THE QUALITY OF 1984 KANSAS WHEAT (*Triticum aestivum* L. em. Thell) SEED AND ITS EFFECT ON THE QUALITY AND YIELD OF GRAIN

by

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INTRODUCTION AND LITERATURE REVIEW

In the fall of 1984 Kansas farmers planted 12.7 million acres of wheat (Triticum aestivum L. em. Thell.). According to the Kansas Crop and Livestock Reporting Service (18) that accounts for 17% of the nation's winter wheat production.

There are many factors that determine yield potential of the crop, quality of seed being a primary consideration. Tekrony (39) listed five factors which determine high seed quality: [1] genetic (varietial) purity, [2] mechanical integrity, [3] seed-borne disease infection, [4] germination and vigor and [5] freedom from crop and weed seed contamination. These factors separate quality seed from bin run seed; bin run seed can be seed that the farmer augers directly from a bin into a planter with no cleaning or testing, or it may be seed of a preferred variety that has been custom conditioned, treated, bagged, and tested. In spite of source and handling of bin run seed, difference in quality between this seed and seed produced within established seed production practices has been documented by Tekrony (39).

The major emphasis of this study has been to examine quality of wheat seed being planted in Kansas, and how each individual seed quality factor--varietial purity, mechanical integrity, disease infection, germination and vigor, and freedom from crop and weed seed contamination--can ultimately influence grain yield and quality. And, by so doing a producer can determine specific areas where improvement is needed.

DRILL BOX SURVEYS

The major source of information used in this study is a 1984 Kansas Wheat Drill Box Survey, a random sampling of seed planted in 1984. Numerous other studies, from Kansas and other locations, have documented the quality seed of wheat and other crops. Information from earlier Kansas drill box surveys was gathered from the files of the Kansas Crop Improvement Association.

In a 1954 survey in Republic County, Kansas, it was found that 40% of 467 wheat samples collected were contaminated with noxious weed seeds. Thirty samples of spring wheat seed were collected in early 1955 which averaged 97.95% mechanical purity and .03% weed seed. Nineteen samples contained prohibited or restricted noxious weed seeds. In the fall of 1955, twenty-two more samples were collected and seed analysis showed mechanical purity and weed seed contamination at approximately the same levels.

Dale R. Schilling, Agricultural Extension Agent in Kingman County, Kansas collected 59 wheat seed samples from 52 growers in the fall of 1960. Less than two-thirds of the seed samples had been cleaned before planting and only one seedlot was not home-grown. Many samples exhibited low germination and contained large quantities of weed seed; it was obvious that little had been done to improve quality before planting.

Clapp (4) described another survey done in Republic County in 1959 covering 4% of that county's wheat acreage. Only 2 of sixty-one samples collected were purchased from a seed dealer; fifty-eight percent of those samples were reported to have been

cleaned. There was a large range in seed quality with a germination range of 16% to 98% and mechanical purity ranging from 94.98% to 99.83%. This survey is the earliest mention in the literature cited of a difference in quality between cleaned and uncleaned seed. Also it is the first time that samples collected were planted for varietal purity and only 25 of 58 samples were found to be varietal pure.

Clapp (4) also described a 1959 survey done in Cheyenne County, Kansas where 43 wheat samples were collected and a kernel analysis showed only 47% to be pure for the variety the farmer had reported.

According to a news bulletin (15) released in 1960, 45 samples of wheat were submitted for the Finney County, Kansas fair wheat show. Kernel analysis showed that 69% of those samples were pure for variety stated.

Another news release (16) explained a drill box survey conducted in 1961 in 22 northeastern Kansas counties. Forty-eight of ninety-three samples were found to be pure for the reported variety. Two-thirds of the samples were reported to be cleaned, but only six samples were purchased from a seed dealer. Seed germination was higher than previous surveys mentioned, but mechanical purity values showed that some samples were very clean and others were very dirty; and over half of the samples still contained weed and other crop seeds.

In 1962, 92 wheat seed samples were collected from 14 northeastern Kansas counties. Clapp (4) reported the results in another KCIA news release. Seven of 92 samples were purchased

from a dealer, and 62 were found to be pure as to reported variety. Fifty-seven of 92 samples were cleaned. Samples again ranged from low to high quality, but only 33 samples would pass all mechanical purity requirements for certified seed.

Among surveys on other crops is a report by Brickbauer, et al. (3), dealing with oats planted in Wisconsin from 1964 to 1969. In this survey homegrown seed accounted for 63% of collected samples; ninety-four per cent were reported to be cleaned, but only 14% were found to be free of weed and crop seeds and to have a germination of 90% or greater. The results also showed that 12% were mixtures or were incorrectly named as to variety.

In 1963 Ray (31) conducted a survey of cotton seed planted in Texas. Seventy four samples of one cotton variety were collected and planted in yield and varietal purity trials. Data for three years of planting showed an advantage of 116 pounds of lint per acre for registered and certified seed above bin run seed. Varietal purity analysis also showed a seed mixture in some farmer samples.

Tekrony (40) was concerned that Kentucky soybean yields averaged 28 bushels per acre even though some farmers were consistently producing 40 bushel yields. A survey of 19 western Kentucky counties was conducted with 354 samples of soybean seed collected. It was found that 47% of seed was purchased from seedsmen and 30% was of certified seed classes. Ninety five percent of the samples were cleaned commercially and only six samples, all homegrown, were not cleaned. Mechanical purity

averaged more than 99% for all samples, but certified seed showed 0.5% higher purity and much less weed and other crop seeds than homegrown samples.

In 1978 a soybean seed survey was conducted in Missouri by Murphy and Aslin (28). Their findings showed about 20% of surveyed farmers planted certified seed, and only seven of 250 samples received were not cleaned. It was also reported that use of certified seed had expanded tremendously in past years and that most seed planted was either certified or one year from certified. These results showed that quality was improved from a 1955 survey.

Quality of soybean seed planted in Kansas was a concern of Lubbers (23) when he conducted a survey in 1978. Three hundred seventy-nine samples were collected, with 90.5% of the samples cleaned and an average of .03% weed and other crop seeds per sample. Use of homegrown seed increased from the western (25-40%) to the eastern Kansas (70-76%). Twenty percent of the samples were of one of the certified classes, and 86.8% of samples were three years of certification.

Because soybeans are a nineteen million dollar industry in Georgia and high quality seed is one essential input into the soybean production, Hollifield and Lowery (12) initiated a survey to determine source and quality of the soybean seed planted by Georgia farmers. Forty-six of 135 seed samples collected were of certified status and 81 samples were either homegrown or purchased from another farmer. Eighteen of the samples, all homegrown, failed to meet minimum standards under Georgia State Seed

Law and were deemed unsaleable. A yield trial showed a 4.5 bushel per acre advantage to planting certified seed of recommended varieties, as well as a 5.9 bushel per acre advantage of certified seed over the seed found unsaleable. Many farmers had planted seed that was certified or only 1 or 2 years from certified showing they believed in purchasing certified seed to improve yields.

In addition to studies done in this country, studies throughout the world have looked at quality of seed planted. Williams (45) looked at impurities in wheat seed planted by Ethiopian farmers. Average mechanical purity of samples was only 94.2% primarily because of primitive threshing and separation problems; when mechanical cleaning was used, purity was found to be higher.

In India, a survey of wheat farmers by Sharma, et. al. (35) found uncertified samples were generally poorer quality and lower yielding than check plots planted with certified seed. A positive correlation was found between genetic impurity and number of years that seed had been used by the farmer.

A survey was conducted by Westerlind and Oliveras (44) in the spring of 1983 to compare quality of cereal seed sown in eastern Sweden. In this survey, the germination, seed vigor, and mechanical purity of uncertified samples was all lower than certified samples. Only 30% of the uncertified samples were considered to have been well cleaned.

Seed quality was the subject of a survey of Brazilian rice farmers by Dan, et. al. (7) in 1978. Ninety-two percent of the

rice seed planted was locally produced by the farmers or their neighbors. Only one-half of the samples had germination of 85% or better, and more than three-fourths of the samples had undesirable red rice grains in excess of certified seed standards.

A survey of wheat growers by McLelland (25) evaluated 650 samples of spring wheat grown in Alberta, Canada in 1980. Samples were graded according to the Canadian Seeds Act and 16% of samples graded No. 2 and 18% graded "reject." This was an improvement over a 1973 survey in which 50% of samples fell into one of those two classes. Homegrown seed accounted for 60% of the samples, which was about the same as the 1973 survey; the quality of those samples was higher than in 1973. Eighteen percent of farmers reported that the sample that they supplied was classified as certified seed, the use of this type of seed being up from the 1973 survey.

Quality of wheat seed improved in Manitoba (24) in 1981 over 1976 according to a survey in the province. Seventy-four percent of 267 wheat samples were homegrown and 27% of samples were of the certified classes. Almost all of samples were reported to have been cleaned, but 28% were graded "reject" because at least one quality factor was low.

Regarding surveys conducted in the United States on seed wheat, a Georgia survey (43) showed that many farmers are still planting seed that is unfit for planting. Forty-six percent of all samples collected were homegrown with another 19% purchased from neighbors, and only 12% of samples were certified. Analysis

showed certified seed was of very high quality and uncertified, homegrown seed was of much lower quality. Thirty-two of those homegrown samples did not meet minimum state seed law standards.

In Oregon, Goetze (10) found that of 99 wheat seed samples collected in 1976, most had a germination of at least 85%. The mechanical purity of the seed samples was not as encouraging, with the inert material ranging from .09% to 5.12% in this survey, and 34 of the samples contained weed seeds.

A study conducted in North Dakota in 1980 and 1981 by Ball, et al. (1) collected samples of barley, durum wheat, and oats, as well as 325 spring wheat samples. Fifty-nine of the spring wheat samples did not pass minimum standards for certification because of excessive inert material; eight other samples had low germination, or weed or other crop seeds in excess of acceptable limits. Fifty-two percent of those wheat samples collected were either one or two years from certified. All but three spring wheat samples were reported to be cleaned, and 69% of those were conditioned at a local elevator.

In the fall of 1976, Schoeff (34) collected uncleaned seed samples at cleaning plants in Kansas to investigate the quality of wheat being stored by farmers. It was concluded that 26% of the samples had some serious defects or insect damage that would lower its quality for use as grain or seed.

In an attempt to discover the quality of seed being planted and how it affects yield, Jacques (13) conducted a survey in 1973 of 534 Kansas wheat growers. He found that 52% of farmers planted just one variety of wheat, and 94% of seed was homegrown

or purchased from another farmer. Fifty-nine percent of samples received were two years from certified or more with only 3.9% being of certified classes. Tests showed that only 64.8% of the seed received had a germination of 90% or greater and 78% of the samples had been cleaned.

In addition to drill box surveys, there are other ways of judging the quality of seed that farmers plant. Hazen (11) looked at analysis reports of 1522 samples of wheat seed tested by the Kansas State Seed Lab in 1945. He found that 15.87% contained weed seeds and 10.05% contained seeds of other crops; cheat was the most predominant weed seed, and field bindweed, in 4.73% of the samples, was the most prevalent primary noxious weed. For farmers wanting to eliminate weeds when producing clean seed, Hazen recommended "roqueing the field, sowing in [a] clean seed bed and sowing pure, clean seed."

In 1979 Paulsen (29) collected wheat samples from farmers and separated them by appearance. No significant differences were found in seed protein or seed germination or in the grain produced by that seed. He showed that it would be difficult to select seed on visual characteristics only. Thus, if a farmer decides to use bin run seed it should be tested for germination and vigor.

QUALITY COMPONENTS

The influence that seed weight or size has on grain yield has been recognized for many years. In 1733 Tull (42) recommended planting "middle-siz'd seed" because it would give more plants to the acre and would save the large kernels which

would produce more flour. More recently in 1924 in Nebraska, Kiesselbach (20) showed yield advantages of large seed compared to smaller, lighter seed. Studies on barley (19,27) showed that seed size has an effect on vigor and yield in that crop as well. When varieties of Kansas wheat were looked at for seed size differences, both Bolaria (2) and Robertson (33) agreed that seed weight was the most important factor studied in relation to yield. Taylor (37) made continuous selections of large and small seeds from large and small seeded selections of one variety and showed that large seeds produce more large seed, higher test weight, and increased yields.

Protein levels of wheat used for grain are important because they influence grain pricing and ultimate food value. One such study by Evans and Bhatt (8) showed that there is a tendency for protein level to be higher in larger seed classes. A study by Shroyer and Cox (36) collected samples of various cultivars of wheat and found that the large seed fraction contained the highest weight of N per 200 kernels. Paulsen (30) showed similar findings, but went on to show that kernel weight differed by cultivar, and these differences are affected by environmental factors but rankings of different cultivars remained similar despite the environment. These studies indicate the relationship between seed size and protein content of seed and how these two factors ultimately affect the protein of the grain produced.

If seed size has an effect on protein, does it also show any correlation to actual plant growth? Evans and Bhatt (8) noted that seed size influenced seedling vigor in all cultivars tested

regardless of planting depth or harvest method, and since vigorous seedlings can withstand more stress, the result was better stand establishment. Lowe and Ries (22) found a high correlation between seed protein and total dry matter produced three weeks after sowing. Plants grown from high protein seeds were taller, had a larger leaf area in the first leaf and higher shoot dry matter after seven days than did plants from low protein seeds.

Ries and Evenson (32) showed similar results in a 1973 study that used several wheat cultivars, noting that "because seedling size or vigor, regardless of genotype, is related to protein content of seed, it may prove beneficial for seed producers to increase the protein content of seed." Paulsen (30) also showed that breeding can have an effect on kernel weights and consequently on protein levels in the seed itself. Paulsen summed his remarks by saying, "Increasing the size or protein content of wheat seed probably lessens the limitations that are imposed by the nutrient and allows more active germination and seedling growth".

Of course the ultimate goal of any seed used is the production of a maximum grain yield. Grain yield was the subject of a study by Fjell, et al. (9) that used foundation seed of 12 different cultivars to look at the relationship of seed size to grain kernel size and grain yield. Evidence was found to show that larger seed produces larger grain. The same study showed that heavy kernels were associated with higher yields, and that "yield can be increased more rapidly by increasing [kernel weight] than by increasing kernel number."

SEED CERTIFICATION

The selection and use of high quality seed is one of the basic keys to satisfactory crop performance and competitive yields. Hollifield and Lowery (12) listed these benefits of purchasing certified seed:

[1] Assurance of receiving seed of known performance, varietal purity and high germination,
[2] Convenience of purchase,
[3] Product liability,
[4] Absence of noxious weeds, and
[5] Access to newest varieties.

Use of good seed is one of the easiest and most economical ways to increase quality of any crop. A common method of insuring quality seeds for planting is seed certification. Muresan (26) told of the need for seed certification:

> In order to avoid any doubt...about originality and varietal purity...seed certification [has] been developed. Without this guarantee [seed certification] a good deal of the plant breeders' work would be lost since the farmer who purchases seed could never be sure whether the seed meets his requirement.

Copeland (5) discusses some problems with seed quality including: low germination, poor seedling vigor, mechanical damage and seed borne diseases. One of the best ways to insure that all of these factors reach the highest level is to purchase certified seed. Copeland and Greenman (6) defined certification as:

> A system for bringing high quality seed of outstanding field varieties to farmers and seedsmen. The central concept is varietal purity, which is comparible to a pedigree in animals. It represents the seed with the genetic potential and varietal purity to produce high yields.

Planting of bin run grain for seed may not reduce quality of seed, but according to Copeland and Greenman old seed results in a "loss of crop quality...due to contamination by weeds, other

crops and other varieties or by a disease buildup" (6).

Not only does certified seed insure that the farmer would plant higher quality seed but there is also evidence of yield increases when planting certified seed. Thomison (41) reviewed a study in Illinois on soybeans which ran for 17 years that showed a yearly yield advantage of 2.81 bushels per acre for certified seed over uncertified seed. Another study that Thomison looked at in northwestern Ohio showed a 3.1 bushel per acre difference for certified seed. It was emphasized that bin run seed does have costs above grain price and that farmers could increase profits by $19.53 per acre for soybeans by planting certified seed.

In a news release, the Illinois Crop Improvement Association looked at that same study which showed that bin run soybeans with a market value of $6.20 per acre actually cost $8.37 per acre to plant. Coupling with a 2.5 bushel/acre differential in yield can show a farmer an additional $14.00 income per acre.

CONCLUSIONS

1. Results of surveys on numerous crops over a thirty year period show that farmers are increasing the use of higher quality seed. Less homegrown seed is being planted, more is being cleaned, and varietal and mechanical purity is improving, although all factors still could be improved upon.

2. Use of high quality seed can increase grain yields over low quality seed. Use of larger, heavier seeds increases protein content, which in turn produces more vigorous seedlings and ultimately can show grain yield advantages.

3. Seed certification standards are a method of insuring the quality of seed being planted. Certification can dictate quality--mechanical purity, varietial purity, seed size, and absence of weed seeds--so that the farmer can be assured that he is planting the best quality seed available.

MATERIALS AND METHODS

COLLECTION OF SEED SAMPLES AND SURVEY INFORMATION

A random sample of wheat farmers was drawn by the Kansas Crop and Livestock Reporting Service. Growers were selected on a county by county basis with regards to number of growers in the county and number of acres of wheat raised within that county. Approximately 18 to 20 farmers were selected from each county in the western and central crop reporting districts and 12 to 16 farmers per county in the three eastern crop reporting districts. A total of 1755 names were drawn from nine crop reporting districts in the state of Kansas.

A questionnaire (Appendix) was developed to gather information about the quality of wheat seed being planted, management practices of farmers who plant the seed, and future directions that farmers will choose regarding seed use and management. These questionnaires along with the list of the selected farmers' names and instructions were sent to county agricultural extension agents for collection of seed samples. Agents were asked to contact each farmer on their list, explain the purpose of the survey, collect a five pound sample of one wheat variety which was to be planted in the fall of 1984. Additionally, county agents assisted the farmers' completion of these questionnaires about the seed.

After the samples were obtained they were collected by area extension agronomists, or other Agronomy Department personnel and transported to the Agronomy Department in Manhattan for processing. Since many of the 1755 farmers on the list were

difficult to locate, a total of 662 samples were collected and used to form the basis of this work.

As samples were received, data from the questionnaire were transferred to computer files. Approximately 500g of seed from each sample of seed were sent to the State Seed Testing Laboratory, Topeka, Kansas for analysis of germination, mechanical purity, presence of inert material, name and number of noxious weed seeds present, and the name of other common weed or other crop seed contaminants. Also included on each report was a notification if the seed sample as submitted was not in compliance with the Kansas State Seed Law.

Determination of bushel test weight of the remaining seed was made by filling a one pint container, weighing it on an electronic scale which converted the weight to pounds per bushel. The same one pint subsample was also used for determining three screening fractions. The seed was separated on a mechanical screen shaker for one minute, and weights and percentages of total weight were found for the three fractions--seed that remained on top of a 6/64" by 3/4" (24mm x 19lmm) screen, seed that fell through that screen but remained on top of a 5/64" by 3/4" (20mm x 19lmm) screen, and seed that passed through both screens.

Another subsample of approximately 40 grams was removed from the main sample. One thousand kernels were mechanically counted from this subsample, dried at 65^{o} C, and weighed. The same subsample was ground and sent to the Soil Testing Laboratory for nitrogen determination (38). Total N was multiplied by 5.7 to convert to protein percentage.

YIELD TRIALS

Since Newton, Tam 105, and Larned were the most used varieties by acres harvested in 1984, it was determined that samples from these varieties would be used for yield trials. A fourth variety, Scout, was also used in yield trials because enough samples were collected that a valid comparison could be made between this survey and the one conducted in Kansas by Jacques (13) in 1973. Thirty-eight samples of each Tam 105 and Newton, and 37 samples of Larned were randomly selected for planting at experiment fields near Manhattan and Hutchinson. Nine samples of Scout were selected for planting at Hutchinson and eleven for planting at Manhattan. Each variety was treated as an individual experiment with foundation seed of that variety being used as a control. The experiments with Newton, Tam 105, and Larned seed each contained 39 plots while the Scout experiment contained 12 plots. Plots were laid out in a randomized complete block design and replicated three times. Each plot was 4 rows wide 1.02 m by 5.49 m long. Plots at both locations were fertilized as if they were regular production fields, with a 95-28-0 applied at Manhattan and 90-40-0 applied at Hutchinson. Seeding rates at both locations were approximately 40-50 grams per plot, but were on a volume rather than weight basis. Plots were planted at Hutchinson on 14 October, 1984 and on 3 November, 1984 at Manhattan. Delays in planting at both locations occurred due to rains, and moist soil resulted in some planting difficulties.

Stand ratings were taken at Hutchinson on 9 November, 1984,

but because of late planting in Manhattan, fall emergence was low and stand ratings were not taken. A spring stand rating was taken on 4 March, 1985 at Hutchinson and 1 April, 1985 at Manhattan. Ratings were taken on a six point scale with 6 being excellent, 5 and 4 being good, 3 and 2 being fair, and 1 being poor. To determine these ratings a quick visual overview of the plots was conducted; stand density, vigor, and uniformity within the plot were all considered when determining the ratings for each plot.

Head counts were taken at both locations approximately four weeks before harvest. Number of heads were counted in a 61 cm long section in the middle of the second row of each plot in all four replications.

Plots were trimmed to 4.57 m, and all four rows harvested, for a total area of 4.66 m^2. Harvesting occurred on 19 June, 1985 at Hutchinson and 28 and 29 June, 1985 at Manhattan with a mechanical harvester. The harvested grain was cleaned through a fanning mill, weighed, and converted to kg/ha. Bushel test weights and screening fractions of the grain were obtained in the same manner as previously described for the seed.

Another subsample of grain from each replication was saved, and used to measure the 1000 kernel weight. Additionally, a protein analysis was performed on the Newton, Larned, and Scout grain samples from Hutchinson. The method for deriving 1000 kernel weight and protein for the grain was the same as was previously described.

Data collected from the questionnaire and the seed analysis

was recorded in frequency tables. Mean values for stand ratings, head counts, yields, test weights, screening fractions, seed weights, and proteins were calculated and compared with the data from the 1973 survey (13). Correlations were run between the 1973 survey means and 1984 questionnaire and seed analysis means. Statistical analyses on yield and yield components for each variety were calculated for both locations. Similar analysis of data obtained on Scout from the 1973 survey allowed comparison of this variety between the two surveys.

VARIETAL PURITY PLOTS

At the time of collection of seed samples, a subsample was removed to be planted in a varietal purity study at the Manhattan location. Plots were originally designed to be four-row plots 5.49 m by 1.02 m, but because of land availability most of the plots were 3.66 m long. Samples were planted in groups by variety with a control of one or more plots of foundation seed of that variety. Because of planting errors and space restrictions 607 of the original 662 seed samples were planted in the purity plots.

Approximately three weeks before harvest and again just prior to harvest, evaluations of varietial purity were made. Identification of off-types and incorrect varieties was based on morphological characteristics such as height, straw color, leaf characteristics, and spike characteristics. Results were reported into one of three categories: 1) Pure-no other varieties or off-types within variety present, 2) Mixed-1% to 30% other varieties or off-types, or 3) Incorrect-contamination by

other varieties of more than 30% of total plants. This information was incorporated with specific questionnaire data to construct varietal purity frequency tables.

It was determined from the questionnaire which plots were planted with seed that was six or more years from certification. Sixteen plots were found to be in that category with six different varieties being represented. Approximately 25 heads were hand harvested from those plots, threshed, and run through a fanning mill. Electrophoresis was run on these samples in accordance with methods described by Lookhart et al. (21). Foundation or registered seed for those varieties was used as a comparison when searching for genetic drift in those older samples.

RESULTS OF SURVEY INFORMATION AND SEED ANALYSIS

The 662 samples received in the survey included 50 varieties, two hybrids and two other samples that were reported to be mixtures of two varieties. As shown in Table 1, Newton was the most frequently reported variety in the state with 175 samples or 26.4% of the total. It was also the most used variety in five of the nine crop reporting districts second in popularity in the East Central and South Central and, third in the West Central and Southwest Districts. Hawk was the second most used variety with 114 samples, or 17.2%. Hawk was the most used variety in the central one-third of the state where it was the variety of choice of 16.8% to 28% of participants and was also the most used variety in the West Central and South Central Crop Reporting Districts.

Tam 105 was the third most used variety with 96 samples, or 14.5%. It was most used in the three central crop reporting districts and had the most samples, along with Hawk, in the West Central Crop Reporting District. Larned and Arkan were equal in popularity in the survey with 45 samples, or 6.8%. Larned is a variety that is more adapted to drier areas of the western portion of the state as evidenced by 33 samples from the western three districts and no samples from the eastern one-third of the state. Larned was the most used variety in the Southwest District of Kansas. Arkan's adaptation region is further east than Larned, and all of the Arkan samples originated from the eastern two-thirds of the state. Arkan was the most used variety in the East Central District.

Table 1 VARIETIES BY STATE AND CROP REPORTING DISTRICT

Variety	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
Arkan	0* .00%**	0 .00%	0 .00%	8 1.21%	15 2.27%	5 .76%	2 .30%	9 1.36%	6 .91%	45 6.80%
Baca	0 .00%	0 .00%	2 .30%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	2 .30%
Brule	2 .30%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	2 .30%
Buckskin	2 .30%	0 .00%	0 .00%	0 .00%	0 .00%	2 .30%	0 .00%	0 .00%	0 .00%	4 .60%
Centurk/ Centurk 78	2 .30%	0 .00%	0 .00%	0 .00%	2 .30%	0 .00%	0 .00%	2 .30%	0 .00%	6 .91%
Eagle	5 .76%	7 1.06%	10 1.51%	2 .30%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	24 3.63%
Garst variety	3 .45%	0 .00%	3 .45%	1 .15%	0 .00%	0 .00%	0 .00%	1 .15%	0 .00%	8 1.21%
Hawk	4 .60%	13 1.96%	15 2.27%	16 2.42%	28 4.23%	28 4.23%	6 .91%	4 .60%	0 .00%	114 17.22%
Larned	8 1.21%	11 1.66%	14 2.11%	1 .15%	5 .76%	6 .91%	0 .00%	0 .00%	0 .00%	45 6.80%
Monarch	0 .00%	0 .00%	1 .15%	0 .00%	0 .00%	1 .15%	0 .00%	0 .00%	0 .00%	2 .30%
Mustang	0 .00%	0 .00%	1 .15%	0 .00%	1 .15%	3 .45%	3 .45%	1 .15%	2 .30%	11 1.66%
Newton	19 2.87%	8 1.21%	12 1.81%	28 4.23%	48 7.25%	26 3.93%	14 2.11%	8 1.21%	12 1.81%	175 26.44%
NK 830	0 .00%	1 .15%	0 .00%	1 .15%	4 .60%	1 .15%	0 .00%	0 .00%	0 .00%	7 1.06%
NK 835	0 .00%	0 .00%	0 .00%	1 .15%	0 .00%	1 .15%	0 .00%	0 .00%	0 .00%	2 .30%
Pioneer varieties	0 .00%	0 .00%	0 .00%	0 .00%	2 .30%	1 .15%	3 .45%	1 .15%	1 .15%	8 1.21%

Table 1 Continued

Variety	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
PL145	0 .00%	0 .00%	2 .30%	0 .00%	1 .15%	1 .15%	0 .00%	0 .00%	0 .00%	4 .60%
Rocky	1 .15%	0 .00%	0 .00%	0 .00%	1 .15%	0 .00%	1 .15%	0 .00%	0 .00%	3 .45%
Sage	0 .00%	5 .76%	3 .45%	1 .15%	0 .00%	1 .15%	0 .00%	0 .00%	0 .00%	10 1.51%
Sandy	0 .00%	3 .45%	2 .30%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	5 .76%
Scout/ Scout 66	1 .15%	4 .60%	4 .60%	2 .30%	1 .15%	1 .15%	0 .00%	0 .00%	0 .00%	13 1.96%
Tam 101	0 .00%	0 .00%	0 .00%	1 .15%	0 .00%	1 .15%	0 .00%	0 .00%	0 .00%	2 .30%
Tam 105	4 .60%	13 1.96%	21 3.17%	20 3.02%	12 1.81%	10 1.51%	3 .45%	5 .76%	8 1.21%	96 14.50%
Triumph/ Triumph 64	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	1 .15%	0 .00%	1 .15%	2 .30%
Tut	1 .15%	0 .00%	0 .00%	1 .15%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	2 .30%
Vona	3 .45%	3 .45%	3 .45%	8 1.21%	3 .45%	4 .60%	0 .00%	1 .15%	1 .15%	26 3.93%
Wichita	0 .00%	1 .15%	0 .00%	0 .00%	0 .00%	0 .00%	1 .15%	0 .00%	0 .00%	2 .30%
Wings	1 .15%	1 .15%	1 .15%	2 .30%	0 .00%	1 .15%	3 .45%	4 .60%	1 .15%	14 2.11%
Others+	3 .45%	1 .15%	3 .45%	1 .15%	3 .45%	8 1.21%	2 .30%	1 .15%	6 .91%	28 4.23%
Column Total	59 8.91%	71 10.73%	97 14.65%	94 14.20%	126 19.03%	101 15.26%	39 5.89%	37 5.59%	38 5.74%	662 100.00%

* number of samples
** % of column total
+ Includes single samples of Bennett, Bounty Hybrid, Caldwell, Chanute, Danne, Hart, Kaw, McNair 1003, Parker, Plainsman V, Quantum Hybrid, Ram, Red Chief, Satanta, Tenmarq, Trison, Walker, Weathermaster, and 5409.

Seventh and ninth on the list of varieties are Eagle, with 24 samples and 3.6% of the total, and Scout with 13 samples and 1.9%. In the 1973 Kansas Drill Box Survey (14), Scout was the leading variety with 30.6% of samples received, and Eagle was second with 20.1%.

Kansas farmers are planting more varieties of wheat per farm than they did in 1973. Table 2 shows that 41% are now planting one variety, 32% plant two varieties and almost 27% plant three or more varieties. This is in contrast to the 1973 data (Figure 1) which showed that 52% planted just one variety. The main reason for the trend to more varieties is an increase in the number of available varieties. More diversity in their characteristics gives the farmer the opportunity to spread his risk with different wheat types. As in 1973, farmers in the western parts of the state planted more varieties than those in the east,

Table 2. Varieties Planted per Farm by Area of the State

Number of Varieties	Area of the State			
	West	Central	East	State
	----------% of samples----------			
1	44.1	33.4	57.9	41.4
2	34.4	30.9	28.9	31.8
3	16.3	21.9	8.8	17.6
4	4.0	10.6	4.4	7.2
5	0.8	2.6	0.0	1.5
6 or more	0.4	0.6	0.0	0.5

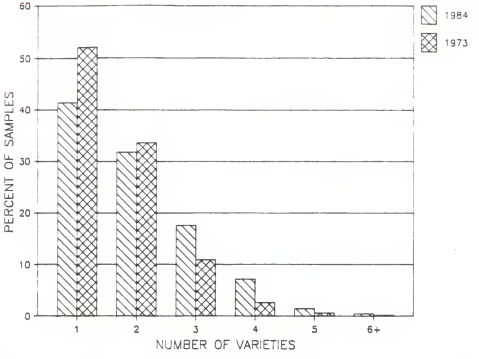

Fig. 1. Number of varieties planted per farm 1984 vs. 1973.

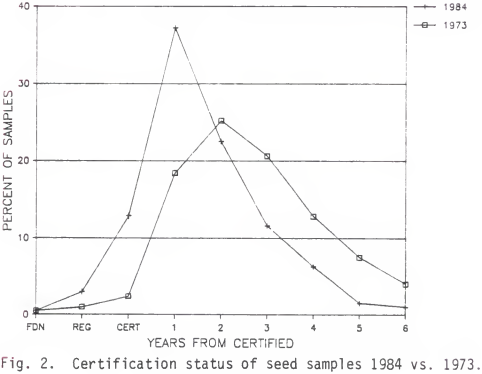

Fig. 2. Certification status of seed samples 1984 vs. 1973.

probably due to the larger acreages being planted.

Kansas farmers are planting more seed that is certified or closer to certified status than in 1973. Table 3 shows that 17% of samples received were in one of the certified classes or a hybrid, while in 1973 (Figure 2) only four percent of seed planted was in one of those classes. The eastern three crop reporting districts showed the highest use of certified seed, and a correspondingly lower proportion of seed which was further from certification. The western districts showed the highest use of further from certification seed. Table 4 illustrates that although 17% of the samples were of the certified classes, only 9.5% of total acreage was planted to certified classes of seed. Part of the reason for the difference is that hybrid, foundation, and registered seed fields tend to be smaller than production fields (3% of samples and only slightly more than 1% of acreage). Overall, the percentage of acres planted per dis

Table 3. Certification Status of Seed Samples by Area of State

Class of Seed	Area of the State			
	West	Central	East	State
	% of samples			
Certified Classes	9.9	14.8	35.2	16.7
1-2 Years From Certified	53.7	66.7	51.4	59.7
3-5 Years From Certified	28.1	15.8	12.4	19.3
6 or more Years From Certified	8.3	2.7	1.0	4.3

Table 4. CERTIFIED ACRES BY STATE AND CROP REPORTING DISTRICT

Class of seed	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
Hybrid	0*	0	75	0	0	50	0	0	0	125
	.00%**	.00%	.23%	.00%	.00%	.20%	.00%	.00%	.00%	.08%
Foundation	0	0	0	0	167	0	0	0	0	167
	.00%	.00%	.00%	.00%	.84%	.00%	.00%	.00%	.00%	.11%
Registered	0	70	50	170	822	140	45	233	29	1,559
	.00%	.29%	.15%	.83%	4.15%	.56%	3.00%	6.89%	.95%	1.05%
Certified	1,544	380	3,170	2,030	2,192	994	368	726	745	12,149
	8.29%	1.55%	9.82%	9.95%	11.05%	3.99%	24.53%	21.48%	24.29%	8.18%
1 year from certified	5,358	8,741	9,622	7,971	8,254	10,922	490	1,134	1,233	53,725
	28.76%	35.65%	29.79%	39.06%	41.62%	43.86%	32.67%	33.55%	40.20%	36.17%
2 years from certified	3,550	6,958	6,325	6,225	4,007	6,791	255	1,119	740	35,970
	19.05%	28.38%	19.58%	30.50%	20.21%	27.27%	17.00%	33.11%	24.13%	24.22%
3 years from certified	1,605	3,724	4,801	1,475	2,354	3,705	245	168	260	18,337
	8.61%	15.19%	14.87%	7.23%	11.87%	14.88%	16.33%	4.97%	8.48%	12.35%
4 years from certified	3,166	2,820	2,002	1,347	668	1,249	72	0	60	11,384
	16.99%	11.50%	6.20%	6.60%	3.37%	5.02%	4.80%	.00%	1.96%	7.66%
5 years from certified	260	760	0	910	0	250	0	0	0	2,180
	1.40%	3.10%	.00%	4.46%	.00%	1.00%	.00%	.00%	.00%	1.47%
6-10 years from certified	7	1,068	3,502	220	426	800	0	0	0	6,023
	.00%	4.36%	10.84%	1.08%	2.15%	3.21%	.00%	.00%	.00%	4.05%
More than 10	3,143	0	2,750	60	940	0	25	0	0	6,918
	16.87%	.00%	8.51%	.29%	4.74%	.00%	1.67%	.00%	.00%	4.66%
Column total	18,633	24,521	32,297	20,408	19,830	24,901	1,500	3,380	3,067	148,537

* Number of acres
** % of column total

trict is slightly lower than the percentage of certified samples planted in that district. However, the eastern one-third of the state shows not only higher use of certified seed, but also that seed is planted on a larger percent of the wheat acreage.

For the survey four sources of seed were considered: 1) homegrown, 2) another farmer, 3) farmer dealer, and 4) commercial dealer. Homegrown seed is normally bin run grain used for seed, but can be certified seed produced on the farmer's own land and used to plant his next year's crop. Another farmer seed is only bin run grain purchased from another farmer and used as seed. Seed from a farmer dealer is either a private variety or certified seed that has been handled as seed from the production field through final conditioning. A commercial dealer is one whose main business is the retail sale of seed and/or other farm supplies.

Throughout the the state, homegrown seed is still most popular (Table 5) accounting for almost 68% of all plantings. In

Table 5. Source of Seed by area of the State

Source of Seed	Area of the State			
	West	Central	East	State
	----------% of samples----------			
Farmer-Dealer	12.4	13.2	17.0	13.6
Homegrown	70.2	69.3	58.9	67.8
Commercial-Dealer	3.6	5.0	14.3	6.1
Another Farmer	13.8	12.5	9.8	12.5

contrast, 13.5% was purchased from farmer dealers, 12.5% from another farmer and only 6.1% from commercial dealers. The use of homegrown seed was highest in the west where acreages are largest, and seed purchased from a farmer dealer was highest in the east where acreages and field sizes are smallest.

When making a comparison with 1973 (Figure 3), homegrown seed was the highest percentage in both surveys, but in 1984 about 9% less farmers are planting homegrown than in 1973. Combining that 9% drop with a 6% decrease in another farmer seed, there is approximately a 15% increase in purchases of the normally higher quality farmer dealer and commercial dealer seed in 1984 compared to 1973.

Eighty-three percent of samples received in this survey were cleaned before planting (Table 6). This is an increase of 4.3% from 1973 (Figure 4) when 78.2% was cleaned prior to planting. Cleaning by a commercial cleaner was most popular with 63% of farmers sampled. Seed cleaned by the farmer at home was 14% and that cleaned by another farmer was 6% of the total.

The central part of the state, especially North Central and Central Districts, showed the highest percent of seed cleaned. There was no difference in percent of samples cleaned between the eastern one-third and the western one-third of the state. In the west, the larger amount of seed cleaned at home resulted in a proportional decrease in seed cleaned in commercial plants.

Over 56% of the seed cleaned by someone other than the farmer himself was cleaned within 10 miles of the farmer's home (Table 7). Fifteen (5%) of the sample lots were transported more

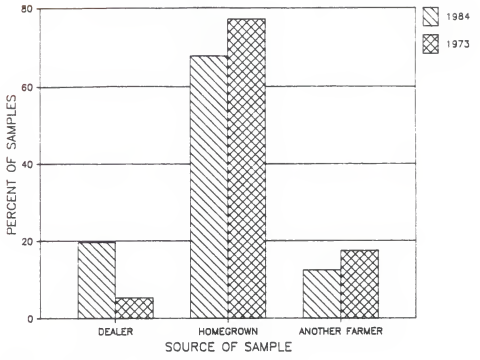

Fig. 3. Source of seed 1984 vs. 1973.

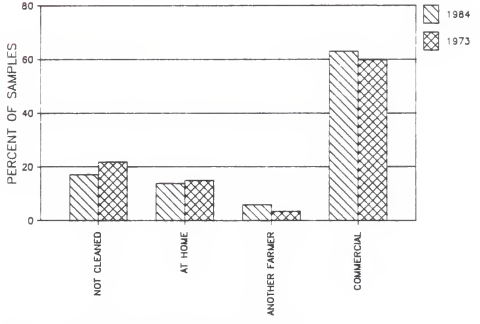

Fig. 4. Seed cleaning 1984 vs. 1973.

Table 6. SEED CLEANING BY STATE AND CROP REPORTING DISTRICT

Cleaned	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
No	12*	14	23	8	11	17	7	9	8	109
	20.34%**	20.29%	24.73%	8.79%	9.09%	18.09%	18.92%	26.47%	21.62%	17.17%
At Home	11	10	18	11	15	15	3	2	3	88
	18.64%	14.49%	19.35%	12.09%	12.40%	15.96%	8.11%	5.88%	8.11%	13.86%
Commercial	31	44	41	70	88	57	24	22	23	400
	52.54%	63.77%	44.09%	76.92%	72.73%	60.64%	64.86%	64.71%	62.16%	62.99%
Another Farmer	5	1	11	2	7	5	3	1	3	38
	8.47%	1.45%	11.83%	2.20%	5.79%	5.32%	8.11%	2.94%	8.11%	5.98%
Total samples cleaned	47	55	70	83	110	77	30	25	29	526
	79.66%	79.71%	75.27%	91.21%	90.91%	81.91%	81.08%	73.53%	78.38%	82.83%
Column total	59	69	93	91	121	94	37	34	37	635

* Number of samples
** % of column total

Table 7. MILES DRIVEN TO CLEAN SEED BY STATE AND CROP REPORTING DISTRICT

Miles driven	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
1-5	7*	16	7	15	21	13	4	4	4	91
	25.00%**	43.24%	21.88%	25.42%	27.27%	26.53%	22.22%	28.57%	26.67%	27.66%
06-1	6	6	6	17	28	19	5	2	5	94
	21.43%	16.22%	18.75%	28.81%	36.36%	38.78%	27.78%	14.29%	33.33%	28.57%
11-15	7	6	5	13	10	10	4	3	2	60
	25.00%	16.22%	15.63%	22.03%	12.99%	20.41%	22.22%	21.43%	13.33%	18.24%
16-20	4	5	7	5	8	3	4	2	2	40
	14.29%	13.51%	21.88%	8.47%	10.39%	6.12%	22.22%	14.29%	13.33%	12.16%
21-30	3	2	4	7	8	3	0	1	1	29
	10.71%	5.41%	12.50%	11.86%	10.39%	6.12%	.00%	7.14%	6.67%	8.81%
31-40	1	1	2	2	2	0	1	2	1	12
	3.57%	2.70%	6.25%	3.39%	2.60%	.00%	5.56%	14.29%	6.67%	3.65%
41-50	0	1	0	0	0	0	0	0	0	1
	.00%	2.70%	.00%	.00%	.00%	.00%	.00%	.00%	.00%	.30%
Greater than 50	0	0	1	0	0	1	0	0	0	2
	.00%	.00%	3.13%	.00%	.00%	2.04%	.00%	.00%	.00%	.61%
Column Total	28	37	32	59	77	49	18	14	15	329

* number of farms
** % of column total

than 30 miles to be cleaned. There were no major differences in miles traveled to clean seed among the nine crop reporting districts.

Fungicide was used as a seed treatment on 36% of the samples (Table 8), a figure almost identical to the 1973 data. The western part of the state with its lower rainfall and humidity, showed lowest fungicide use. The rest of the state showed nearly a 50% use of fungicide. Central Kansas fungicide use paralleled that of 1973, but use in the east almost doubled in the span of 11 years.

Insecticide use dropped from 20% of samples in 1973 to 13% in the current survey (Table 8). The central part of the state showed less insecticide use than did the east or the west. There is some doubt in the accuracy of these results due to the inability of farmers to distinguish between fungicide and insecticide and, their having no knowledge of how seed was treated before purchase.

Testing of the seed before planting gives an indication of the quality of the seed. Only 18% (Table 9) of samples received

Table 8. Samples Using Seed Treatments by Area of the State

Treatment	Area of the State			
	West	Central	East	State
	----------% of samples----------			
Fungicide	18.6	44.7	48.1	36.4
Insecticide	12.3	10.8	22.0	13.2

Table 9. Laboratory Testing Before Planting by Area of State

Lab Tested	Area of the State			
	West	Central	East	State
	----------% of samples----------			
Yes	10.0	17.0	36.8	18.1
No	90.0	83.0	63.2	81.9

had been laboratory tested for germination and/or mechanical purity before planting. Laboratory testing before planting was lowest in the west and highest in the eastern parts of the state. Some farmers did indicate that even though they did not laboratory test their seed, a home test was performed to determine germination percentage.

Soil testing can be an aid in achieving higher yields, and 37% of those responding indicated that they followed a regular program of soil testing (Table 10). Three contiguous districts; Northwest, West Central, and North Central, had the lowest percent of farmers in soil test programs. In the Southwest and South Central Districts about 50% followed soil testing programs. These results may have been influenced by the use of the term "regular soil testing program" on the questionnaire. This idea was not defined and indications were that the program ranged from yearly testing to one test in a 4-5 year span.

Of farmers who indicated a regular soil test program, 78% used a private lab and 22% used the university extension facility (Table 10). Use of the university extension lab was highest in

Table 10. REGULAR PROGRAM OF SOIL TESTING BY STATE AND CROP REPORTING DISTRICT

Soil tests	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
Yes	15*	20	48	27	39	49	13	17	13	241
	25.42%**	28.17%	52.17%	29.03%	31.71%	49.00%	34.21%	45.95%	34.21%	37.02%
No	44	51	44	66	84	51	25	20	25	410
	74.58%	71.83%	47.83%	70.97%	68.29%	51.00%	65.79%	54.05%	65.79%	62.98%
Column Total	59	71	92	93	123	100	38	37	38	651
SAMPLES ANALYZED BY:										
Commercial Lab	13	19	46	21	32	41	6	3	3	184
	86.67%	95.00%	95.83%	77.78%	88.89%	85.42%	46.15%	18.75%	25.00%	78.30%
University Ext. Lab	2	1	2	6	4	7	7	13	9	51
	13.33%	5.00%	4.17%	22.22%	11.11%	14.58%	53.85%	81.25%	75.00%	21.70%
Column total	15	20	48	27	36	48	13	16	12	235

* Number of farms
** % of column total

the eastern three crop reporting districts.

Drill row spacing is a general indication of the amount of rain expected in the area. The western three crop reporting districts normally receive the lowest amount of precipitation and their row spacings were either 10", 12" or 14" (Table 11). The central part of the state has more rainfall and drill spacings were eight and ten inches. Seven and eight inch spacings are the most popular in the east where moisture is generally more plentiful.

Only six of the samples received were found to have a germination of less than 80% (Table 12). Sixty-four percent germinated between 95% and 100%, and another twenty-seven percent were between 90% and 95%. This is in contrast to the 1973 survey (Figure 5) where 35% of the seed germinated at 90% or less. Most of the samples were in the highly acceptable range of 90%-100%, but it is interesting to note that the western part of the state exhibited the highest percent of 95-100% germinating seed.

Table 13. Mechanical Purity of Seed Samples by Area of State

Purity	Area of the State			
	West	Central	East	State
	----------% of samples----------			
Less than 90%	0.4	1.6	0.9	1.0
90-95%	7.9	6.5	2.6	6.1
95-99%	60.4	44.8	27.2	45.7
99-100%	31.3	47.1	69.3	44.1

Table 11. DRILL ROW SPACE BY STATE AND CROP REPORTING DISTRICT

Drill row space	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
Broadcast	0*	1	0	0	0	0	2	0	0	3
	.00%**	1.41%	.00%	.00%	.00%	.00%	5.26%	.00%	.00%	.46%
6"	0	0	0	0	0	0	2	1	0	3
	.00%	.00%	.00%	.00%	.00%	.00%	5.26%	2.78%	.00%	.46%
7"	0	0	1	1	1	1	21	22	26	73
	.00%	.00%	1.09%	1.08%	.81%	1.02%	55.26%	61.11%	70.27%	11.27%
8"	0	0	14	26	70	67	12	12	10	211
	.00%	.00%	15.22%	27.96%	56.45%	68.37%	31.58%	33.33%	27.03%	32.56%
9"	1	0	0	0	0	0	0	0	0	1
	1.69%	.00%	.00%	.00%	.00%	.00%	.00%	.00%	.00%	.15%
10"	21	21	55	53	51	29	1	1	1	233
	35.59%	29.58%	59.78%	56.99%	41.13%	29.59%	2.63%	2.78%	2.70%	35.96%
12"	32	38	15	13	2	1	0	0	0	101
	54.24%	53.52%	16.30%	13.98%	1.61%	1.02%	.00%	.00%	.00%	15.59%
14"	5	11	7	0	0	0	0	0	0	23
	8.47%	15.49%	7.61%	.00%	.00%	.00%	.00%	.00%	.00%	3.55%
Column Total	59	71	92	93	124	98	38	36	37	648

* number of farms
** % of column total

Table 12. LABORATORY GERMINATION BY STATE AND CROP REPORTING DISTRICT

Germination %	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
50-64	1*	0	0	0	0	0	0	0	0	1
	1.69%**	.00%	.00%	.00%	.00%	.00%	.00%	.00%	.00%	.15%
65-74	0	0	1	0	0	0	0	1	1	3
	.00%	.00%	1.03%	.00%	.00%	.00%	.00%	2.70%	2.63%	.46%
75-79	0	1	0	0	0	0	1	0	0	2
	.00%	1.41%	.00%	.00%	.00%	.00%	2.56%	.00%	.00%	.31%
80-84	1	2	0	2	5	1	2	0	0	13
	1.69%	2.82%	.00%	2.17%	4.31%	1.00%	5.13%	.00%	.00%	2.00%
85-89	4	4	2	8	10	4	2	3	3	40
	6.78%	5.63%	2.06%	8.70%	8.62%	4.00%	5.13%	8.11%	7.89%	6.16%
90-94	6	18	25	34	38	20	11	11	12	175
	10.17%	25.35%	25.77%	36.96%	32.76%	20.00%	28.21%	29.73%	31.58%	26.96%
95-100	47	46	69	48	63	75	23	22	22	415
	79.66%	64.79%	71.13%	52.17%	54.31%	75.00%	58.97%	59.46%	57.89%	63.94%
Column Total	59	71	97	92	116	100	39	37	38	649

* number of samples
** % of column total

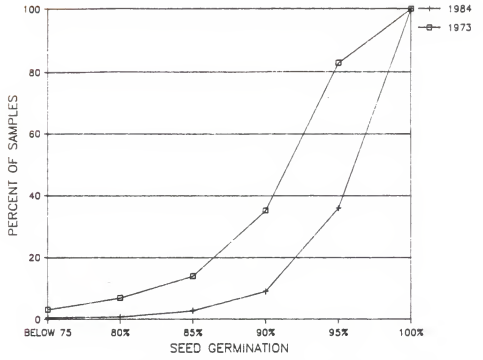

Fig. 5. Germination percentage of seed samples 1984 vs. 1973.

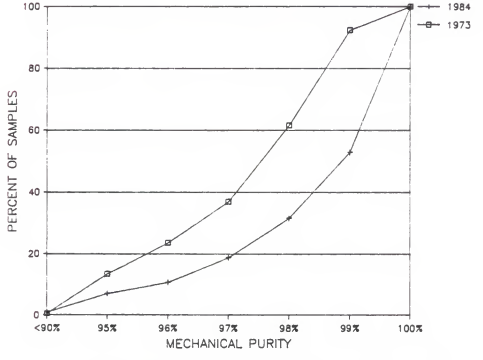

Fig. 6. Mechanical purity of seed samples 1984 vs. 1973.

Mechanical purity of the seed ranged from near 100% pure to less than 75% (Table 13). Over 44% of samples were between 99% and 100% pure while 48 samples, or 7.1%, were less than 95% pure with 7 samples being below 90%. As in the 1973 survey (Figure 6), the highest purity seed came from eastern Kansas, but in 1973 only 59-74% of the seed from that part of the state was 98.5% pure or better, while in 1984, 75-90% of the seed from that area fell into that same group.

Absence of inert material makes for higher mechanical purity, and the 1984 (Table 14) survey shows a trend toward cleaner seed with less inert material than in 1973. Sixty-two percent of the 1984 samples contained less than 1.5% inert material while in 1973, only 40% contained inert material of 1.5% or less. The eastern one-third of the state had the lowest amount of inert material since mechanical purity and inert material normally behave inversely. The Northeast District had the lowest amount of inert material, having 64% of its samples

Table 14. Inert Material in Seed Samples by Area of State

Inert Material	Area of the State			
	West	Central	East	State
	----------% of samples----------			
0.5% or Less	15.7	23.5	51.3	25.7
0.5-1.0%	17.0	26.8	21.7	22.8
1.0-5.0%	59.0	46.2	26.1	46.8
Greater Than 5%	8.3	3.5	0.9	4.7

with 0.5% or less inert material.

Weed seed is a second component of mechanical purity. Weed seeds appeared in 14% more samples in 1984 than the 1973 survey. In that survey 15% of the samples contained weed seeds, 17% of the samples in the west contained weed seeds, 39% in the central and 34% in the eastern part of the state. All three areas showed increases over the 1973 survey. Chess (Bromus commutatus), the most commonly found weed seed, was found in 15.8% of all samples. Chess was the most common weed seed in all crop reporting districts except the Northwest, where downy brome (Bromus tectorum) was most common (Table 15). Chess was found in 10% of all samples in the 1973 survey. Cheat (Bromus secalinus) was found in 7.7% of samples but only in samples from the eastern two-thirds of the state. The third most common weed, Pennycress (Thlaspi arvense), was also found mainly in eastern districts. Twelve samples contained seed of the prohibited noxious weed, field bindweed (Convolvulus arvensis) (17), but none was found in the eastern one-third of the state. One sample from the North Central District contained a seed of the prohibited noxious weed, musk thistle (Carduus nutans).

The third component of mechanical purity is the presence of seed of other crops. Almost 10% of the samples contained other crop seeds, with sorghum (Sorghum bicolor) being the most predominant--found in 30 samples (4.5%) (Table 16). Rye (Secale cereale), which can be a problem in wheat seed was found in only two samples, both from the North Central District. The main method that other crop seeds are introduced into wheat seed is

Table 15. WEEDS FOUND BY STATE AND CROP REPORTING DISTRICT

Weed seed found	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
Field bindweed+ (Convolvulus arvensis)	0 .00%	1 1.41%	1 1.03%	3 3.19%	6 4.76%	1 .99%	0 .00%	0 .00%	0 .00%	12 1.81%
Musk thistle+ (Carduus nutans)	0 .00%	0 .00%	0 .00%	1 1.06%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	1 .15%
Cheat (Bromus secalinus)	0 .00%	0 .00%	0 .00%	11 11.70%	17 13.49%	11 10.89%	3 7.69%	1 2.70%	8 21.05%	51 7.70%
Chess (Bromus commutatus)	7 11.86%	6 8.45%	5 5.15%	24 25.53%	17 13.49%	21 20.79%	7 17.95%	8 21.62%	10 26.32%	105 15.86%
Dock (Rumex crispis)	0 .00%	0 .00%	0 .00%	3 3.19%	0 .00%	1 .99%	0 .00%	1 2.70%	6 15.79%	11 1.66%
Downy brome (Bromus tectorum)	11 18.64%	1 1.41%	2 2.06%	7 7.45%	3 2.38%	3 2.97%	0 .00%	0 .00%	0 .00%	27 4.08%
Jointed goatgrass (Aegilops cylindrica)	0 .00%	1 1.41%	2 2.06%	3 3.19%	3 2.38%	2 1.98%	0 .00%	1 2.70%	2 5.26%	14 2.11%
Pennycress (Thlaspi arvense)	1 1.69%	1 1.41%	0 .00%	17 18.09%	11 8.73%	1 .99%	6 15.38%	8 21.62%	2 5.26%	47 7.10%
Pigweed (Amaranthus retroflexus)	0 .00%	1 1.41%	1 1.03%	1 1.06%	1 .79%	1 .99%	0 .00%	0 .00%	0 .00%	5 .76%
Wild buckwheat (Polygonum convolvulus)	1 1.69%	1 1.41%	0 .00%	10 10.64%	8 6.35%	2 1.98%	2 5.13%	2 5.41%	4 10.53%	30 4.53%
Other weeds++	2 3.39%	0 .00%	1 1.03%	3 3.19%	7 5.56%	3 2.97%	0 .00%	1 2.70%	2 5.26%	19 2.87%
Total samples with weeds	13	11	15	40	40	34	8	14	17	192

* number of samples
** % of total samples for column
\+ primary noxious weed seeds
++ Includes Giant foxtail (Setaria fabreii), Hedge bindweed (Convolvulus sepium), Barnyardgrass (Echinochl crusgali), Cleaver (Galium aparine), Cranesbill (Geranium carolinanum), Dodder (Cuscute spp.), Little barley, (Hordeum pusillum), Witchgrass (Pancium capillare), Lambsquarters (Chenopodium album), Peppergrass (Lepidum spp.), Vetch (Vicia spp.).

Table 16. OTHER CROPS FOUND BY STATE AND CROP REPORTING DISTRICT

Crop seed found	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
Alfalfa (Medicago sativa)	0* .00%**	0 .00%	0 .00%	0 .00%	0 .00%	1 .15%	1 .15%	0 .00%	0 .00%	2 .30%
Barley (Hordeum vulgare)	0 .00%	0 .00%	0 .00%	0 .00%	2 .30%	0 .00%	0 .00%	0 .00%	1 .15%	3 .45%
Bromegrass (Bromus inermis)	0 .00%	1 .15%	0 .00%	1 .15%	0 .00%	0 .00%	1 .15%	0 .00%	0 .00%	3 .45%
Clover (Trifolium spp.)	0 .00%	0 .00%	0 .00%	1 .15%	0 .00%	0 .00%	0 .00%	0 .00%	3 .45%	4 .61%
Fescue (Festuca spp.)	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	1 .15%	0 .00%	1 .15%	2 .30%
Oats (Avena sativa)	1 .15%	0 .00%	0 .00%	0 .00%	0 .00%	1 .15%	1 .15%	0 .00%	1 .15%	4 .61%
Rye (Secale cereale)	0 .00%	0 .00%	0 .00%	2 .30%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	2 .30%
Sorghum (Sorghum bicolor)	1 .15%	2 .30%	2 .30%	5 .76%	9 1.36%	4 .61%	3 .45%	2 .30%	3 .45%	31 4.70%
Soybeans (Glycine max)	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	1 .15%	0 .00%	2 .30%	3 .45%
Total samples with other crops	1	3	2	9	11	6	8	2	10	52

* number of samples
** % of column total

not growth of that crop in seed fields, but the contamination within seed cleaners, storage bins and other handling equipment.

The Kansas State Seed Law (17) prohibits the sale of seed if it contains any prohibited noxious weed seeds, excessive amounts of restricted noxious weed seeds, or two percent or more of any combination of weed seeds. Thirty samples received in the 1984 survey fell into one of those three categories (Table 17). Twelve samples contained prohibited noxious weed seeds, 17 contained excessive amounts of restricted noxious weed seeds, and one sample contained more than two percent of total weed seeds. Of the 30 unsaleable samples, 20 were from the central one-third of the state and only two were from the west.

As indicated by Robertson (33), seed size and density are very important factors in seedling vigor and ultimate grain yield. Bushel test weight (Table 18) is one method of measuring seed density. Over 20% of the samples received had a test weight between 60 and 61 pounds per bushel, and 56% of all samples were

Table 18. Bushel Test Weight of Seed Samples by Area of State

Pounds per Bushel	Area of the State			
	West	Central	East	State
	----------% of samples----------			
Less than 58	7.4	14.7	37.7	16.2
58-60	20.3	33.0	32.5	28.0
60-62	44.1	37.6	24.5	37.6
Greater than 62	28.2	15.7	5.3	18.2

Table 17. UNSALEABLE SAMPLES UNDER THE STATE SEED LAW BY STATE AND CROP REPORTING DISTRICT

Reason Unsaleable	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
Prohibited Noxious Weed Seeds	0* .00%**	1 .15%	1 .15%	3 .45%	6 .91%	1 .15%	0 .00%	0 .00%	0 .00%	12 1.81%
Excessive Restricted Weed Seeds	0 .00%	0 .00%	0 .00%	5 .76%	4 .60%	0 .00%	2 .30%	5 .76%	1 .15%	17 2.57%
Total Weed Seeds Exceed 2% by Weight	0 .00%	0 .00%	0 .00%	1 .15%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	1 .15%
Total unsaleable samples	0 .00%	1 .15%	1 .15%	9 1.36%	10 1.51%	1 .15%	2 .30%	5 .76%	1 .15%	30 4.53%

* Number of samples
** % of total samples

at or above that 60 pound level. The range of test weights was the widest in the west and narrowest in the east, but more samples with heavier test weights did come from the west.

A method of determining seed size is to look at the three screening fractions (Tables 19, 20 & 21). Twenty-four percent of the samples had 70%-80% of seed falling into the large (>6/64) category, again with the west having the largest seed and the east having the smallest. The bulk of the samples had a middle fraction between 10% and 40% of the sample, without any major differences between the districts. Therefore in contrast to the top fraction, the bottom (<5/64) fraction was greatest in the east and the smallest in the west.

Analysis of the samples for protein showed levels that centered around 11%-12%, but the majority of samples ranged from 9% to 14% (Table 22). The range of proteins was wider in the west and narrower in the east, but both seem to be centered around the 11-12% level. Though not clearly illustrated by this table, larger seed, as found the west, normally exhibits a lower protein percent as indicated by Evans and Bhatt (8).

Table 23 shows mean values for some seed variables for the seven most popular varieties received in the survey. Mean protein values were mainly between 11.4% and 11.8%, except for Arkan, which had a mean protein of 12%. Mean bushel test weights ranged from 59 to 61 pounds per bushel, with varieties more commonly used in the western part of the state having heavier test weights. Since Arkan was developed to have kernels which are more plump, this therefore gives higher mean values for the

Table 19. TOP SCREENING FRACTION BY STATE AND CROP REPORTING DISTRICT

% Over 6/64 Screen	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
90.00-100.00	5* 8.47%**	1 1.41%	3 3.09%	1 1.08%	4 3.17%	6 6.00%	3 7.69%	6 16.22%	9 23.68%	38 5.76%
80.00-89.99	17 28.81%	24 33.80%	21 21.65%	15 16.13%	26 20.63%	18 18.00%	7 17.95%	9 24.32%	8 21.05%	145 21.97%
70.00-79.99	20 33.90%	16 22.54%	27 27.84%	25 26.88%	33 26.19%	28 28.00%	2 5.13%	7 18.92%	7 18.42%	165 25.00%
60.00-69.99	8 13.56%	12 16.90%	11 11.34%	16 17.20%	23 18.25%	14 14.00%	10 25.64%	6 16.22%	2 5.26%	102 15.45%
50.00-59.99	6 10.17%	8 11.27%	12 12.37%	13 13.98%	13 10.32%	12 12.00%	9 23.08%	1 2.70%	5 13.16%	79 11.97%
40.00-49.99	0 .00%	4 5.63%	11 11.34%	8 8.60%	14 11.11%	11 11.00%	2 5.13%	4 10.81%	4 10.53%	58 8.79%
30.00-39.99	3 5.08%	2 2.82%	6 6.19%	5 5.38%	7 5.56%	7 7.00%	0 .00%	3 8.11%	1 2.63%	34 5.15%
20.00-29.99	0 .00%	2 2.82%	4 4.12%	8 8.60%	3 2.38%	4 4.00%	5 12.82%	0 .00%	2 5.26%	28 4.24%
10.00-19.99	0 .00%	2 2.82%	1 1.03%	2 2.15%	3 2.38%	0 .00%	1 2.56%	1 2.70%	0 .00%	10 1.52%
0.00-9.99	0 .00%	0 .00%	1 1.03%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	1 .15%
Column Total	59	71	97	93	126	100	39	37	38	660

* number of samples
** % of column total

Table 20. MIDDLE SCREENING FRACTION BY STATE AND CROP REPORTING DISTRICT

% Over 5/64 Screen	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
90.00-100.00	0* .00%**	0 .00%	1 1.03%	0 .00%	1 .79%	0 .00%	0 .00%	0 .00%	0 .00%	2 .30%
80.00-89.99	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%
70.00-79.99	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	1 2.70%	0 .00%	1 .15%
60.00-69.99	0 .00%	1 1.41%	1 1.03%	6 6.45%	2 1.59%	1 1.00%	2 5.13%	0 .00%	1 2.63%	14 2.12%
50.00-59.99	2 3.39%	4 5.63%	8 8.25%	7 7.53%	6 4.76%	6 6.00%	3 7.69%	0 .00%	0 .00%	36 5.45%
40.00-49.99	2 3.39%	2 2.82%	7 7.22%	11 11.83%	18 14.29%	13 13.00%	5 12.82%	6 16.22%	5 13.16%	69 10.45%
30.00-39.99	5 8.47%	13 18.31%	20 20.62%	14 15.05%	24 19.05%	18 18.00%	9 23.08%	0 .00%	6 15.79%	109 16.52%
20.00-29.99	14 23.73%	15 21.13%	27 27.84%	23 24.73%	29 23.02%	25 25.00%	9 23.08%	11 29.73%	3 7.89%	156 23.64%
10.00-19.99	26 44.07%	25 35.21%	24 24.74%	29 31.18%	38 30.16%	28 28.00%	8 20.51%	12 32.43%	11 28.95%	201 30.45%
0.00-9.99	10 16.95%	11 15.49%	9 9.28%	3 3.23%	8 6.35%	9 9.00%	3 7.69%	7 18.92%	12 31.58%	72 10.91%
Column Total	59	71	97	93	126	100	39	37	38	660

* number of samples
** % of column total

Table 21. BOTTOM SCREENING FRACTION BY STATE AND CROP REPORTING DISTRICT

% Through 5/64 Screen	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
50.00 & up	1*	0	0	0	0	0	0	0	0	1
	1.69%**	.00%	.00%	.00%	.00%	.00%	.00%	.00%	.00%	.15%
40.00-49.99	0	0	1	0	0	0	0	0	0	1
	.00%	.00%	1.03%	.00%	.00%	.00%	.00%	.00%	.00%	.15%
30.00-39.99	0	2	1	0	1	0	0	0	0	4
	.00%	2.82%	1.03%	.00%	.79%	.00%	.00%	.00%	.00%	.61%
20.00-29.99	0	0	3	4	2	2	2	1	1	15
	.00%	.00%	3.09%	4.30%	1.59%	2.00%	5.13%	2.70%	2.63%	2.27%
15.00-19.99	1	3	6	8	6	7	1	3	1	36
	1.69%	4.23%	6.19%	8.60%	4.76%	7.00%	2.56%	8.11%	2.63%	5.45%
10.00-14.99	8	10	16	24	19	14	6	4	6	107
	13.56%	14.08%	16.49%	25.81%	15.08%	14.00%	15.38%	10.81%	15.79%	16.21%
5.00-9.99	21	29	27	32	33	32	10	10	6	200
	35.59%	40.85%	27.84%	34.41%	26.19%	32.00%	25.64%	27.03%	15.79%	30.30%
1.00-4.99	25	27	37	25	55	40	10	12	18	249
	42.37%	38.03%	38.14%	26.88%	43.65%	40.00%	25.64%	32.43%	47.37%	37.73%
.50-.99	2	0	5	0	5	4	5	1	2	24
	3.39%	.00%	5.15%	.00%	3.97%	4.00%	12.82%	2.70%	5.26%	3.64%
.00-.49	1	0	1	0	5	1	5	6	4	23
	1.69%	.00%	1.03%	.00%	3.97%	1.00%	12.82%	16.22%	10.53%	3.48%
Column Total	59	71	97	93	126	100	39	37	38	660

* number of samples
** % of column total

Table 22. PROTIEN OF SEED BY STATE AND CROP REPORTING DISTRICT***

Protein %	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
8.00-8.49	0* .00%**	0 .00%	1 1.03%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	1 2.63%	2 .30%
8.50-8.99	0 .00%	1 1.41%	3 3.09%	1 1.06%	0 .00%	4 4.00%	0 .00%	0 .00%	1 2.63%	10 1.52%
9.00-9.49	6 10.17%	3 4.23%	12 12.37%	1 1.06%	2 1.60%	9 9.00%	1 2.56%	1 2.70%	5 13.16%	40 6.06%
9.50-9.99	6 10.17%	5 7.04%	9 9.28%	1 1.06%	7 5.60%	11 11.00%	3 7.69%	4 10.81%	6 15.79%	52 7.88%
10.00-10.49	7 11.86%	5 7.04%	6 6.19%	4 4.26%	8 6.40%	16 16.00%	3 7.69%	5 13.51%	2 5.26%	56 8.48%
10.50-10.99	2 3.39%	6 8.45%	8 8.25%	11 11.70%	11 8.80%	7 7.00%	3 7.69%	5 13.51%	5 13.16%	58 8.79%
11.00-11.49	11 18.64%	12 16.90%	13 13.40%	11 11.70%	24 19.20%	14 14.00%	8 20.51%	4 10.81%	3 7.89%	100 15.15%
11.50-11.99	7 11.86%	4 5.63%	7 7.22%	8 8.51%	13 10.40%	15 15.00%	3 7.69%	7 18.92%	7 18.42%	71 10.76%
12.00-12.49	5 8.47%	6 8.45%	8 8.25%	15 15.96%	10 8.00%	3 3.00%	5 12.82%	3 8.11%	1 2.63%	56 8.48%
12.50-12.99	10 16.95%	12 16.90%	14 14.43%	18 19.15%	19 15.20%	5 5.00%	4 10.26%	2 5.41%	2 5.26%	86 13.03%
13.00-13.49	3 5.08%	5 7.04%	7 7.22%	15 15.96%	16 12.80%	5 5.00%	4 10.26%	3 8.11%	1 2.63%	59 8.94%
13.50-13.99	2 3.39%	7 9.86%	5 5.15%	7 7.45%	9 7.20%	4 4.00%	3 7.69%	2 5.41%	3 7.89%	42 6.36%
14.00-14.49	0 .00%	3 4.23%	2 2.06%	1 1.06%	2 1.60%	4 4.00%	1 2.56%	1 2.70%	1 2.63%	15 2.27%
14.50-14.99	0 .00%	2 2.82%	1 1.03%	0 .00%	3 2.40%	2 2.00%	0 .00%	0 .00%	0 .00%	8 1.21%
15 & up	0 .00%	0 .00%	1 1.03%	1 1.06%	1 .80%	1 1.00%	1 2.56%	0 .00%	0 .00%	5 .76%
Column Total	59	71	97	94	125	100	39	37	38	660

* number of samples
** % of column total
*** based on nitrogen level times 5.7

Table 23. SEED MEAN VALUES FOR MOST COMMON VARIETIES

Variable	ARKAN	HAWK	LARNED	NEWTON	SCOUT	TAM 105	VONA
Protein	12.02%	11.67%	11.67%	11.63%	11.84%	11.46%	11.81%
Bushel Weight	58.93	59.65	61.46	60.18	61.00	59.18	59.53
Over 6/64 fraction	82.89%	67.59%	73.50%	62.30%	74.55%	63.08%	37.02%
Over 5/64 fraction	14.55%	28.55%	20.98%	32.14%	19.75%	27.98%	48.48%
Thru 5/64 fraction	2.55%	7.37%	5.35%	7.33%	5.69%	9.01%	14.47%
Seed Weight	24.60	28.51	29.06	25.60	28.10	25.94	23.22
Germination	94.10%	95.35%	92.93%	93.64%	94.09%	94.37%	93.91%
Purity	99.37%	98.12%	97.93%	98.02%	97.53%	96.93%	98.32%
Cert. Status	.43	1.52	2.58	1.73	5.81	1.65	1.60
Number of samples	45	114	45	175	13	96	26

top screening fractions. Conversely, Vona, a small seeded variety, has higher mean values in the middle and bottom fractions. Seed weight, as bushel test weight, is somewhat larger for varieties used in the western part of the state. Germination and purity show no real differences, probably because these variables are more a function of management than variety.

Mean values for certification status are indicators of the years since that variety has been released. Arkan, which is a rather new variety, has a value of 0.43, which means that the average of all samples of Arkan is slightly less than one-half year from certified. Older varieties such as Larned show a mean value of more than 2.5. Scout, which has been in use for over 20 years, had a mean value of 5.8 years from certified.

Correlations were run on those some common variables for each of the seven varieties. Significant correlations which were consistent over a group of varieties are shown in Table 24. Protein percent was significantly negatively correlated to bushel test weight, seed weight and top screening fractions and, positive correlations to the two smaller seed fractions. Purity showed a negative correlation with the bottom screening fraction where small weed seeds and inert material often collect. Three varieties showed a significant positive correlation between germination and purity. Certification status showed negative correlations with purity in three varieties.

SUMMARY ON SURVEY INFORMATION AND SEED ANALYSIS

1. According to figures from the Kansas Crop and Livestock Reporting Service (18), varieties collected were in proportion to

Table 24. CORRELATIONS WITH PROTEIN CONTENT

VARIABLE	ARKAN	HAWK	LARNED	NEWTON	SCOUT	TAM 105	VONA
Bushel test weight	-.29894	-.25566 **	-.30466	-.24109 **	.23395	-.21912 *	-.59308 **
Over 6/64 fraction	-.40824 **	-.60363 **	-.58878 **	-.47483 **	.45292	-.67264 **	-.6282 **
Over 5/64 fraction	.35146 *	.23745 *	.61353 **	.27339 **	-.43561	-.65096 **	.50448 *
Thru 5/64 fraction	.49930 **	.47872 **	.23101	.36054 **	-.39568	.4699 **	.49318 *
CORRELATIONS WITH PURITY							
Thru 5/64 fraction	-.52187 **	-.45688 **	-.48452 **	-.60104 *	-.65662 *	-.40924 **	-.48512 *
Germination	.44589	.30043 **	.41673 **	.46392	.79602 **	-.33689	.07512
Certification status	.32567	.14817	-.32008 **	.22391	.20981	-.29653 **	-.58623 **

* Significant at 5% level
** Significant at 1% level

actual plantings from throughout the state. Newton was the most popular variety, followed by Hawk, Tam 105 and Larned.

2. More varieties are being planted on each farm compared to the 1973 survey.

3. The 1984 seed is closer to certified status than in 1973.

4. Less homegrown seed is being planted, and purchases from farmer dealers and commercial dealers are increasing compared to 1973. Most of this seed is cleaned commercially within 10 miles of the farmers' home.

5. Use of fungicide has remained fairly stable over eleven years, but use of insecticide on seed has decreased.

6. A minority of farmers test their seed and soil before planting, and there is a variation of those percentages throughout the state.

7. Laboratory analysis of seed showed increased germination and purity, and lower inert material than in 1973, but those values were variable depending on origin of the seed.

8. The same weeds were common in both surveys, but a larger percent of samples in 1984 contained weed seeds.

9. Size and quality of the seed is considered to be good, but the better seed in terms of size, seed weight and total protein originated from the western part of the state.

10. As seed size increased, protein percentage decreased.

11. The amount of material in the bottom screening fraction is a good indicator of mechanical purity of the sample.

12. Certified seed has a tendency to have higher germination and higher mechanical purity.

RESULTS OF VARIETAL PURITY STUDY

FIELD PLOT EVALUATIONS

In compiling the results of the varietal purity evaluations, the seed samples were grouped into one of three varietal purity groups. Two of these groups, pure seed (no other varietal contaminates), and incorrect (contaminated by other varieties by more than 30%) were rather easily seen in the evaluations. The third group, mixtures, can include contamination by one or more of three different groups: off-types, out-crosses, or true mixtures. Off-type plants are within varietal characteristics but differ from the norm by more than one characteristic. Off-type plants are fairly common, even in classes of certified seed and tend to express themselves more in some years than in others. Out-crosses are caused in the previous generation when pollen of one parent variety fertilized the parent plant which results in seed which produces a plant with some characteristics derived from each parent. Out-crosses in seed production fields can be minimized with utilization of border strips, rogueing, and isolation areas. True mixtures are the results of the mechanical mixing of two or more varieties in equipment or storage. When placing a sample in the mixture category, no distinction was made as to which type of mixture occurred or to the level of that mixture except that the mixture was between one plant and 30% of the total plot.

Table 25 shows a distribution of varietal purity by crop reporting district. The South Central District showed the highest percentage of pure seed, while the North Central District had

Table 25. VARIETAL PURITY OF SAMPLES BY CROP REPORTING DISTRICT

Variety reported	North East	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
Pure	48.08%	32.26%	43.16%	41.86%	47.62%	61.70%	59.38%	57.14%	54.29%	48.32%
Mixture	44.23%	61.29%	50.53%	50.00%	46.67%	35.11%	37.50%	37.14%	42.86%	45.97%
Incorrect	7.69%	6.45%	6.32%	8.14%	5.71%	3.19%	3.13%	5.71%	2.86%	5.70%

the highest amount of incorrect samples. The western three districts and the northern two districts in the central one-third of the state showed lower numbers of pure samples and more incorrect samples than did the four remaining districts. This is a contrast to the 1973 survey (13) where the eastern districts showed the lowest purity figures.

The seed certification system was developed as a method of insuring varietal purity. Table 26 shows varietal purity of certified seed and of that reported to be one or more years from certified status. In this table, foundation, registered, and certified seed, as well as hybrids, were included in the certified class. Nearly 60% of the certified class was varietally pure with only about 40% of seed two or more years from certification being varietally pure. The percentage of incorrect lots increased each year that the seed was further from certified. This happens because each year that seed is replanted more opportunities for mixing of lots or mis-identification of storage bins occur. In the 1973 survey 57.9% of the non-certified samples were pure as compared to 46.6% in this survey while approximately six percent of non-certified samples in each survey were incorrect.

Maintenance of varietal purity is not only difficult as the seed is further from certification, but it is also difficult to maintain as the number of years that the variety has been on the market increases. Table 27 gives the relationship of varietal purity and the age of the variety. Sample lots of seed that were released for production in 1983 and 1984 showed no incorrect

Table 26. VARIETAL PURITY AS AFFECTED BY CERTIFICATION STATUS

Variety reported	Certification Status					
	Certified	1 year-off	2 years-off	3-4 years-off	5-10 years-off	10+ years-off
Pure	59.55%	54.59%	40.16%	38.95%	42.31%	42.86%
Mixture	39.33%	42.03%	53.28%	53.68%	42.31%	28.57%
Incorrect	1.12%	3.38%	6.56%	7.37%	15.38%	28.57%

Table 27. VARIETAL PURITY AS AFFECTED BY AGE OF VARIETIES

Variety reported	Years variety is on the market					
	1-2	3-4	5-6	7-10	11-15	16+
Pure	56.67%	52.76%	28.28%	53.44%	52.17%	43.75%
Mixture	43.33%	40.94%	64.64%	43.38%	34.78%	37.50%
Incorrect	0.00%	6.29%	9.09%	3.17%	13.05%	18.75%

labeling, while seed which has been on the market for three or more years showed varying percentages of incorrect samples from three to thirteen percent. In the 1973 survey, five varieties of various ages were looked at and results showed that older varieties had a lower varietal purity.

An exception may be that popular varieties are kept more pure. In 1973, Scout, the oldest variety looked at and the most used variety in that survey, exhibited less incorrect samples than some of the newer varieties. In this survey the most popular variety, Newton, fell into the category of seven to ten years from release date and had only 3.17% incorrect samples. This may be because that variety is so popular that quality conscious growers are still using certified seed when planting.

The relationship between varietal purity and seed source is explained in Table 28. Normally homegrown and other farmer seed is considered to be lower in quality than the more closely managed farmer dealer or commercial dealer seed. In the case of this study there is not enough evidence to uphold that statement. Homegrown seed did have the lowest pure seed percentage and the highest amount of incorrect samples, but farmer dealer seed was also low in pure samples and commercial dealer seed had nearly as high a percentage of incorrect samples. The 1973 survey showed a much more dramatic difference; homegrown and other farmer seed were similar to 1984 but the dealer category showed 71.4% pure samples and no incorrectly labeled lots.

Tables 29 and 30 show a relationship between varietal purity and two management factors, seed cleaning and laboratory testing

Table 28. VARIETAL PURITY AS AFFECTED BY SOURCE OF SEED

Variety reported	Seed source			
	Homegrown	Other farmer	Farmer dealer	Comm. dealer
Pure	46.13%	56.16%	49.40%	57.14%
Mixture	47.38%	41.10%	48.19%	37.14%
Incorrect	6.48%	2.74%	2.41%	5.71%

Table 29. VARIETAL PURITY AS AFFECTED BY SEED CLEANING

Variety reported	Seed cleaning			
	No	At home	Other farmer	Comm. dealer
Pure	48.60%	48.10%	57.14%	47.48%
Mixture	42.99%	48.10%	34.29%	47.48%
Incorrect	8.41%	3.80%	8.57%	5.86%

Table 30. VARIETAL PURITY AS AFFECTED BY LAB TESTING OF SEED

Variety reported	Laboratory tested before planting	
	Yes	No
Pure	56.60%	47.00%
Mixture	38.68%	47.00%
Incorrect	4.72%	6.00%

before planting. A larger percentage of seed that had been cleaned before planting was found to be varietal pure, with no real distinction between who cleaned the seed. Also, seed that has been laboratory tested for germination and/or mechanical purity showed advantages in both pure seed samples and less incorrect samples. This table does not say that cleaning or laboratory testing will increase varietal purity, rather it shows that farmers who use a complete management program which includes seed cleaning and testing also take care to insure the purity of the variety that they plant.

ELECTROPHORESIS EVALUATION

Seven of the 16 samples used for this evaluation were judged to be pure as to variety in the field evaluations. Six more samples were in the mixture category, and three were incorrect. None of the pure or mixed samples showed any discernible differences in protein bands in comparison with the controls.

A sample of Eagle, evaluated as incorrect, differed from the control in two of the bands. An incorrect sample of Wichita differed from control in numerous bands. A sample of Tenmarq showed an additional band at one location, and had another band which was wider than the control.

CONCLUSIONS FROM VARIETAL PURITY STUDY

1. The eastern and southern districts of the state had a higher percentage of samples that were varietally pure.
2. Use of certified seed increases the probability that seed

planted is the desired variety, while using uncertified seed does not insure that high degree of purity.

3. As the time increases that a variety has been available, an increasing number of samples labeled as that variety are incorrect.

4. Contamination of varieties occurs at a higher rate with growers who use a lower level of seed management practices such as seed cleaning or laboratory testing of seed.

5. Seedlots that are many years from certified exhibit identical protein bands after electrophoresis to those of foundation seed and therefore any differences in yield or quality are due to differences in management practices not genetics.

RESULTS AND DISCUSSION OF YIELD STUDY

To show usefulness to farmers, any relationship of seed quality to improved grain yield should be consistent over varieties and locations. The assumption of consistency between varieties is made because 1) in this survey that relationship was tested on only four varieties, and 2) many farmers are now planting more than one variety and it would be improbable that they would make major management changes in seed between varieties. The assumption of consistency between locations is made because 1) only two locations and one year's plantings were used for this study, and 2) many factors looked at in this study, i.e. seed cleaning or seed source have nothing to do with location of seed production.

Analysis of variance was run for stand rating, yield, test weight, headcount, top, middle and bottom screening fractions, and seed weight on each of the eight variety/location combinations. Additionally, protein for Larned, Newton and Scout and the fall stand rating were also included from the Hutchinson data. Neither fall stand rating nor head count showed significant differences at the 5% level for any of the eight variety/location combinations. Yield and grain protein showed differences in only one combination, and therefore those four components were not analyzed further. Significant differences (Table 31) were found in five to seven of the variety/location combinations for the other six yield factors.

Because differences were evident, an effort was made to determine if these differences were caused by seed quality or

Table 31. MEAN SQUARE VALUES FOR YIELD FACTORS

Yield Factor	Manhattan				Hutchinson			
	Larned	Newton	Scout	Tam 105	Larned	Newton	Scout	Tam 105
Spring Stand Rating	2.982	.843 **	.970 *	1.019 *	1.341 **	1.416 **	.455	1.345 **
Test Weight	10.511 *	2.316 **	3.619 +	15.025 **	3.253 +	4.733 **	.786	3.690 **
Top Screening Fraction	171.538 **	68.629 +	111.407 *	265.357 **	224.160	312.481 **	82.106	281.797 **
Middle Screening Fraction	84.877 **	22.197 *	64.979 **	64.173	166.381	153.403 **	57.647	131.391 **
Bottom Screening Fraction	45.353 **	24.153 *	12.085	118.940 +	63.299 **	29.532	4.114	36.211 **
Kernal Weight	4.615 **	2.199 **	1.347	7.486 **	4.354 **	4.105 **	1.366	4.978 **

+ Significant at the 10% Level
* Significant at the 5% Level
** Significant at the 1% Level

management factors. Four management factors--source of seed, cleaning of seed, laboratory testing of seeds and certification status of seed--were considered. A comparison of mean values showed that virtually no differences were found for any of the six yield factors within those four management areas, and in no case was there a consistency of differences among the eight variety/location combinations.

Since Robertson (33) found yield advantages when planting larger, heavier seeds over small, light seeds, efforts were then made to find any differences in that area. Samples were classified into three groups: 1) large, heavy seeds, 2) small, light seeds, and 3) a middle group using both 1000 kernel weight and percent top screening fraction. No consistent, real differences were found for stand rating, test weight, the three screening fractions, or seed weight. These results are not inconsistent with the results found by Robertson because plots in that study were planted on a seed count basis while this study was planted on a volume basis as practiced by farmers. These findings are consistent with those found by Paulsen (30) where seed was also planted on a volume basis.

Correlations between seed quality factors and grain yield components were calculated to look for relationships between seed quality and grain yield. The main objective was again to find correlations that were consistent among a majority of the eight variety/location combinations. Significant correlations were observed, but none showed significance through most of the combinations. No consistent relationship was found when looking

within a location among varieties, or within varieties regardless of location.

When making correlations among yield components, some factors (Table 32) were found to be consistent within a variety. Larned showed relationships between kernel weight and yield and between head count and yield. Newton showed a relationship between stand rating and head count. Tam 105 displayed relationships between test weight and a number of factors including yield, stand rating, and head count. No relationships were found to be consistent between locations for Scout.

When making comparison between Scout samples collected in 1973 and 1984, no differences were found that were consistent over the two years and the two locations. The stand ratings at Manhattan were the only components that showed consistent differences over both years. No seed quality to grain yield correlations were found that were consistent among two or more of the four year/location combinations.

CONCLUSIONS OF YIELD STUDY

Even though no real evidence was found in this study to link seed quality to yield components, it does not necessarily suggest that there is no link. The problem may lie in the use of samples obtained in the method used here and the amount of control over the samples that are collected in a drill box survey. Many factors contribute to a single component of seed quality such as the effect certification status has on grain yield. Seed can be cleaned and sized by individuals with numerous types of cleaners, using varying standards of quality and many levels of machine

Table 32. CORRELATIONS BETWEEN 1984 YIELD FACTORS

Variety		MANHATTAN	HUTCHINSON
Larned			
	Grain weight/Yield	.4785 **	.1344 *
	Head Count/Yield	.3663 *	.2741 *
Newton	Stand Rating/Head Count	.4153 **	.3826 *
Tam 105	Test Weight/Yield	.7467 **	.6993 **
	Stand Rating/Test Weight	.4876 *	.3209 *
	Head Count/Test Weight	-.4567 *	-.4795 **

* Significant at 5% level
** Significant at 1% level

operation expertise. This seed can be produced over various parts of the state using numerous production practices over widely varying planting dates. Plus, certification status was only one component of a larger group of interrelated components which were studied that included an almost infinite group of variables. This large group makes the task of finding one or a small group of variables that do have an effect on yield almost impossible.

A better method of investigation may be to design a study to look at just one component of seed, i.e. seed certification, using seed produced at a few locations, cleaned to a few quality levels, and planted for grain production under a few different planting systems.

Since there are so many variables in the production of seed and grain, the best method for the farmer to find what works for him would be to take a single seed lot, divide it into two lots, apply an approved production practice to one and plant the other in his normal method. Accurate assessment of grain produced from each lot would tell the farmer if that practice pays for itself with increased yield.

LITERATURE CITED

1. Ball, W. S., A. Mann, and V. Anderson. 1982. North Dakota drill box survey 1980 and 1981. North Dakota State University Extension Service.

2. Bolaria, T. 1954. Quality of seed and its influence on the growth of wheat. M.S. Thesis, Kansas State Univ., Manhattan, Kansas.

3. Brickbauer, E. A., D. Forsyth, and E. S. Oplinger. 1970. Oat seed quality and seeding practices. Fact Sheet A2038, The University of Wisconsin Extension.

4. Clapp, A. L. 1970. The Kansas Seed Grower. Kansas Crop Improvement Association.

5. Copeland, L. O. 1977. High quality seed. Extension Bulletin E1161, Michigan State University Extension Service.

6. Copeland, L. O., and D. C. Greenman. 1976. Seed certification in Michigan. Michigan State University Extension Bulletin.

7. Dan, E. L., E. Dan, and E. C. LesQueves. 1983. Quality of rice seed used in Espirito Santo. Seed Abstracts 6-2869.

8. Evans, L. E., and G. M. Bhatt. 1977. Influence of seed size, protein content and cultivar on early seedling vigor of wheat. Can. J. Plant Sci. 57:929-935.

9. Fjell, D. L., G. M. Paulsen, and T. L. Walter. 1985. Relationship among planted and harvested kernel weights on grain yield and protein on winter wheat. Euphytica 3(in press).

10. Goetze, N. 1976. Seed analysis of wheat seed survey samples. Oregon State University.

11. Hazen, L. R. 1947. Factors affecting purity of crop seeds in Kansas. M.S. Thesis, Kansas State College, Manhattan.

12. Hollifield, T., and H., Lowery. 1984. 1983 Soybean drill box survey. Georgia Crop Improvement Association.

13. Jacques, R. M. 1976. A survey of wheat seed quality and its effect on yield. M.S. Thesis, Kansas State University, Manhattan, Kansas.

14. Jacques, R. M., L. A. Burchett and R. L. Vanderlip. 1976. Quality of Wheat in Kansas Drill Boxes. Agr. Exp. Sta. Kansas State Univ. Bulletin 599.

15. Kansas Crop Improvement Association. 1960. Kansas seed studied. News Release.

16. Kansas Crop Improvement Association. 1962. Seed quality is poor. News Release.

17. Kansas Department of Agriculture. 1985. Kansas State Seed Law. Section K. S. A. 2-1415 (j).

18. Kansas Crop and Livestock Reporting Service. Crops. 1985. Vol. 85, No. 2.

19. Kaufman, M. L., and A. A. Guitard. 1967. The effect of seed size on early plant development in barley. Can. J. Plant Sci. 47:73-78.

20. Kiesselbach, T. A. 1924. Relation of seed size to yield of small grain crops. J. Amer. Soc. Agron. 16:670-682.

21. Lookhart, G. L., B. L. Jones, S. B. Hall, and K. F. Finney. 1982. An improved method for standardizing the polyacrylamide gel electrophoresis of wheat gladin proteins. Cereal Chem. 59:178-181.

22. Lowe, L. B., and S. K. Ries. 1971. Effects of the environment on the relation between seed protein and seedling vigor in wheat. Can. J. Plant Sci. 52:157-164.

23. Lubbers, E. 1979. Kansas soybean seed survey. M.S. Thesis, Kansas State Univ., Manhattan, Kansas.

24. Manitoba Agriculture. 1982. 1981 Manitoba Seed Grain Survey. Farm Facts.

25. McLelland, Murray. 1980. Provincial Seed Drill Survey 1980. Alberta Agriculture. Bulletin Number 47.

26. Muresan, T. 1968. High quality seeds, an important factor in increasing agricultural yields. Seed production and certification lectures. Bucharest, Rumania.

27. Morrison, K. J., and Felix M. Entenmann. (undated). Seed size study. Washington State University Extension Pub.

28. Murphy, William J., and Wynard E. Aslin. 1978. 1978 Soybean Seed Survey. Missouri Seed Improvement Assoc.

29. Paulsen, Gary. 1979. Wheat quality studies. Report to Kansas Crop Improvement Association.

30. Paulsen, G. M. 1984. Agronomic implications of kernel weight and protein of Kansas wheat. Trans. Kans. Acad. of Sci. 87:19-25.

31. Ray, L. L. 1966. Comparative performance of cotton seed procured from planter box survey and certified and registered seed. Texas A & M University.

32. Ries, S. K. and E. H. Evenson. 1973. Protein content and seed size relationships with seedling vigor of wheat cultivars. Agron. Journal 65:884-886.

33. Robertson, Larry D. 1984. Effect of seed size and density on winter wheat performance. Kansas Ag. Experiment Station Bulletin 74R. Kansas State University.

34. Schoeff, Robert W. 1977. Wheat quality survey-Fall 1976. Kansas State University and Kansas Grain and Feed Dealers Association.

35. Sharma, S. P., M. R. Singh, S. Singh, D. Singh, and A. Singh. 1978. Seed survey in wheat in relation to certification standards. Indian Agric. Res. Inst., New Dehli, India. Div. of Seed Tech. Field Crops Abs. 31-02333.

36. Shroyer, J. P., and T. S. Cox. 1984. Effects of cultivar, environment, and their interaction on seed quality of hard red winter wheat from production fields. J. of Appl. Seed Prod. 2:24-28.

37. Taylor, J. W. 1928. Effect of the continuous selection of large and small wheat seed on bushel weight, varietal purity and loose smut infection. J. Am. Soc. Agron. 20:856-867.

38. Technicon Monograph I. Technicon Private Ltd., Tarrytown, N. Y.

39. Tekrony, Dennis M. 1984. Bin run seed versus high quality seed-Does the farmer really care? Proceedings-The Fourteenth Soybean Research Conference 14:1-8. American Seed Trade Association.

40. Tekrony, Dennis M. 1973. Soybean seed survey. University of Kentucky, College of Agriculture, Agronomy Notes.

41. Thomison, Peter R. 1985. The benefit of using certified seed. The Agronomist 2:7-8. University of Maryland.

42. Tull, Jethro. 1733. Horse-Hoeing Husbandry. A. Millar. p.106.

43. University of Georgia. (undated). Georgia's drill box survey. Georgia Cooperative Extension Service.

44. Westerlind, E., and M. Oliveras. 1984. Drill box survey of spring cereal seed. Seed Abstracts 7-2831.

45. Williams, G. H. 1975. A survey of impurities in Ethiopian crop seed samples. East African Agricultural and Forestry Journal 40:453-456.

DEDICATION

Dedicated to Harold Thiele from whom I learned that to comprehend a large project a person must understand each small part.

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APPENDIX

KANSAS STATE UNIVERSITY
1984 Kansas Wheat Drill Box Survey
Survey Form

SECTION ONE: Answer questions for sample variety.

1.Identification number_____ _____ _____
District County ID Number

2.Variety (Hybrid) sampled_____

3.Acres to be planted with this seed lot_____

4.Enter acres, seeding rate and expected planting date for each cropping system used to plant this seed lot.

Summer Fallow: Acres_____ Rate_____lbs/Ac Date_____
Continuous Cropped:Acres_____ Rate_____lbs/Ac Date_____
Irrigated: Acres_____ Rate_____lbs/Ac Date_____
Double Cropped: Acres_____ Rate_____lbs/Ac Date_____

5.Source of this seed lot:Homegrown_____ Farmer dealer_____
Other farmer_____ Other dealer_____

6.Seed treatment:
Insecticide:Yes_____ No_____ Don't know_____
Fungicide: Yes_____ No_____ Don't know_____
If yes, name seed treatment(s)_____

7.Was seed cleaned? Yes_____ No_____ Don't know_____
If cleaned-At home_____ Another farmer_____
Commercial_____ Don't know_____
If not at home-How many miles to cleaner?_____
Type of cleaner:Air-screen_____ Length grader_____
Gravity table_____ Other[name]_____
Not known_____

8.Was seed laboratory tested? Yes_____ No_____
Reported germination_____% Purity_____% Inert_____%

9.Is this seed Certified_____Registered_____
Foundation_____ Hybrid_____
Other_____ How many years from certifed?_____

SECTION TWO: Answer these questions for all other seed lots.

10.Additional acreage planted with other lots of the sample variety:Acres_____ Source_____

11.Other varieties to be planted in 1984:
Variety_____ Acres_____ Source_____
Variety_____ Acres_____ Source_____
Variety_____ Acres_____ Source_____

SECTION THREE: Future trends.

13.What percentage of wheat seed planted five years from now (1989) do you expect to purchase?_____%

14.Expected source of purchased seed in five (5) years:
[Rank in order of estimated importance]
_____Major company dealer
_____Local certified seed grower/dealer
_____Local farmer/uncertified grower
_____Other[name]_____

SECTION FOUR: Cultural practices.

15.What is the row spacing of your drill?_____inches

16.Do you soil test on a regular basis?Yes_____ No_____
If yes, who normally runs the tests?
Commercial lab_____ University extension_____

17.Estimated 1984 average farm wheat yield_____Bu./Ac.

(Send seed analysis tag if possible)
Check here if grower requests a copy of final survey report_____

TABLE A-1 NUMBER OF VARIETIES PLANTED BY STATE AND CROP REPORTING DISTRICT

Number of Varieties	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
1	25*	25	50	29	36	39	21	22	23	270
	42.37%**	42.37%	51.55%	30.85%	31.03%	38.61%	53.85%	59.46%	60.53%	41.41%
2	25	24	29	37	31	28	12	11	10	207
	42.37%	33.80%	29.90%	39.36%	26.72%	27.72%	30.77%	29.73%	26.32%	31.75%
3	7	17	13	15	28	25	5	3	2	115
	11.86%	23.94%	13.40%	15.96%	24.14%	24.75%	12.82%	8.11%	5.26%	17.64%
4	1	4	4	8	18	7	1	1	3	47
	1.69%	5.63%	4.12%	8.51%	15.52%	6.93%	2.56%	2.70%	7.89%	7.21%
5	1	0	1	4	3	1	0	0	0	10
	1.69%	.00%	1.03%	4.26%	2.59%	.99%	.00%	.00%	.00%	1.53%
6 or more	0	1	0	1	0	1	0	0	0	3
	.00%	1.41%	.00%	1.06%	.00%	.99%	.00%	.00%	.00%	.46%
Column total	59	71	97	94	116	101	39	37	38	652

* Number of farms
** % of column total

Table A-2 CERTIFIED STATUS OF SAMPLES BY STATE AND CROP REPORTING DISTRICT

Class of seed	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
Hybrid	0* .00%**	0 .00%	1 1.18%	0 .00%	0 .00%	1 1.16%	0 .00%	0 .00%	0 .00%	2 .33%
Foundation	0 .00%	0 .00%	0 .00%	0 .00%	3 2.52%	0 .00%	0 .00%	0 .00%	0 .00%	3 .50%
Registered	0 .00%	1 1.59%	1 1.18%	2 2.17%	5 4.20%	2 2.33%	2 5.71%	4 11.43%	1 2.86%	18 2.98%
Certified	5 9.26%	2 3.17%	10 11.76%	9 9.78%	16 13.45%	6 6.98%	13 37.14%	7 20.00%	10 28.57%	78 12.91%
1 year from certified	23 42.59%	22 34.92%	24 28.24%	34 36.96%	49 41.18%	38 44.19%	10 28.57%	13 37.14%	12 34.29%	225 37.25%
2 years from certified	7 12.96%	16 25.40%	17 20.00%	31 33.70%	23 19.33%	23 26.74%	4 11.43%	8 22.86%	7 20.00%	136 22.52%
3 years from certified	7 12.96%	10 15.87%	13 15.29%	6 6.52%	14 11.76%	10 11.63%	3 8.57%	3 8.57%	4 11.43%	70 11.59%
4 years from certified	8 14.81%	6 9.52%	8 9.41%	4 4.35%	5 4.20%	4 4.65%	2 5.71%	0 .00%	1 2.86%	38 6.29%
5 years from certified	2 3.70%	3 4.76%	0 .00%	3 3.26%	0 .00%	1 1.16%	0 .00%	0 .00%	0 .00%	9 1.49%
6-10 years from certified	1 .00%	3 4.76%	9 10.59%	2 2.17%	2 1.68%	1 1.16%	0 .00%	0 .00%	0 .00%	17 2.81%
More than 10	2 3.70%	0 .00%	2 2.35%	1 1.09%	2 1.68%	0 .00%	1 2.86%	0 .00%	0 .00%	8 1.32%
Column total	54	63	85	92	119	86	35	35	35	604

* Number of samples
** % of column total

Table A-3 SOURCE OF SEED BY STATE AND CROP REPORTING DISTRICT

Source of seed	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
Farmer Dealer	7* 11.86%**	3 4.23%	18 18.95%	10 10.64%	20 16.00%	12 12.00%	9 23.68%	6 16.67%	4 10.53%	89 13.57%
Homegrown	44 74.58%	55 77.46%	59 62.11%	70 74.47%	86 68.80%	65 65.00%	19 50.00%	21 58.33%	26 68.42%	445 67.84%
Commercial Dealer	1 1.69%	3 4.23%	4 4.21%	6 6.38%	6 4.80%	4 4.00%	5 13.16%	4 11.11%	7 18.42%	40 6.10%
Another Farmer	7 11.86%	10 14.08%	14 14.74%	8 8.51%	13 10.40%	19 19.00%	5 13.16%	5 13.89%	1 2.63%	82 12.50%
Column total	59	71	95	94	125	100	38	36	38	656

* Number of samples
** % of column total

Table A-4 FUNGICIDE USE BY STATE AND CROP REPORTING DISTRICT

Fungicide	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
Yes	16*	13	11	45	66	25	14	21	17	228
	27.59%**	27.59%	12.36%	51.14%	55.00%	26.04%	35.90%	58.33%	51.52%	36.36%
No	39	54	75	40	52	66	25	12	16	379
	67.24%	79.41%	84.27%	45.45%	43.33%	68.75%	64.10%	33.33%	48.48%	60.45%
Don't know	3	1	3	3	2	5	0	3	0	20
	5.17%	1.47%	3.37%	3.41%	1.67%	5.21%	.00%	8.33%	.00%	3.19%
Column Total	58	68	89	88	120	96	39	36	33	627

Table A-5 INSECTICIDE USE BY STATE AND CROP REPORTING DISTRICT

Insecticide	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
Yes	14*	5	7	7	10	8	3	7	9	70
	25.00%**	25.00%	7.53%	10.29%	12.66%	9.52%	10.71%	25.93%	29.03%	13.23%
No	39	58	83	57	65	67	25	16	19	429
	69.64%	92.06%	89.25%	83.82%	82.28%	79.76%	89.29%	59.26%	61.29%	81.10%
Don't know	3	0	3	4	4	9	0	4	3	30
	5.36%	.00%	3.23%	5.88%	5.06%	10.71%	.00%	14.81%	9.68%	5.67%
Column Total	56	63	93	68	79	84	28	27	31	529

* number of samples
** % of column total

Table A-6 SEED LABORATORY TESTED BEFORE PLANTING BY STATE AND CROP REPORTING DISTRICT

Lab tested	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
Yes	4*	3	15	17	23	14	15	16	11	118
	7.02%**	4.29%	15.96%	18.09%	18.55%	14.00%	38.46%	43.24%	28.95%	18.07%
No	53	67	79	77	101	86	24	21	27	535
	92.98%	95.71%	84.04%	81.91%	81.45%	86.00%	61.54%	56.76%	71.05%	81.93%
Column Total	57	70	94	94	124	100	39	37	38	653

* number of samples
** % of column total

Table A-12. CROPPING SYSTEM ACREAGE BY STATE AND CROP REPORTING DISTRICT

Cropping System	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
Summer Fallow	14,063* 83.83%**	24,701 88.33%	24,062 66.43%	12,210 59.34%	10,369 48.91%	12,773 43.65%	70 4.01%	229 6.72%	512 14.84%	98,989 61.63%
Continuous Cropped	2,198 13.10%	692 2.47%	3,517 9.71%	8,105 39.39%	10,424 49.17%	13,290 45.41%	1,384 79.27%	3,164 92.84%	2,387 69.17%	45,161 28.12%
Double Cropped	0 .00%	498 1.78%	325 .90%	263 1.28%	301 1.42%	227 .78%	272 15.58%	15 .44%	552 16.00%	2,453 1.53%
Irrigated	515 3.07%	2,075 7.42%	8,315 22.96%	0 .00%	106 .50%	2,975 10.17%	20 1.15%	0 .00%	0 .00%	14,006 8.72%
Column Total	16,776	27,966	36,219	20,578	21,200	29,265	1,746	3,408	3,451	160,609

* number of acres
** % of column total

Table A-8 INERT MATERIAL BY STATE AND CROP REPORTING DISTRICT

Inert Material %	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
0-.49	10*	5	21	12	39	22	25	20	14	168
	16.95%**	7.04%	21.21%	12.90%	33.05%	22.22%	64.10%	52.63%	36.84%	25.69%
.50-.99	9	12	18	24	33	26	7	9	11	149
	15.25%	16.90%	18.18%	25.81%	27.97%	26.26%	17.95%	23.68%	28.95%	22.78%
1.00-1.49	12	12	12	13	11	14	4	2	7	87
	20.34%	16.90%	12.12%	13.98%	9.32%	14.14%	10.26%	5.26%	18.42%	13.30%
1.50-1.99	8	5	13	9	8	15	1	1	4	64
	13.56%	7.04%	13.13%	9.68%	6.78%	15.15%	2.56%	2.63%	10.53%	9.79%
2.00-2.99	9	17	15	17	10	10	1	4	1	84
	15.25%	23.94%	15.15%	18.28%	8.47%	10.10%	2.56%	10.53%	2.63%	12.84%
3.00-3.99	5	4	8	10	10	4	1	1	1	44
	8.47%	5.63%	8.08%	10.75%	8.47%	4.04%	2.56%	2.63%	2.63%	6.73%
4.00-4.99	1	11	3	3	5	4	0	0	0	27
	1.69%	15.49%	3.03%	3.23%	4.24%	4.04%	.00%	.00%	.00%	4.13%
5.00-9.99	5	4	9	5	2	4	0	1	0	30
	8.47%	5.63%	9.09%	5.38%	1.69%	4.04%	.00%	2.63%	.00%	4.59%
Greater than 10%	0	1	0	0	0	0	0	0	0	1
	.00%	1.41%	.00%	.00%	.00%	.00%	.00%	.00%	.00%	.15%
Column Total	59	71	99	93	118	99	39	38	38	654

* number of samples
** % of column total

Table A-9 BUSHEL TEST WEIGHT OF SEED SAMPLE BY STATE AND CROP REPORTING DISTRICT

Pounds per bushel	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
Less than 55	0* .00%**	0 .00%	0 .00%	1 1.08%	1 .79%	1 1.00%	0 .00%	1 2.70%	2 5.26%	6 .91%
55.00-55.99	1 1.69%	1 1.41%	2 2.06%	2 2.15%	5 3.97%	1 1.00%	4 10.26%	3 8.11%	4 10.53%	23 3.48%
56.00-56.99	0 .00%	2 2.82%	3 3.09%	5 5.38%	6 4.76%	4 4.00%	4 10.26%	5 13.51%	3 7.89%	32 4.85%
57.00-57.99	1 1.69%	1 1.41%	6 6.19%	7 7.53%	10 7.94%	4 4.00%	3 7.69%	6 16.22%	8 21.05%	46 6.97%
58.00-58.99	3 5.08%	6 8.45%	9 9.28%	11 11.83%	28 22.22%	11 11.00%	8 20.51%	6 16.22%	4 10.53%	86 13.03%
59.00-59.99	10 16.95%	7 9.86%	11 11.34%	19 20.43%	20 15.87%	13 13.00%	7 17.95%	5 13.51%	7 18.42%	99 15.00%
60.00-60.99	21 35.59%	19 26.76%	20 20.62%	16 17.20%	22 17.46%	25 25.00%	6 15.38%	6 16.22%	6 15.79%	141 21.36%
61.00-61.99	7 11.86%	14 19.72%	19 19.59%	22 23.66%	15 11.90%	20 20.00%	5 12.82%	2 5.41%	3 7.89%	107 16.21%
62.00-62.99	15 25.42%	19 26.76%	23 23.71%	6 6.45%	13 10.32%	16 16.00%	0 .00%	0 .00%	1 2.63%	93 14.09%
63.00-63.99	0 .00%	2 2.82%	1 1.03%	4 4.30%	3 2.38%	4 4.00%	0 .00%	3 8.11%	0 .00%	17 2.58%
64.00-64.99	1 1.69%	0 .00%	1 1.03%	0 .00%	3 2.38%	1 1.00%	0 .00%	0 .00%	0 .00%	6 .91%
over 65.00	0 .00%	0 .00%	2 2.06%	0 .00%	0 .00%	0 .00%	2 5.13%	0 .00%	0 .00%	4 .61%
Column total	59	71	97	93	126	100	39	37	38	660

* Number of samples
** % of column total

Table A-10 1000 SEED WEIGHT BY STATE AND CROP REPORTING DISTRICT

Grams per 1000 seeds	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
15.00-16.99	0* .00%**	1 1.41%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	0 .00%	1 .15%
17.00-18.99	0 .00%	1 1.41%	1 1.03%	1 1.06%	2 1.61%	0 .00%	0 .00%	1 2.70%	0 .00%	6 .91%
19.00-20.99	0 .00%	1 1.41%	3 3.09%	7 7.45%	3 2.42%	5 4.95%	6 15.38%	3 8.11%	2 5.26%	30 4.55%
21.00-22.99	4 6.78%	2 2.82%	5 5.15%	13 13.83%	16 12.90%	11 10.89%	7 17.95%	6 16.22%	8 21.05%	72 10.91%
23.00-24.99	4 6.78%	7 9.86%	14 14.43%	23 24.47%	29 23.39%	22 21.78%	7 17.95%	8 21.62%	4 10.53%	118 17.88%
25.00-26.99	14 23.73%	16 22.54%	16 16.49%	17 18.09%	33 26.61%	21 20.79%	7 17.95%	8 21.62%	11 28.95%	143 21.67%
27.00-28.99	18 30.51%	11 15.49%	21 21.65%	14 14.89%	22 17.74%	19 18.81%	7 17.95%	4 10.81%	6 15.79%	122 18.48%
29.00-30.99	12 20.34%	19 26.76%	20 20.62%	13 13.83%	15 12.10%	14 13.86%	1 2.56%	3 8.11%	5 13.16%	102 15.45%
31.00-32.99	5 8.47%	10 14.08%	12 12.37%	5 5.32%	1 .81%	4 3.96%	1 2.56%	3 8.11%	1 2.63%	42 6.36%
33.00-34.99	2 3.39%	2 2.82%	5 5.15%	0 .00%	3 2.42%	1 .99%	3 7.69%	1 2.70%	1 2.63%	18 2.73%
35.00-36.99	0 .00%	1 1.41%	0 .00%	1 1.06%	0 .00%	4 3.96%	0 .00%	0 .00%	0 .00%	6 .91%
Column Total	59	71	97	94	124	101	39	37	38	660

* number of samples
** % of column total

Table A-11 ESTIMATED FIRST CHOICE OF PURCHASE IN 1989 BY STATE AND CROP REPORTING DISTRICT

Source	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
Major	5*	20	19	24	23	19	7	3	6	126
	9.80%**	29.85%	24.05%	29.27%	22.33%	23.75%	20.00%	10.00%	24.00%	22.83%
Grower/Dealer	33	24	42	37	64	46	20	17	16	299
	64.71%	35.82%	53.16%	45.12%	62.14%	57.50%	57.14%	56.67%	64.00%	54.17%
Other Dealer	13	22	17	17	13	15	7	7	2	113
	25.49%	32.84%	21.52%	20.73%	12.62%	18.75%	20.00%	23.33%	8.00%	20.47%
Foundation Seed (KSU)	0	1	1	4	3	0	1	3	1	14
	.00%	1.49%	1.27%	4.88%	2.91%	.00%	2.86%	10.00%	4.00%	2.54%
Column Total	51	67	79	82	103	80	35	30	25	552

* number of farmers sampled
** % of column total

Table A-7 MECHANICAL PURITY BY STATE AND CROP REPORTING DISTRICT

Mechanical Purity %	North West	West Central	South West	North Central	Central	South Central	North East	East Central	South East	Entire State
Less than 90	0* .00%**	1 1.41%	0 .00%	1 1.09%	2 1.69%	2 2.00%	0 .00%	0 .00%	1 2.63%	7 1.08%
90.00-94.99	5 8.47%	4 5.63%	9 9.28%	8 8.70%	4 3.39%	8 8.00%	0 .00%	1 2.70%	2 5.26%	41 6.30%
95.00-95.99	1 1.69%	11 15.49%	3 3.09%	2 2.17%	4 3.39%	3 3.00%	0 .00%	0 .00%	0 .00%	24 3.69%
96.00-96.99	4 6.78%	5 7.04%	12 12.37%	13 14.13%	10 8.47%	4 4.00%	1 2.56%	3 8.11%	2 5.26%	54 8.29%
97.00-97.99	11 18.64%	19 26.76%	13 13.40%	16 17.39%	10 8.47%	12 12.00%	1 2.56%	3 8.11%	1 2.63%	86 13.21%
98.00-98.49	7 11.86%	4 5.63%	12 12.37%	7 7.61%	8 6.78%	14 14.00%	1 2.56%	1 2.70%	5 13.16%	59 9.06%
98.50-98.99	12 20.34%	11 15.49%	12 12.37%	14 15.22%	10 8.47%	12 12.00%	5 12.82%	2 5.41%	6 15.79%	84 12.90%
99.00-99.49	9 15.25%	11 15.49%	18 18.56%	19 20.65%	33 27.97%	26 26.00%	7 17.95%	9 24.32%	8 21.05%	140 21.51%
99.50-99.99	10 16.95%	5 7.04%	18 18.56%	12 13.04%	37 31.36%	19 19.00%	24 61.54%	18 48.65%	13 34.21%	156 23.96%
Column Total	59	71	97	92	118	100	39	37	38	651

* number of samples
** % of column total

THE QUALITY OF 1984 KANSAS WHEAT (*Triticum aestivum* L. em. Thell) SEED AND ITS EFFECT ON THE QUALITY AND YIELD OF GRAIN

by

JAMES ROBERT STANELLE

B. S., University of Wisconsin-Platteville, 1972

AN ABSTRACT OF A MASTERS THESIS

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ABSTRACT

Winter wheat (Triticum aestivum L. em. Thell.) production in the State of Kansas has long been important. Knowing the quality of the seed being planted and how that seed quality can affect the quality of grain can be of considerable importance.

This study was conducted to investigate the quality of the seed that is being planted by farmers, how that seed is acquired and what management factors are applied to it. Additional studies were conducted to establish the affect that seed has on grain yield and quality, and, the varietal purity of the seed samples. Some comparisons where made between this survey and a similar survey conducted in 1973.

Seed samples were collected from 662 Kansas wheat growers. Information on seed and farming practices was collected on a questionnaire and seed quality information was obtained through laboratory analysis. A yield study was conducted on selected samples of four varieties at Manhattan and Hutchinson. A varietal purity determination was made through visual evaluations of unreplicated plots planted at Manhattan.

Information gathered from the questionnaire showed that wheat farmers are using better management practices, planting more varieties on their farms, and planting more seed that is certified or closer to certified status than in the 1973 survey. Seed analysis showed an increase in germination, mechanical purity, and seed weight as well as a more extensive weed problem than in 1973.

Analysis of variance on data from harvested grain showed

some significant sample differences for spring stand rating, test weight, seed weight, and screening fractions. Further analysis of these factors failed to show that those differences occurred in any areas that could be influenced by management. A few significant correlations between seed quality factors and grain quality were found. These correlations were not found to be consistent between locations or within varieties.

Approximately one-half of the samples had some type of varietal impurity present and six percent were incorrectly reported as to variety. Newer varieties and varieties closer to certified status had the highest varietal purity.