	
		60.7		61.10		58.80		60.86	
	Average		60.66		61.12		57.93		59.96
9		59.5		59.40		55.60		57.55	
		59.6		59.70		56.20		58.17	
		59.6		59.65		56.80		58.79	
	Average		59.56		59.58		56.20		58.17
10		63.4		64.45		59.20		61.27	
		63.5		63.85		59.40		61.48	
		63.5		64.25		59.20		61.27	
	Average		63.46		64.18		59.27		61.34

Average Test Weights by Four Methods for the Ten Samples

Standard weight	16 cc. (wt. x 5.0)	4 cc. (wt. x 20.0)	4 cc. (wt. x 20.7)
60.55	60.94	57.32	59.33

by Aamodt and Torrie are largely due, no doubt, to differences in technique in making the micro determinations.

In view of the relationships brought out in the table which indicate the probability that micro methods may be successfully employed to find a test weight strictly comparable to standard methods, it seemed desirable to conduct a further and more extensive study of the methods, and to work out by modern statistical techniques a suitable factor to employ in calculating test weight from micro measurements. An examination of the effect of variations in test weight upon the comparative differences obtained between methods will also be made. This project is now approaching completion and a publication will shortly be made of the results and conclusions obtained.

Literature References

Aamodt, O. S., and Torrie, J. H.
1934 A simple method for determining the relative weight per bushel of the grain from individual wheat plants. Can. J. Research *11*:589-593.

Tax Delinquency as Related to Local Government Organization and Finance

By MORRIS H. TAYLOR, Assistant Agricultural Economist[1]

AN increasing amount of rural land is tax delinquent. In May 1940 7,222,678 acres of rural land were tax delinquent, of which 2,154,773 acres were subject to tax deed. The delinquency is much greater in western North Dakota due to lower rainfall and less productive land than is found throughout the Red River Valley.

There are a number of factors contributing to the tax delinquency of farm land. Among these are the adverse weather conditions and resulting crop failures, tax moratoria, excessive tax levies and the relative low purchasing power of the farmers. The effect of the climate upon crop yields and hence tax delinquency is self evident.

Tax Moratoria

The tax moratoria was instituted under ex-governor Langer's administration as a measure to aid in sustaining private ownership of farms of North Dakota. Undoubtedly many farmers suffering from drought and low income were benefited by the tax moratoria. However, ex-governor Langer pointed out that soon after the tax moratoria had gone into effect that his committee had gathered data to the effect that large corporations and non-resident landlords were collecting rentals and refusing to pay taxes. Likewise, certain resident owners financially able to pay their taxes refused to pay taxes currently due with the view to obtaining legislation to outlaw delinquent taxes.

A rather amusing case was called to the author's attention recently. A land owner took advantage of the tax moratoria and did not pay his taxes for 6 years. It was announced that the moratoria would no longer apply and that interest and penalty would apply after March 1, 1939; and also that counties may proceed to take tax deed to tax delinquent lands. This land owner paid his delinquent taxes on March 1, 1939 amounting to $1000. About a week later, the Board of County Commissioners extended the moratoria, as was their privilege, and

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