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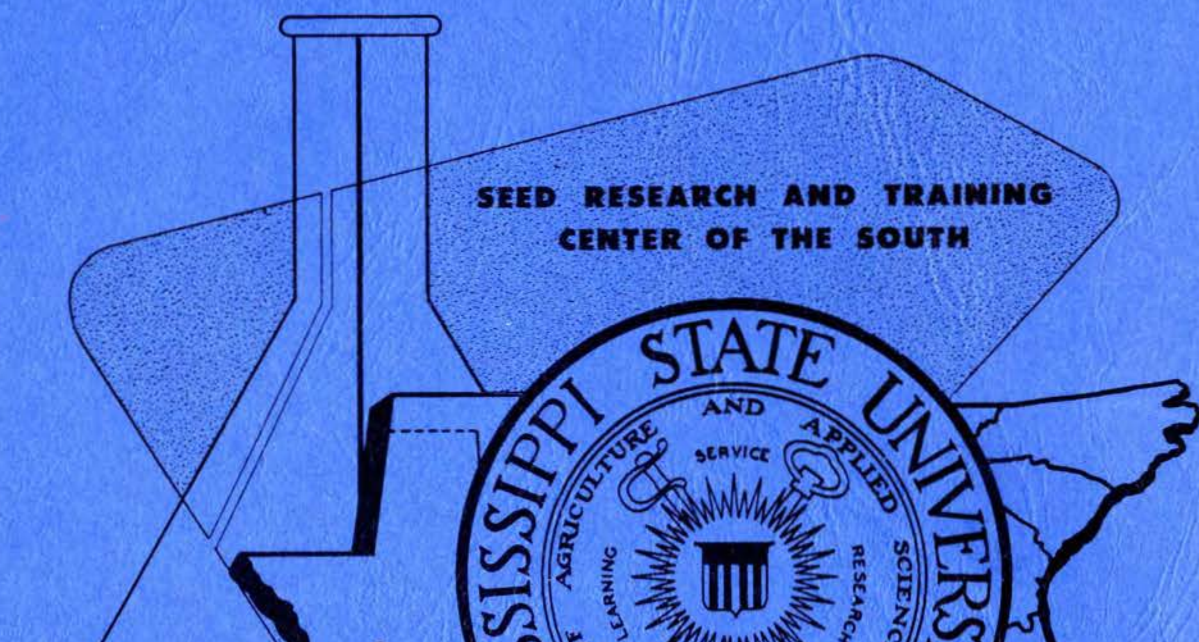
Proceedings: 1967 Short Course for Seedsmen (Full Document)

Proceedings

1967 SHORT COURSE
for
SEEDSMEN



APRIL 10 - 13, 1967

SEED TECHNOLOGY LABORATORY

STATE COLLEGE **MISSISSIPPI**

Sponsored By The Mississippi Seedsmen's Association

PROCEEDINGS
1967 Short Course for Seedsmen
April 10 - April 13, 1967

Seed Technology Laboratory
Mississippi State University
State College, Mississippi

A SUCCESSFUL SHORT COURSE
REQUIRES

A Wide-eyed Staff

An Exchange of Ideas

Demonstration of Principles

and their application

Effective Teaching

and Industry's Support

TABLE OF CONTENTS

PROGRAM

"UPGRADING OF SEED QUALITY"

MONDAY, APRIL 10

8:00 "Registration & Housing", Mr. Charles C. Baskin, Seed Technology Laboratory
Free Coffee, Cokes, and Doughnuts furnished all week, courtesy of manufacturers and their representatives

10:00 "Tour of Unique Facilities, Dr. Ken Matthes, Seed Technology Laboratory
Boll Weevil Laboratory
Wood Products Utilization Laboratory
or
Movies of interest to the Seed Industry
Seed Technology-Auditorium

12:00 LUNCH

1:25 "Through Planned Programs"
Presiding: Dr. James C. Delouche

1:30 Welcomes and Introductions

2:00 "Upgrading Seed Quality-A Job for the Entire Seed Industry", Mr. Lloyd Arnold, Arnold-Thomas Seed Service, Fresno, California

3:00 Coffee, Cokes, and Doughnuts

3:30 "Equipment Demonstrations"
Manufacturers Representatives
or
"Crop Seed Identification", Mr. T. Wayne Still, Seed Technology Laboratory

7:00 Bar-B-Que Chicken Dinner
Entertainment
University Cafeteria
Courtesy of Mississippi Seed Improvement Association
and
Mississippi Seedsmen's Association

TUESDAY, APRIL 11

8:25 "Through Better Processing"
Presiding: Mr. Bill Gregg

8:30 "Operate-Don't Just Run-Your Cleaners", Mr. James Henderson, A. T. Ferrell Co. Saginaw, Michigan

9:30 "Seed Surface Separations", Mr. Charles Vaughan, Seed Technology Laboratory

10:00 Coffee, Cokes, and Doughnuts

10:30 "Dimensional Sizing Can Improve Quality", Mr. George Dougherty, Seed Technology Laboratory

11:00 "Calibrated Treaters-Save Your Money", Dr. Howard Potts, Seed Technology Laboratory

11:30 "Potential Uses of Color Separators", Mr. "Bill" Boyd, Seed Technology Laboratory

12:00 LUNCH

1:25 "Through Automation"
Presiding: Mr. A. H. "Bill" Boyd

1:30 "Usable Controls for Existing Plants", Mr. E. E. Brown, E. R. Brown Instrument Company, Shreveport, Louisiana

2:00 "Automatic Weighing, Packaging, and Handling", Mr. Stanley Berg, Howe-Richardson Scale Company, Clifton, New Jersey

2:30 "Advantages and Problems of Partial Automation", Mr. N. L. Pugh, Mill Superintendent, Riverside Industries, Marks, Mississippi

3:00 Coffee, Cokes, and Doughnuts

3:30 "Equipment Demonstrations", Manufacturers Representatives
or
"Weed Seed Identification", Mr. Travis Rushing, Seed Technology Laboratory

WEDNESDAY, APRIL 12

8:25 "Through Better Handling"
Presiding: Mr. George Dougherty

8:30 "Use and Mis-Use of Gravity Separators", Mr. Bill Gregg, Seed Technology Laboratory

10:00 Coffee, Cokes, and Doughnuts

10:30 "Seed Storage to Maintain Quality", Dr. G. Burns Welch, Seed Technology Laboratory

11:00 "Predicting Seed Storability", Dr. James Helmer, Seed Technology Laboratory

11:30 "Mechanical Damage:Immediate and Latent Effects on Seeds", Dr. James C. Delouche, Seed Technology Laboratory

12:00 LUNCH

1:25 "Through Improved Tests"
Presiding: Mr. Charles Vaughan

1:30 "Seed Facts from Tetrazolium Testing", Dr. R. P. Moore, North Carolina State University, Raleigh, North Carolina

2:15 Door Prize Drawings

2:30 "Tetrazolium Workship", Dr. R. P. Moore and Dr. D. F. Grabe
or
"Equipment Demonstrations", Manufacturers Representatives

7:00 Mississippi Style Barbeque Courtesy of W. R. Grace & Company, Sawan Division, Columbus, Mississippi

THURSDAY, APRIL 13

8:25 "Through Quality Control" Presiding: Dr. Howard C. Potts

8:30 "Seed Quality Tests and Their Significance", Dr. Don F. Grabe, Iowa State University, Ames, Iowa

9:30 Self-evaluation Examination

10:00 Coffee, Cokes, and Doughnuts

10:30 "An Effective Quality Control Program", Dr. C. D. Harrington, Asgrow Seed Co., Twin Falls, Idaho

11:30 Discussion of Examination, All Speakers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STAFF LISTINGS

Supporting Staff

1. Faye Osborne	Secretary
2. Sydney Cook	Secretary
3. Alice Perkins	Laboratory Technician
4. Linda Jabri	Head Secretary
5. Diane Smith	Laboratory Technician
6. William Daniel	Research Assistant
7. Dero Kinard	Technical Assistant
8. Curtis Reed	Technical Aide
9. Jimmy Clardy	Technical Aide

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10. H. Dean Bunch, Chief of Party	Rio de Janeiro
11. C. Hunter Andrews	Rio de Janeiro
12. Paul R. Mezynski	Salvador
13. Dumont A. Souleyrette	Recife
14. James M. Beck	Rio de Janeiro

Guatemala Staff

15. Billy S. Barnes, Chief of Party	Guatemala City

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Students

1. N. S. Gill	India
2. Carlos Herrera . . .	Peru
3. Noble Kearney . . .	Mississippi
4. Anastacio Mercado . . .	Philippines
5. Kyle Rushing	Kentucky
6. P. D. Singh	India
7. Prasoot Sittisroung . . .	Thailand

Not Pictured

8. Hamid Benhalima . . .	Morocco
9. Walter Green	Mississippi
10. Hugh Maxey	Mississippi
11. Charles Sibley . . .	Mississippi

SEED PROCESSING AND HANDLING

Handbook No. 1 March 1967

The background for this page depicts the front cover of the recently completed Handbook No. 1 "Seed Processing and Handling". This 295 page, illustrated book includes the basic information used in all talks delivered in this subject area. It is a compilation of information from the personal experiences, research and theories of the Staff of the Seed Technology Laboratory and the many Equipment manufacturers, Seedsmen, and Research personnel who have so generously given their time and efforts to the success of the Seed Technology Laboratory.

Anyone interested in purchasing a copy may do so by sending $3.00 to the Seed Technology Laboratory, Box 5267, State College, Mississippi 39762.

Seed Processing and Handling

Seed Technology Laboratory
Mississippi State University
State College, Mississippi

UPGRADING SEED QUALITY - A JOB FOR
THE ENTIRE SEED INDUSTRY

Lloyd E. Arnold [1]

During this 16th Annual Short Course for Seedsmen, you will have the opportunity to gain valuable information in six extremely important areas that can and do function for the "Upgrading of Seed Quality". They are: THROUGH....planned programs....better processing....automation ....better handling....improved tests....quality control. Each and every one of these areas should command your attention. I shall leave it to the several extremely well qualified persons on the program to explore with you what can be done NOW to improve seed quality.

As a director of the American Seed Research Foundation, I am more than pleased to note a number of speakers on your program who have carried on seed research projects for the foundation. I believe it will be of interest to you to learn of the scope of some of the research projects supported by the American Seed Research Foundation. This past year the following projects were brought to a close:

1. Seed Transmission of Plant Pathogenic Bacteria with Emphasis on the Factors Affecting Seed Contamination and Seedling Infection. Dr. R. G. Grogan, University of California, Davis.

2. A Seed Bibliography. Dr. Lela V. Barton, Boyce Thompson Institute for Plant Research, Yonkers, New York.

3. Affects of Physiological Seed Deterioration on Plant Growth and Development. Dr. D. F. Grabe, Iowa State University, Ames, Iowa.

4. Developments of Methods for Predicting Longevity (Life Expectancy) of Crop Seed Lots in Storage. Dr. James C. Delouche, Mississippi State University, State College, Mississippi.

5. Investigation of the Degenerative Life Processes of Aging Seeds. Dr. R. P. Moore, North Carolina State University, Raleigh, North Carolina.

1/ Mr. Arnold is the president of Arnold-Thomas Seed Company in Fresno, California.

6. The Role of Protein and Nucleic Acid Synthesis During Seed Germination. Dr. J. H. Cherry and Dr. F. O. Lanphear, Purdue University, Lafayette, Indiana.

This year the foundation will initiate the following projects:

1. Biochemistry of Aging of Seeds as Related to Seed Moisture. James F. Harrington, University of California, Davis.

2. Investigation of Effect of Temperature During Imbibition on Germination and Seedling Growth. Charles W. Basham, Colorado State University, Fort Collins, Colorado.

3. Physiological Basis of Seed Longevity. Dr. D. R. Grabe, Iowa State University, Ames, Iowa.

4. Separation of Seeds on Basis of Viability and Vigor. Dr. James C Delouche, Mississippi State University, State College, Mississippi.

5. Role of RNA and Protein Synthesis in Seed Dormancy. Anwar A. Khan, Cornell University, Ithaca, New York.

Many of these projects are quite basic in the nature of research on seed but directly or indirectly they are bound to have an influence on seed quality.

In this all important matter ... "Upgrading Seed Quality" ... possibly we should ask ourselves, "Where do we go from here?"

As an industry, over the last 15 to 20 years, we have made great strides in upgrading seed quality ... thanks to such conferences as this one and others held in several other states. However, there is still a lot of "unfinished business" in this area of "Upgrading Seed Quality". This applies not only to the seed trade who handle the physical movement of the seed from the producer to the consuming farmer but as well to the man who grows the seed, the plant breeders, the extension agronomists, the certification agencies, the seed technologists in our seed laboratories, the industry who manufactures seed cleaning equipment, the container industry, the herbicide, insecticide and fungicide industries, the legume seed preinoculation industry, the fertilizer industry, the farm equipment industry, the cotton ginning industry, the state and federal seed control personnel, the research personnel in Seed Technology Laboratories such as the one here at Mississippi State University and I am sure there are others that should have a part in "Upgrading Seed Quality" which could be added to this list.

So, where do we start to discuss this "unfinished business". To be real honest with you, I am not sure where to start ... but, as we all know, the train will never move unless we open up the throttle slowly at first to take up the slack and then use a heavy hand or foot, whichever may be the case, to bring the moving cargo to the desired speed to match the time schedule to keep out of the way of following trains or to be at a designated point to permit passage of trains moving in the opposite direction, but I am sure that there are trains following me, and with important messages. So, I must move ahead and get the train moving.

Weeds as we will see do represent a serious loss to agriculture in the production of food, feed and fiber. Weeds are plants growing where they are not wanted and are a nuisance for one reason or another. At times, even plants of some of our major agricultural crops can be classed as weeds.

Weeds reduce the quality and quantity of crop and livestock production; increase the cost of labor, equipment and water for irrigation; they may harbor insects, nematodes and disease organisms; clog irrigation and drainage canals and ditches; impair the health of livestock and humans; and cause heavy outlay in funds to control them or keep them in check along highways, railroad right-of-ways, parks, lawns, golf courses and in forests.

Growing weeds represent a heavy drain on available soil moisture. By comparison, the corn plant requires 368 pounds of water to produce a pound of corn (dry-matter basis), whereas lambsquarter and ragweed use 800 and 950 pounds respectively.

The time will come when this nation cannot afford the luxury of weeds on our agricultural crop lands. We, in the seed industry, must do our utmost to help alleviate the losses due to weeds and the drain they exert on our precious supply of water. We sometimes hear - "Water, Water, Everywhere ---!" You know how to finish the phrase. But let's consider some of the facts about this "raw product" in our agricultural enterprise. It has been said, 97.2% of the world's water contains salt and 2.1% is frozen - this leaves only .7% in rivers, lakes and underground geological formations to supply the water for wells, springs, etc. The United States consumes about 355 billion gallons of water daily and the use will increase to about 600 billion gallons by 1980. Thus, I repeat, the seed industry must help alleviate the loss of water in this nation which is consumed by weeds in our agricultural crops.

It has been reported that the average annual loss due to weeds in some of our major crops expressed in a percent of the crop value is:

Cotton	8%	Wheat	12%
Corn	10%	Sorghum	13%
Rice	17%	Peanuts	15%
Barley	12%	Sugar Beets	8%
Oats	17%	Sugar Cane	13%
Rye	12%		

Those engaged in handling and processing the multitude of seed crops, I am sure, view with concern the continued presence of weed seeds in our seed crops. Weed seeds represent one of the real problems in cleaning many of the field seed crops and some vegetable seed crops harvested in the United States. It has been estimated that weeds cause an annual loss to field crops of $1,543,415,000; forage seed crops $29,609,000; vegetable $122,249,000 and the total loss due to weeds for these crops plus pasture and rangelands and fruits and nuts is $2,459,630,000. The cost to try and control weeds in these crops is estimated to be $2,551,050,000. This adds up to a staggering charge against agriculture of over $5,000,000,000.

The seed crops showing heavy dollar losses were alfalfa 9.5 million, red clover 6.2 million, lespedeza 2.9 million and grasses (miscellaneous) 2 million. Data is not available for other seed crops such as vegetables, cereals, corn, etc., but in certain instances I am sure loss due to weeds can be substantial.

This conference has, throughout its existence, devoted many hours to the problem of removing weed seed from crop seeds produced by farmers. While we have made considerable progress in this matter of separating weed seed from crop seeds, it sure looks like someone in the seed industry still has a job to do.

It seems to me that the grower, the first link in the seed industry "chain", should be encouraged, persuaded, cajoled or required to produce seed containing fewer weed seed. Today, he has a great deal more going for him to get this job done - just look at all the herbicides - and I am sure more are on the way. Agronomists, extension service personnel, seed company representatives and the manufacturers of herbicides should work with and appraise the seed grower of the value of controlling weeds.

We must be ready and willing to put our shoulder to the wheel in this process of upgrading seed quality. If we neglect doing our fair share we may find ourselves "has beens". As they say, "Time and Tide wait for no man". In our case, I think we could paraphrase this by saying, Change waits for no one.

Change is all about us. Recently I saw some statistics that reported there were an estimated 3,629,000 babies born in the United

States last year, the lowest number of births since 1950. But the excess of births over deaths added about 1,760,000 million additional individuals to our total population which must be clothed and fed. And, as we all know, this is happening all over the world - and in some places with much greater acceleration. There must be a change if we, as a seed industry, are to have the needed quality seed to keep up with the impact of the population explosion at home and around the world - it is a compelling, demanding and frightening situation.

We, in business, are accustomed to change and I am sure the seed industry is no exception. Change brings with it the possibility of new opportunities. However, we must recognize the danger of just talking about change and yet actually doing very little to prepare for it. There is a real danger of self-deception in believing that we can meet future change by doing more of what we are doing now. We should and must not let ourselves be trapped into a false sense of security.

What can we as a seed industry do to adjust our mental ability toward constant innovation to keep abreast with change? We should:

1. Make a real effort to force change in our habit patterns in order not to become too deeply committed to them to such an extent as to limit our ability to accept new ideas rapidly.

2. Make it a point to master new skills that are part and parcel of change.

3. Adopt an inquiring attitude about whatever phase of the seed industry in which one is engaged.

4. Have an appreciation for and an understanding of the need for team-work.

Possibly, we should ask ourselves:

Why do I operate the way I do?

How much of what I am doing is based on sound principles, how much on opinion?

Are the demands of the seed industry upon me the same today as yesterday?

I am sure that the answers each of you might give to these questions would vary in some degree - but I would hope there would be a reasonable area of agreement. There should be, if we are to keep up with changes - the changes which will be demanded of our industry to further upgrade seed quality, to make the right kinds, varieties and quality of seed available to satisfy a hungry world.

If I thought for a minute that the answers to these questions would be vague, uncertain, at great variance; man, man, we sure got a lot of home work to do. Or maybe we should say in the vernacular of the good old days - boy, I guess we had better go to the wood shed.

Change - my, my, our farm programs sure do bring about change - they are a bit like a yo-yo, you don't know whether you are UP or DOWN. But we in the seed industry do know they do bring about change. At times I think we could safely say "confused change".

The great emphasis on expanded production of grain and oil crops has placed a heavy demand upon our industry to make available seed of these crops. And I dare say, there is a real need for long range planning which could upgrade seed quality in this segment of our industry.

Change. The 1964 census of Agriculture reported only 3,157,864 farms - a decrease of 552,639 from the number reported in 1959 - a 15% decrease. The average size farm in 1964 was 351.5 acres compared to 302.8 acres in 1959 - up 48.7 acres. This change to larger farm units does and will continue to create an interesting challenge to the seed industry as to how best to serve these farmers whose needs will become more demanding as to quality of the seeds they use to make their farming operations productive and profitable.

A comprehensive in-depth study was made by Michigan State University of their agriculture, entitled "Project '80 Rural Michigan Now and in 1980".

I wish to refer specifically to their Research Reports 44 and 47. It is rather interesting to note the guide posts which were established as a basis for evaluating Michigan agriculture by the year 1980.

"Between now and 1980 we assume:

1. No major war.

2. No major depression.

3. Inflation of about 1.5 percent per year in consumer prices.

4. Average weather and little success in controlling weather.

5. Development of new technology will be even more rapid than in the past 15 years.

6. The rate of adoption of new technology will be somewhat faster than in the past 15 years.

7. The continuation of some type of price support program with increasing emphasis on area development.

I believe the study in Michigan is fairly indicative of what is happening throughout the nation and here is what they have to say about the size of farms in Research Report 47:

> "From the standpoint of the total acreage in farms, in 1964 about 41 percent was in farms of less than 180 acres and 59 percent in those above that acreage. By 1980, it is projected that the percentages will be 18 and 82 respectively. A look at the farms of 260 acres and larger may be of interest. In 1964 they made up 14 percent of all farms and contained about 40 percent of the total land in farms. It is projected that by 1980 farms of this size will constitute 35 percent of all the farms and that two-thirds of all farm land will be in such farms. They would average about 420 acres in size."

From this same study in Research Report 44, it is projected that there will be a marked reduction in the number of elevators and farm supply firms serving the farmers in Michigan by 1980. In 1965, there were approximately 650 local grain, feed and farm supply firms - by 1980 it is reasonable to expect there will be only 400 of these firms remaining. This represents about a 3 percent loss in number per year.

Some of the changes that will take place in the producing farm units, with a direct bearing on number of farm supply firms needed and of interest for this discussion, as contained in the Michigan report are:

1. "More scientific methods of production will be employed by all segments of farming. This means purchased input requirements will be specified within close tolerance and the complexities of such things as herbicides, pesticides, and fertilizers will require special new treatment, storage, and handling techniques."

2. "There will be more specialization in production - both by area and by individual farms. This will challenge the local elevator and farm supply agency to offer specialized services and the manager must be a competent counselor for these specialized activities."

3. "Production units will become more sophisticated in their record keeping - with more attention to output-input relation-

ships. This means that as more farm producers begin to examine their activities in terms of what happens over the production time period by complete cycles, market agencies in turn will be challenged to offer their services in terms of package or programs. ..... the market agency with diversified enterprises such as grain, bean and farm supply firms in Michigan will be challenged to adopt more appropriate record keeping systems and analytical techniques than are in common use today."

Yes - we are caught up in a dynamic and ever-changing agriculture - one which will challenge the ingenuity and tax the resourcefulness of those, particularly the seed industry, charged with servicing this segment of our national economy.

In any society, seed is the Foundation for Greatness. This is true whether we are considering wheat, corn, rice, cotton, soybeans, grasses, small seeded legumes or, for that fact, most any crop which contributes to man's sustenance or pleasure. Just look at reported acre yields - corn over two hundred bushels, wheat one-hundred-fifty bushels plus, alfalfa nine tons plus. And, I am sure, other fantastic yield patterns could be cited for many other commercial crops in the United States. Suffice it to say, this would not have happened unless there was available, quality seed of the proper varieties for our farmers to accomplish such feats of production. Just think, U.S. farmers last year spent $599 million for improved seed.

There is a dismal side to this picture which I am afraid does not contribute to such production performances. I now refer to the quality of some of the seed which our industry makes available to the consumer. This is seed improperly labeled as to mechanical purity, germination and freedom from troublesome weed seeds - seed improperly cleaned - seed improperly blended to give a uniform consistency.

The Seed Analysis Report - 1966 by the Pennsylvania Department of Agriculture showed that from July 1, 1965 to June 30, 1966, "Stop Sale" was placed on 401 lots of seed at 81 seed vendors for various reasons. The report covered a total of 4,528 samples taken - 1,095 for purity, 2,014 for noxious weed examination and 5,244 for germination. Inspectors in Pennsylvania collected 1,088 samples of agricultural seed for examination and testing and 11.6% were considered illegal for sale; likewise, of the 224 samples of mixtures of agricultural seed collected, 51.1% were illegal; and 2.9% of the 931 samples of vegetable seeds collected were illegal.

Part of the industry's problem is the type of job some seed growers do in producing a seed crop. A good example of this is the quality of home-grown red clover seed reported by Pennsylvania. A total of 42 samples of red clover were tested or examined and 61.9% were considered illegal for sale. Twenty-six of these samples contained an average of 3,564 noxious weeds per pound, with one showing 40,500 per pound and the lowest had 468 per pound.

In this publication were two tests reported on apparently the same lot of Orchardgrass. At least the lot number reported was the same. One lot was labeled - purity 96.39 and inert 2.97, but when tested purity was found to be 90.07 and inert 9.34. The other lot was labeled - purity 96.39, inert 1.97 and other crop .64, while test results showed purity 92.07, inert 6.13 and other crop 1.80.

I should also like to relate some encouraging information from Indiana in their Inspection Report 58. They reported a steady decline in misbranded seed in a forty-year period. In 1925, 36.4 percent of samples (745) examined were seriously misbranded; by 1939 the figure was 15.8%; in 1940 only 9.9% were misbranded and in 1965 misbranding dropped to a low point of 2.8% of the 2,104 samples examined.

This same report gave a summary on the analysis of 280 lots of tagged and 23 lots of untagged red clover seed. The tagged lots showed a purity of 99.3 percent in contrast to untagged of 96.82 percent; inert .16 percent as compared to 1.0 percent and weeds .08 percent as compared to 1.63 percent. The number of weed seeds per pound on the tagged seed was 379 versus untagged at 7,331 per pound.

Yes --- "Where do we go from here?"

You can see there is plenty yet to be done to "Upgrade Seed Quality". So - where do we start? It is somewhat self-evident from the information on tagged and untagged red clover in Indiana and the results reported from Pennsylvania on red clover that a likely place to start in upgrading seed quality is with the grower. You cannot made a silk purse out of a sow's ear - so be it with seed. Improperly produced seed which contains noxious weeds, crop mixtures, immature seed, frost damaged seed, rain damaged seed, mechanical harvester damage, etc. - once produced under present-day philosophy finds its way into seed trade channels and finally ends up on some farm. How bad or how good such seed may be when it finds its way back to the farm depends in large part on:

1. How poor a quality one is willing to sell or, shall we say, peddle.

2. How successful and efficient one is in upgrading the quality through processing.

3. How much upgrading in quality can be brought about by blending with seed of extremely high quality.

The degree to which an individual firm would use any one or all three of these possibilities will be determined by management in light of market demand, processing facilities to cope with the problem, skilled machine technicians and proper blending facilities.

In regard to the latter, during the meeting of the Grain and Forage Crops Research Advisory Committee to the USDA, we were appraised by Mr. Leo Holman, ARS, of the research on blending seed being conducted here at Mississippi State University. In your Seed Technology Laboratory research is under way to try to come up with an improved seed blender. I understand there are at least four different configurations under test. I hope we may have the opportunity to see the progress being made in this very important area of uniformity of seed when packaged. Also, it is of interest to note this research project is partially financed by the Field Seed Insititue of North America.

As I view the program for this conference, one should be able to gather information to help with what to do with problem crops of seed that the grower "just lets happen" and where it may happen to a seed crop due to no fault of the grower.

Now let's dig a bit deeper into - "Where do we go from here?"

The seed trade has a substantial export market for U.S. grown seed. This past year seed exports reached a total of 128.2 million pounds valued at $33.1 million. Of this total, over half is made up of grass and legume seeds. The export of these seeds reached an all-time record - 68.3 million pounds valued at $18.7 million.

Just as a point of interest - aside from the seed, this nation exports the product of one out of every four crop producing acres. To give you some idea as to this volume, it would take 1.5 plus million freight cars to haul these export commodities. It has been reported this would be equivalent to three solid freight trains stretching from San Francisco to New York.

The importing countries are becoming more demanding both as to variety and quality. I believe many of these countries are moving away from price as the determining factor on where they buy and from whom they buy. There is a growing desire on the part of many countries to request the seed that they buy be certified. In fact, some countries will shortly insist that certain seeds all be certified. This trend may be an advantage to some of our industry and a distinct disadvantage to other segments of our industry. In total, it does mean, however, that growers, extension people and the seed trade must work together to hold and expand the demand for U.S. grown seeds around the world.

The plant breeders, both public and private, have a real job in "Upgrading Seed Quality". Their role, to be sure, will be one of developing new and superior varieties which sould and must have real and economic merit both for the seed producer, the seed merchandizer and the consuming farmer.

The swing to single-cross corn hybrids certainly is not without its problems. Here is a case where the consuming farmer wants this kind of hybrid. The seed corn industry is therefore faced with a sizeable program realigning their entire hybrid corn production program to produce and process in quantity single-cross hybrids for this nation's corn growers.

Our plant breeders and plant scientists are hard at work to hybridize wheat, barley, alfalfa, many vegetables and flowers. Then too, the push to incorporate opaque-2 and floury-2 into corn and to increase the protein content, chlorophyll, xanthophyll, etc., of alfalfa.

Many of our seed crops must be cross-pollinators by insects to assure seed set. There are a number of wild pollinators such as the alkali and leaf-cutter bees, but probably the honey bee is our most versatile and widely used pollinator. Recent research has proven that the honey bee can be selected with preference for certain pollen. The USDA work at Utah has indicated that after three generations of selection, the preference for alfalfa pollen ranges from the high line of about 66 percent to the low line of about 8 percent.

On the strength of this information and other findings, nine seed companies organized Hy-Queen Research, Inc. in March, 1966. This is a non-profit corporation which has contracted with Dadant and Sons, Hamilton, Illinois, to carry on a honey bee breeding program to develop a more effective pollinating honey bee. This is a long-range program. It is projected that in about six years hybrid queen bees with the desired traits will be available and ready for queening colonies for use in pollination of alfalfa seed fields. This research is financed jointly by the two organizations and the anticipated cost of the program will be in the neighborhood of $200,000.

Now, you may ask, what does this have to do with upgrading seed quality of alfalfa seed. Just this, in addition to selection for alfalfa pollen preference there is every indication selection can also be towards a bee that will be active and an effective pollinator in the temperature range of 75° to 85°. In California and the Southwest, by proper management and cultural practices, alfalfa seed crops can be brought into bloom in early to mid-May. Thus, with an effective pollinator at this time of year, it would be possible to harvest the seed crop in July rather than August and September. Aside from assured quality seed production, there should be a savings in weed and harmful insect control and decided savings on cost for irrigation water.

Then in June 1966, the USDA awarded a contract on bee research to the University of Illinois on the role that queen bee secretions play in work activities of bees within and outside of their colonies. The aim of this, and other basic research studies on honey bees, is to develop methods for complete control in bee management. Eventually, scientists hope to substitute chemicals, sound and controlled environment for the conventional bee hive, so that large numbers of honey bees can be used for specific purposes. Maybe someday, we will have a sting-less honey bee - stranger things have happened. Yes - looks like change is on the way for the honey bee.

These men of science are bound to bring about further change in our industry for the betterment of mankind - and for this, we all should be mighty thankful. For by the fruits of their labor, we may be able to hold the line against the staggering pyramiding of world population.

Let's pause for a moment and reflect on this phenomena, if you permit me to use that term. In my home state of California, a prediction was made by Hugo Fisher, California Resources Agency administrator before the Commonwealth Club in San Francisco last July that California will have 1.5 billion residents by the year 2066, if its population continues to expand unchecked.

Various projections as to world population by a given date are too numerous to mention; however, it seems like the year 2000 is a focal point to which long-range projections are directed. Right now the present world population is nearing 3.5 billion and by 2000 will exceed six billion, provided enough food can be produced. The population of the world, as we all know, is very unevenly distributed. By 1975 we can expect an additional 700 million people - that is, more than the population of India and, in fact, more than the entire population of the western hemisphere right now. By the year 2000, if present trends continue, two-thirds of the world population will be in the area from Turkey eastward to include China, India and the islands north of Australia.

These are startling figures if we but pause for a few moments to assess the impact on food production for the 700 million more people that will be populating the face of the earth in 1975. As indicated, this is more than the present population of India or that of the western hemisphere. To cope with the food needs of these 700 million people, it will require an increase in world food production of 22 percent above levels in 1965. This will not be an easy task for it calls for increased production at a faster rate from 1965 to 1975 than took place from 1958 to 1965.

In addition to increased population, we are confronted with changes in our eating habits. For some time, domestically, there has been a decline in per capita consumption of potatoes, wheat, butter, fluid and condensed milk and eggs. Per capita use of food fats and oils and combined use of fruits and vegetables have remained relatively steady. The per capita consumption of beef and veal is expected to expand further, and by 1980 will be around 117 pounds. This compares with a per capita use of 105 pounds in 1964. Thus, anticipated domestic demand for beef by 1980 ranges some 40-50 percent above the high 1964 production rate, which was near the top of the production cycle. On the other hand, the use of pork per capita will decline moderately from 65 pounds in 1964 to less than 60 pounds by 1980. However, by 1980 the domestic market for hogs is projected for an increase of 16 percent when compared with 1964. While there has been indicated a decline in per capita use of milk products, there will still be needed around one-fifth larger production in 1980 than in 1964.

What does this have to do with the seed industry and particularly this conference?

Just this ---------

From where I stand you and that vast array of companies and individuals in many walks of life associated in one way or another with our industry have a major role in seeing that mankind is fed and properly clothed. The more mouths there are to feed and bodies to clothe (excluding the mini-skirt) along with changes which may occur in eating habits are bound to have an influence on crop production patterns around the world. To be an effective seed industry, there is need to be cognizant of these trends and to direct ones skill toward making available quality seed of the kinds needed by the men who till the soil to attain a balanced production of crops in demand for feed, food and fiber.

So, "Where do we go from here?" in this process of "Upgrading Seed Quality".

1. There must be more care by growers to produce seed basically pure and free of harvest injury.

2. There must be more care in handling harvested seed to attain maximum purity, freedom from weeds and vigorous germination.

3. There must be more informational help from extension personnel to assist growers in combatting seed production problems.

4. There must be continued research by Seed Technology laboratories and machinery manufacturers to improve and upgrade processing equipment.

5. Plant breeders and scientists must constantly seek for new and superior varieties and develop new production techniques which will be helpful in maintaining a reasonable seed cost.

6. Associated industries must constantly search for methods of improving their services or products to aid the seed industry to "Upgrade Seed Quality".

Conferences such as this can be very productive if we keep in mind certain guidelines, such as:

1. This meeting belongs to you, otherwise you would not be here.

2. Success of this meeting in some degree rests with you.

3. Enter into the discussions enthusiastically.

4. Share freely of your experience.

5. Confine discussion to the problem under consideration.

6. Say what you think.

7. Listen alertly to the discussion.

8. Appreciate the other fellow's point of view.

9. Avoid monopolizing the discussion.

10. Be prompt and regular in attendance.

And in closing, I would like to draw in part from comments I made in an address before the American Society of Agronomy in Stillwater, Oklahoma on August 23, 1966.

As I view the role of the seed industry in the years ahead, it is full of excitement. The demands upon your time, skills and innate ability will be taxed to the limit by contingencies facing agri-business as it grids itself to feed and clothe the 700 miliion additional people who will populate this world by 1975.

"Upon your shoulders may rest the well-being of mankind. World population by 1975 will require 22 percent more food than is being produced now. The stakes are high - failure could lead to mass starvation in many parts of the world, or indirectly lead to World War III, a thermonuclear holocaust."

I ask you - is there any question as to where we must go from here?

USABLE CONTROLS FOR EXISTING PLANTS

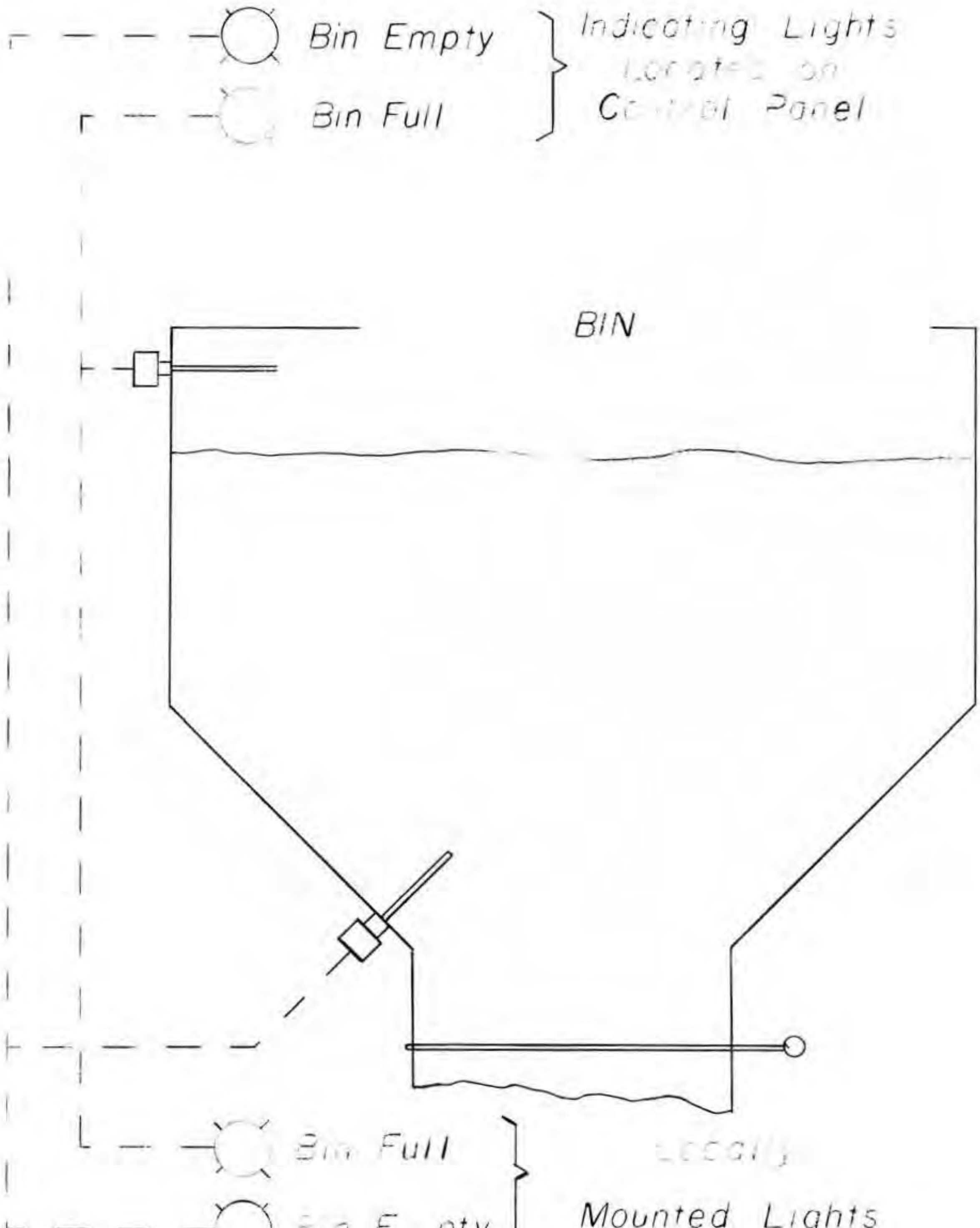
E. Edward Brown [1/]

There are newer and better equipment and techniques now available for control of seed during handling operations. These techniques and equipment are applicable to old as well as new plants.

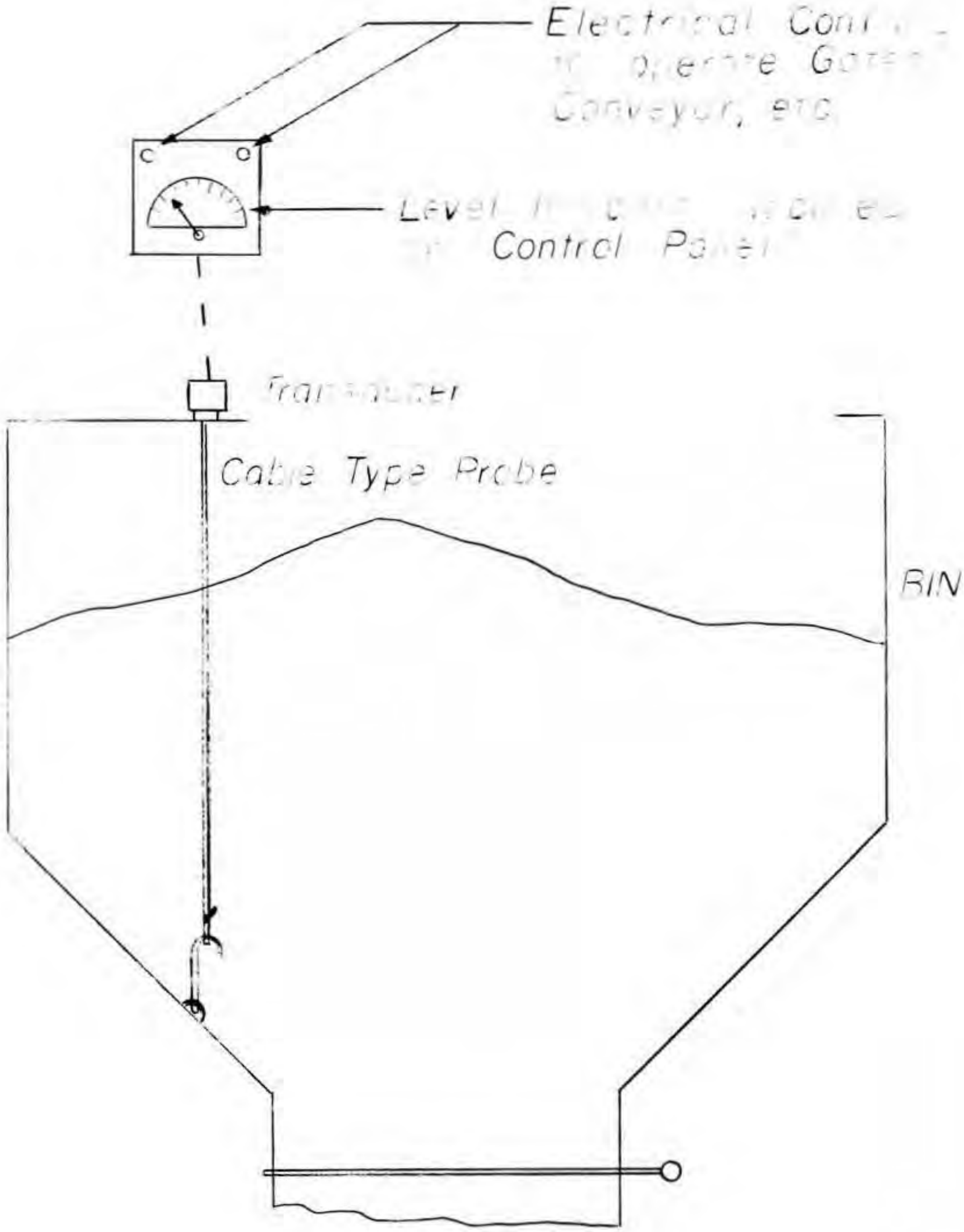
This equipment is generally of all solid state electronic design with no moving parts to wear or to require periodic maintenance and lubrication. This equipment has been made extremely reliable because of the technology gained from the Aerospace Program. Most aircraft and missiles utilize this type device for measuring fuel quantity in their tanks. The redesigned forms for general commercial usage are rugged, reliable, and simple for the layman to install and use. Most manufacturers' designs incorporate plug-in units so that in the event of trouble they can be exchanged like a TV tube with the old unit being sent back for repair. These units can be used to measure any solid or liquid.

The application techniques are simple and can be easily handled by using common sense. The probe is put in the place you want to make a measurement. That is, if you want to light a lamp when the bin is full, you simply install the unit so that the probe is located at the point where the bin is full. Similarly, if you want to know when it is empty, you place the probe at the empty point in the bin. It is impractical to describe all of the applications and things that you can do with radiation probes. Here I have a few drawings showing some common applications of these units. These should provide you with some basic information on what you can use this equipment for.

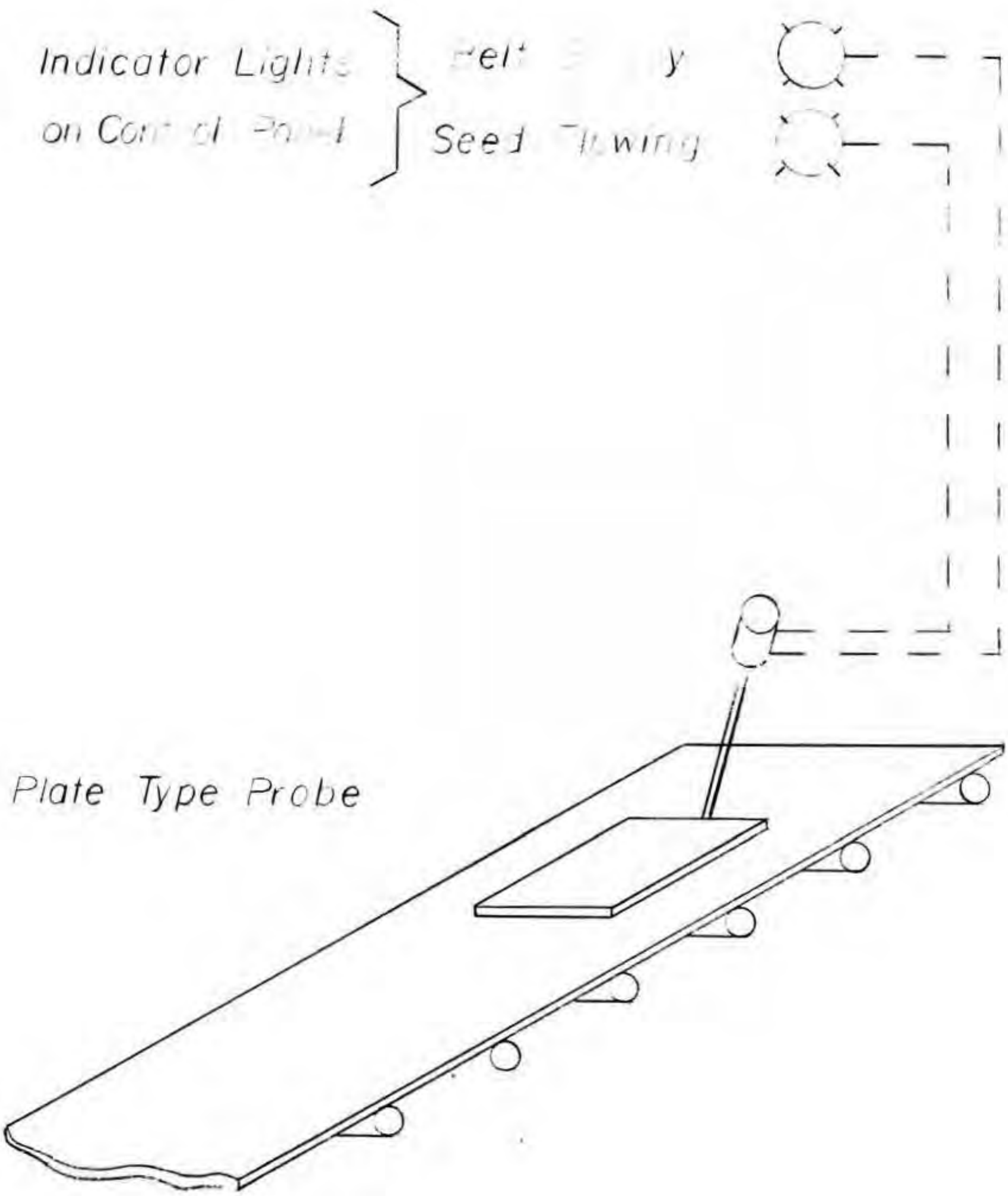
[1/] Mr. Brown is a registered professional engineer and owner of the E. E. Brown Instrument Company of Shreveport, Louisiana.



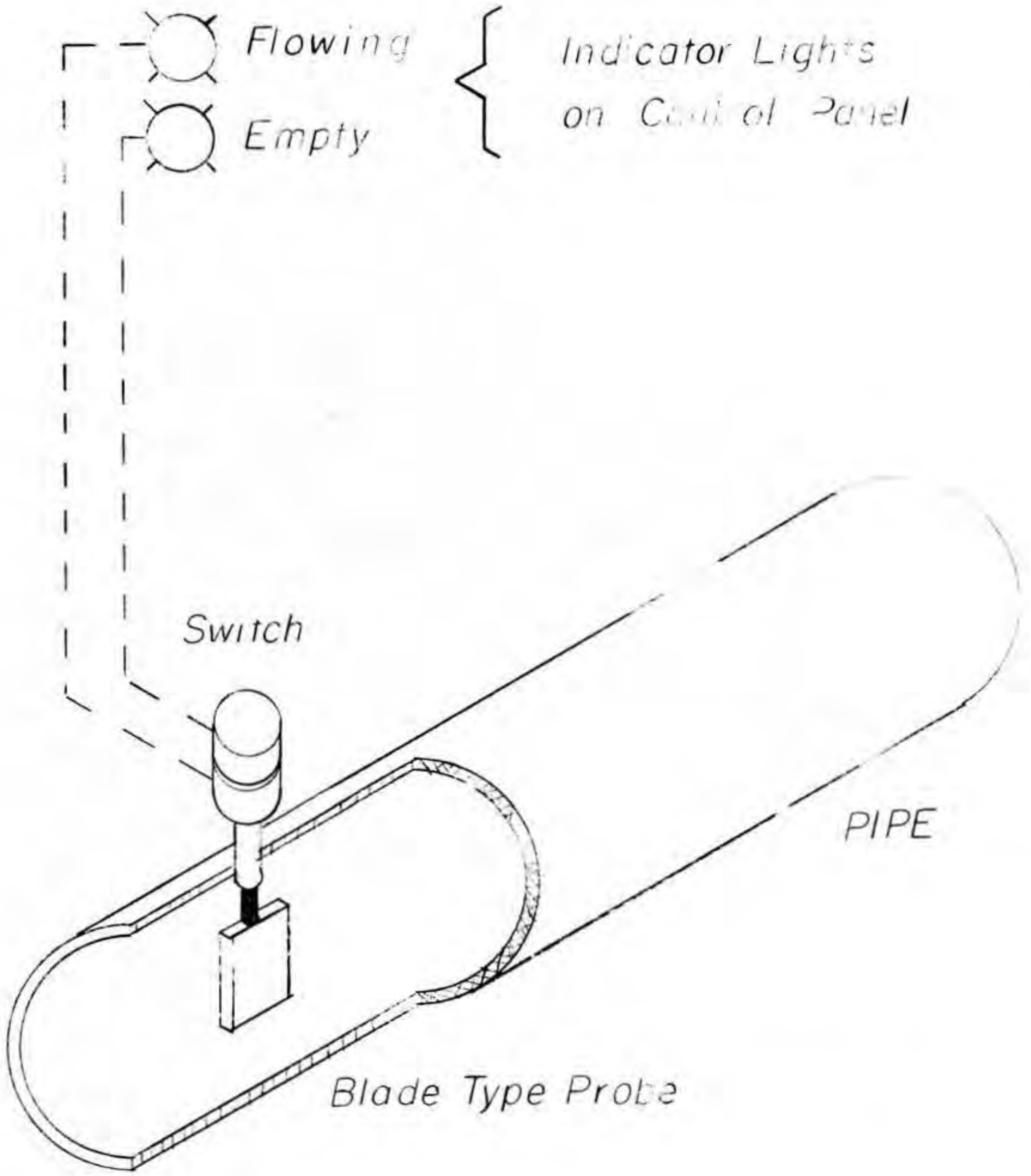
Drawing No. 1 shows how you can use two on-off type probes for indication of the level of seed in a bin. These units can be used for indication only or they can be tied into an automatic plant system and be used to stop and start conveyors, as safety shutdowns, etc.



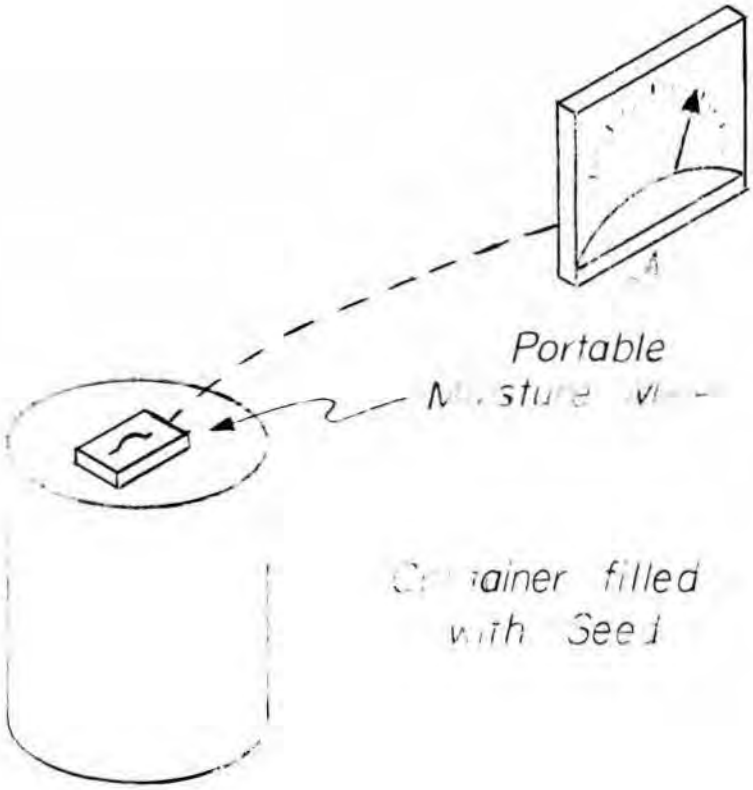
Drawing No. 2 shows the same bin as the first drawing did, using a level unit which continuously displays the amount of material that is currently in the bin. It has a cable type probe which is tied at the top and bottom of the bin. The unit may also be equipped with switches which can be used for the same purposes as the switches which we looked at first. This type level unit does have the advantage that the operator can set the operating points anywhere from full to empty. This feature can be useful as an operating aid to tell him when a vessel is nearly full, empty, etc.



Drawing No. 3 shows how a level switch can be used to determine when a conveyor belt is empty or full. This unit assists the operator by preventing mixing of seed and by getting maximum use out of a conveying system. A flat plate type probe is used for this application.



Drawing No. 4 shows a unit similar to the previous one for conveyor status determination. The same unit is used, however, it is installed in a system where the seed are being pneumatically conveyed.



Drawing No. 5 shows a radiation type device being utilized for moisture content determination on a container of seed. This unit is simply placed on the surface of a bag of seed and the moisture content read from the meter by use of a conversion table. It is portable and can easily be moved from place to place. The device utilizes the slow neutron method of determining the amount of water present.

You have been shown some of the more common uses of radiation type gauges on seed plant applications. They can be used for level and flow sensing; and a special variation of these units can be used for moisture quantity determinations. Use of these units can make you money by preventing loss, by lowering manpower requirements, by maximizing use of plant facilities, and by improving efficiency with centralized control of your plant. I would recommend that you look around your plant and find a place to install a few units so that you can become familiar with their use and application. This will enable you to improve your plant with automation as the need arises in the future.

AUTOMATIC WEIGHING, PACKAGING AND HANDLING

Stanley Berg [1/]

Every bag of processed seed which leaves your plant represents time and money spent on your part. Labor and material costs have been involved to grow the seed, to handle it, to grade, to treat it.

You can think of that bag of seed as being an investment, which is sold to your customers. If that bag of seed were a bag of money you would be very cautious to make certain that the right amount were in it. Every coin would be counted, more or less carefully depending upon its denomination before it left your hands to be deposited.

The bag of seed is really like a bag of money. If it is not measured accurately, your profits can quickly slip by and be lost.

It is in the packaging operation, where the processed seed is weighed into the bag, that plant profits must be protected.

The bags shipped out have to be at least the stated bag weight; maintained as close as possible to prevent excess give-away. There is a real problem in meeting weights and measures requirements, and protecting customer good will--and at the same time preventing profit leaks from developing, especially if the packaging operation is a manual one.

Fortunately the packaging operation lends itself to quick analysis. Your present operation can readily be compared to improves ones indicating the savings which can be realized.

Some packaging operation costs are relatively fixed, the cost of the processed seed, empty bags, thread, tags. Other costs will vary depending on the type of packaging system used, labor contents and the amount of giveaway per bag.

Seed packaging operations range from completely manual, with high labor content per bag to highly sophisticated equipment, where at the high production rates the labor content per bag is very small. We will see that the greatest potential area of saving in going to automatic packaging equipment is in the improved accuracy of filled bag weights.

1/ Mr. Berg is Product Manager, Packaging Division of the Howe-Richardson Scale Company, Clifton, New Jersey.

Depending upon production requirements, as well as the cost of the processed seed, it is possible to choose the most appropriate equipment. Three basic classes of packaging equipment are made to serve the seed industry, each system with its own range of application for which it is best suited.

Let's take a typical packaging operation and analyze it. Obviously, the numbers which will be used are only representative. The analysis is perhaps oversimplified, but does illustrate the point. Example A analyzes a completely manual operation involving two men; one, sacking off the seed volumetrically from a bin, trimming to weight on a platform scale; the other, closing the filled bags, using a cable supported portable sewing head. Both men are hard pressed to maintain the required production. In an effort to make sure the minimum weight is placed in the bag, the weigher tends to give away seed.

We see that the variable cost of the yearly operation is $6010. The type of equipment which would be best suited for this operation is the semi-automatic one man bagging system (Figure 1). Example B illustrates the savings which could be achieved by its use.

In Example B the daily savings over the manual operation were about $72.00. Even in this case, with a relatively low cost seed, the major portion of the saving is in the increased accuracy. Within 30 days the equipment paid for itself. Given wheels for portability, the unit can be moved about from bin to bin to allow its use for a greater portion of the year.

If we take a more expensive product, let's say shelled peanuts, as an example, we will find that more sophisticated equipment is warranted. Again, let us say that our two men are performing the packaging operation at the same production rates. Example C illustrates the basic operation.

The daily variable packaging cost here is $321.60. In this case an automatic scale should be used which can achieve accuracy at ± 1 to 2 ounces at the required speed. Example D illustrates an analysis of its application.

Even with the higher equipment investment, the investment has been paid off in half the time because of the increased accuracy, and the higher seed cost.

The two scale units which have been discussed are completely mechanical in operation. Some seed packaging operations, either because of the high value of the seed, such as the more expensive hybrid

Example A
Soybean Seed Packaging
50# Bags @ $4.00/Bag

Daily Output	120,000 #	
Bags	2,400 Units (Approx 6 BPM)	
Cost of Seed/Oz.	.005	
Existing System - Variable Cost		
Giveaway Per Bag	6 Oz.	
Giveaway Per Day	6 X 2400 X .005 =	$ 72.20
Labor Cost (2) Men		$ 48.00
Variable Pkg. Cost/Day		$ 120.20
Variable Yearly Cost (50 Days)		$ 6010.00

Example B
Soybean Seed Packaging
50# Bags @ $4.00/Bag

Daily Output	120,000 #	
Bags	2,400 Units (Approx 6 BPM)	
Cost of Seed/Oz.	.005	
Existing System - Variable Cost		
Giveaway Per Bag	6 Oz.	
Giveaway Per Day	6 X 2400 X .005 =	$ 72.20
Labor Cost (2) Men		$ 48.00
Variable Pkg. Cost/Day		$ 120.20
Variable Yearly Cost (50 Days)		$ 6010.00
Proposed System one man bagging system Variable Cost		
Giveaway Per Bag	2 Oz.	
Giveaway Per Day	2 X 2400 X .005 =	$ 24.00
Labor Cost (1) Man		$ 24.00
Variable Pkg. Cost/Day		$ 48.00
Variable Yearly Cost (50 Days)		$ 2400.00
Daily Savings		$ 72.20
Annual Savings		$ 3610.00
Equipment Investment		$ 2170.00
Payout Time		30 days

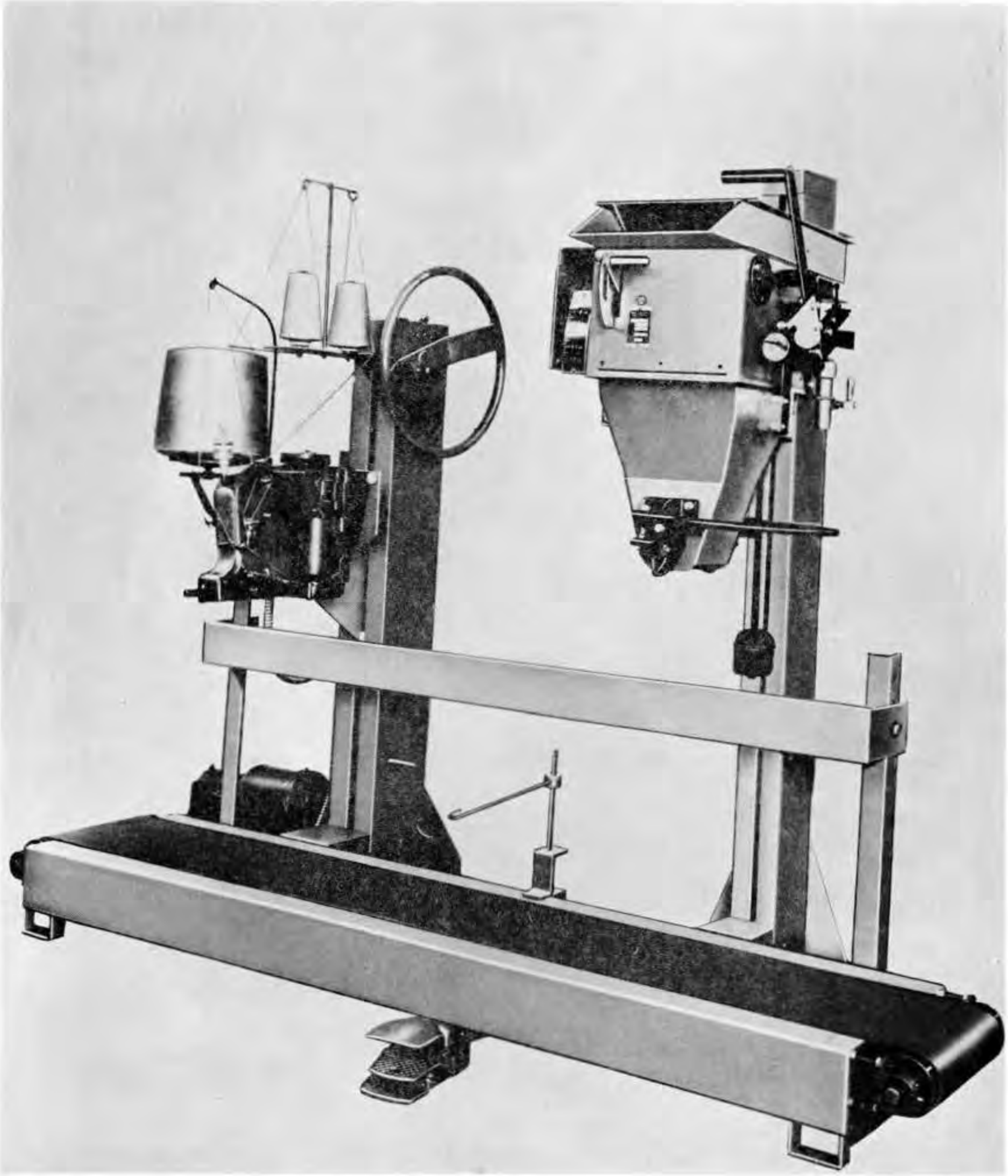


Figure 1. Equipment for a one-man bagging operation.

Example C

Shelled Peanut Seed Packaging

50# Bags @ $15.00/Bag

Daily Output	120,000 #	
Bags	2,400 Units (Approx 6 BPM)	
Cost of Seed/Oz	.019	
Existing System - Variable Cost		
Giveaway Per Bag	6 Oz.	
Giveaway Per Day	6 X 2400 X .019 =	$ 273.60
Labor Cost (2) Men		$ 48.00
Variable Pkg. Cost/Day		$ 321.60
Variable Yearly Cost (50 Days)		$16,080.00

Example D

Shelled Peanut Seed Packaging

50# Bags @ $15.00/Bag

Daily Output	120,000 #	
Bags	2,400 Units (Approx 6 BPM)	
Cost of Seed/Oz	.019	
Existing System - Variable Cost		
Giveaway Per Bag	6 Oz.	
Giveaway Per Day	6 X 2400 X .019 =	$ 273.60
Labor Cost (2) Men		$ 48.00
Variable Pkg. Cost/Day		$ 321.60
Variable Yearly Cost (50 Days)		$ 16,080.00
Proposed System one-man bagging system Variable Cost		
Giveaway Per Bag	1 Oz.	
Giveaway Per Day	1 X 2400 X .019 =	$ 45.60
Labor Cost (1) Man		$ 24.00
Variable Pkg. Cost/Day		$ 69.60
Variable Yearly Cost (50 Days)		$ 3,480.00
Daily Savings		$ 252.00
Annual Savings		$ 12,600.00
Equipment Investment		$ 3,645.00
Payout Time		14 1/2 Days

corn seeds, or clover, perhaps coupled together with high production requirements, from two to three times the output that we used in our previous examples, dictate the need for still more advanced equipment.

The most advanced equipment available for seed mill packaging operations incorporates the automatic feedback principle. High speed and highly accurate automatic weighing equipment is used in conjunction with a checkweigher and a basic weight trend computer to automatically keep bag weights within the guaranteed tolerance.

A typical installation of this complete automatic system is shown in Figure 2. Even a system of this complexity can easily be analyzed for cost savings and investment payout time.

Let's take as an example hybrid corn seed worth 36¢ a pound and a packaging operation with twice the production requirements of those we have discussed. This automatic packaging system pays for itself very quickly when compared with manual filling, requiring two bagging lines; Example E.

Even when this system is compared with two lines, each of which is using a one-man bagging system, within a full year's time the more sophisticated equipment pays for itself. Example F.

These various examples have shown that the two major factors in controlling costs in the packaging operation are weighing accuracy and production requirements. With the choice of proper equipment your profits can be protected by cutting down giveaway. You know the value of your seed and your labor costs. Using the same type of analysis, you can select the equipment best suited to your operation.

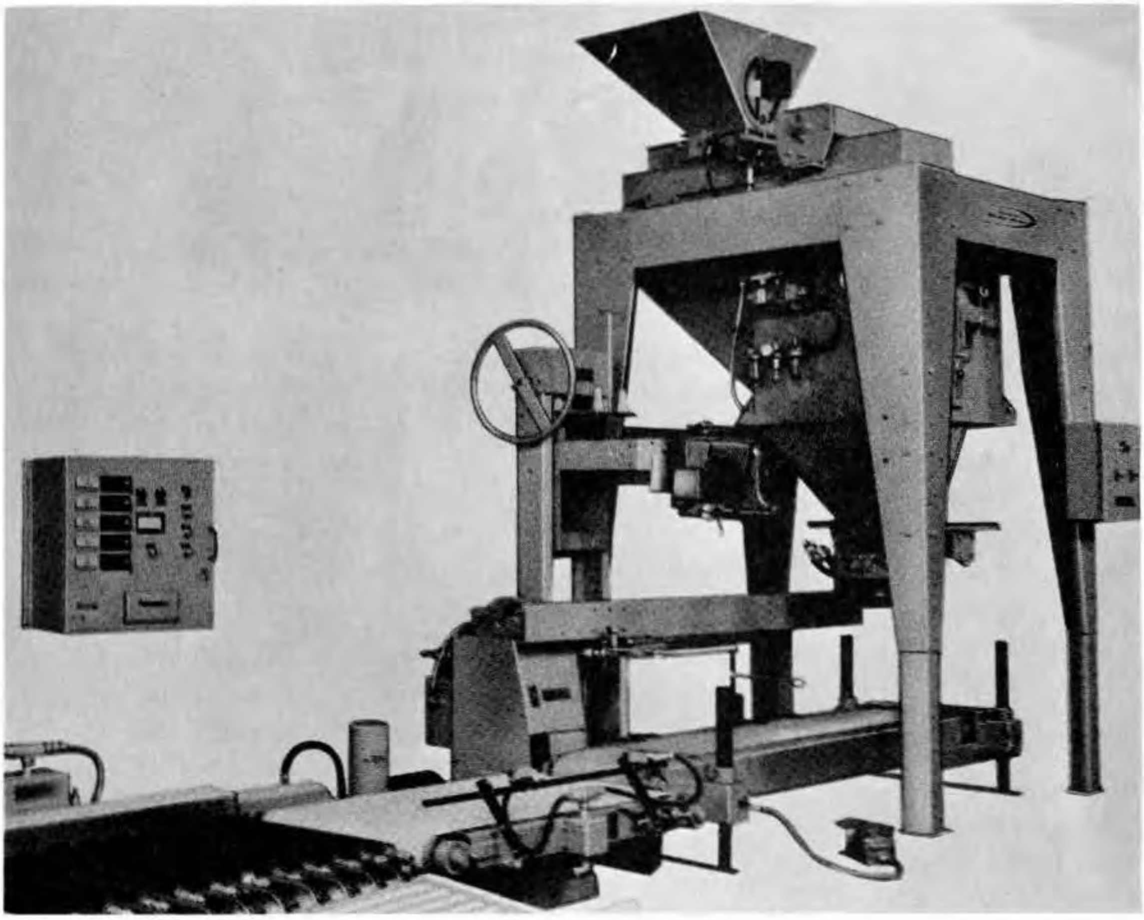


Figure 2. A typical installation of an automatic packaging system.

Example E
Hybrid Corn Seed Packaging
50# Bags @ $18.00/Bag

Daily Output	240,000 #	
Bags	4,800 Units (Approx 12 BPM)	
Cost of Seed/Oz	.0225	
Existing System - Variable Cost		
Giveaway Per Bag 6 Oz.		
Giveaway Per Day 6 X 4800 X .0225=		$ 648.04
Labor Cost (4) Men		$ 96.00
Variable Pkg. Cost/Day		$ 744.04
Variable Yearly Cost (100 Days)		$ 74,404.00
Proposed System Automatic packaging Variable Cost		
Giveaway Per Bag 1/2 Oz.		
Giveaway Per Day 1/2 X 4800 X .0225 =		$ 54.00
Labor Cost (2) Men		$ 48.00
Variable Pkg. Cost/Day		$ 102.00
Variable Yearly Cost (100 Days)		$ 1,020.00
Daily Savings		$ 642.04
Annual Savings		$ 73,384.00
Equipment Investment		$ 16,794.00
Payout Time		26 Days

Example F
Hybrid Corn Seed Packaging
50# Bags @ $18.00/Bag

Daily Output	240,000 #	
Bags	4,800 Units (Approx 12 BPM)	
Cost of Seed/Oz. $	.025	
Existing System - Variable Cost Two-one man bagging systems		
Giveaway Per Bag	1 Oz.	
Giveaway Per Day	1 X 4800 X .0225=	$ 108.00
Labor Cost (2) Men		$ 48.00
Variable Pkg. Cost/Day		$ 156.00
Variable Yearly Cost (100 Days)		$ 1560.00
Proposed System Automatic Packaging Variable Cost		
Giveaway Per Bag	1/2 Oz.	
Giveaway Per Day	1/2 X 4800 X .0225=	$ 54.00
Labor Cost (2) Men		$ 48.00
Variable Pkg. Cost/Day		$ 102.00
Variable Yearly Cost (100 Days)		$ 1,020.00
Daily Savings		$ 54.00
Annual Savings		$ 5,400.00
Equipment Investment		$16,794.00
Payout Time		312 Days

ADVANTAGES AND PROBLEMS OF PARTIAL AUTOMATION

N. L. Pugh, Jr. 1/

If you will bear with me, I would like to point out one or two items important to justify the expenditure for automation in the seed industry.

You will find I am going to be referring mostly to the crop of soybeans and the processing of soybeans.

As I see it, there are two primary requisites for making automation pay. They are:

1. To be able to justify expenditure for installation of automatic equipment, we need to be sure we are going to have a volume of soybeans to substantiate the expenditure for automation.

2. To be able to have satisfactory results from automation, we need a uniform quality soybean supply as free of foreign materials as possible. The foreign materials that give the greatest problems on handling grain seem to be the light materials, such as stems, pods, cockleburs, and grass. The very small grass seeds and weed seeds along with soybean hulls will be a problem if you are drying grain, as the fines will be lost in great quantities to the outside air and'foul up'your property.

Our average yield per acre on soybeans for the nation has stood at 25 bushels per acre for the past five years. It has been calculated that the average yield could be raised six (6) bushels an acre. It was estimated that the six bushel increase would give the grower double his present net profits from soybeans.

To realize Item No. 1, increase volume, and Item No. 2, uniform quality, the grower will need to use the latest available improvements in growing and harvesting.

Some of the points for acquiring these improvements have been established as the use of lime, deep plowing, shallow seedbed preparation, row spacing and plant spacing, with changes for different varieties planting; weed control through the use of herbicides, moisture control, inoculation, keeping in mind the best varieties of soybeans for each locality and the use of the best cutting methods to reduce harvest losses.

In the processing of soybeans we have storage of many different kinds. If flat storage is being used it will be necessary to convey the soybeans to a work bin to begin the automatic handling. If all vertical bins with gravity feed is the case, it will be possible to begin the automatic handling of the soybeans from the storage bins.

This will be the point of beginning in discussing automation.

From this point on, providing the supply is constantly available, the soybeans will be handled automatically.

We now need to determine the limiting factor in the cleaning and drying operation. If the dryer capacity exceeds the capacity of the cleaner being used, you will set the cleaner load to control the rate of flow by use of a variable feeder drive motor. Or it could be that you would need to limit the cleaner load to get the desired moisture reduction through the grain dryer. (Refer to drawing No. 1 at the end of this article)

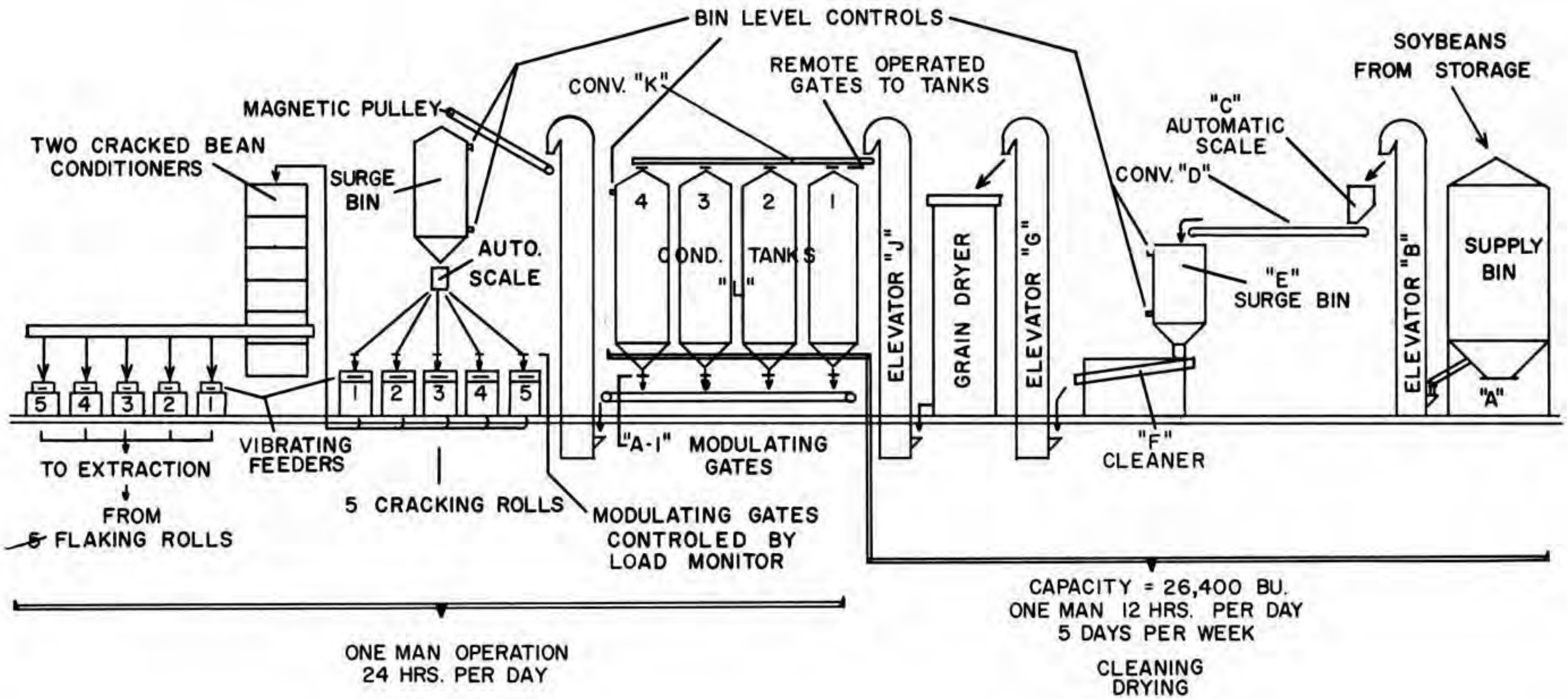
Item "A" - Modulating Gate. We have installed a modulating gate to draw soybeans from the supply bin at the rate and when desired.

Item "B" - The soybeans will discharge into an elevator in this case.

Item "C" - Automatic Scale. The automatic scale will be desirable to give your capacity of flow per day or per shift as desired.

Item "D" - Conveyor from scales to cleaner surge bin.

Item "E" - Cleaner surge bin. The surge bin over the cleaner will need to be large enough to have a capacity large enough to minimize the feeding cycle from the supply bin and also to carry an overflow feed back from the dryer garner bin which I will describe later. There will be a bindicator located in this bin at a point that will shut off the feed from the supply bin, but will have additional space left to hold the volume of soybeans in the elevator leg and conveyors to the dryer in case the garner bin on the dryer becomes filled. There will be another bindicator located near the bottom of this bin that will open the Modulating Gate to supply beans when needed from the supply bin, but not low enough that the cleaner surge bin would run empty before the elevating and conveying time required for the soybeans to reach from the Modulating Gate to the surge bin.


BIN LEVEL CONTROLS
SOYBEANS FROM STORAGE
REMOTE OPERATED GATES TO TANKS
CONV. "K"
MAGNETIC PULLEY
TWO CRACKED BEAN CONDITIONERS
SURGE BIN
"C" AUTOMATIC SCALE
CONV. "D"
4 3 2 1
COND. TANKS "L"
AUTO. SCALE
ELEVATOR "J"
GRAIN DRYER
ELEVATOR "G"
"E" SURGE BIN
ELEVATOR "B"
SUPPLY BIN
"A"
5 4 3 2 1
1 2 3 4 5
VIBRATING FEEDERS
TO EXTRACTION
FROM 5 FLAKING ROLLS
5 CRACKING ROLLS
"A-1" MODULATING GATES
MODULATING GATES CONTROLED BY LOAD MONITOR
"F" CLEANER
CAPACITY = 26,400 BU.
ONE MAN 12 HRS. PER DAY
5 DAYS PER WEEK
CLEANING
DRYING
ONE MAN OPERATION
24 HRS. PER DAY

Item "F" - The cleaner. Can be set up as an independent link in the flow with only the cleaner feeder motor being interlocked to the down stream system.

Item "G" - Elevator from cleaner to the dryer. This elevator should have a dual spout on the discharge so that when the dryer garner bin becomes filled, the overflow will return back to the cleaner surge bin.

Item "H" - Grain Dryer. Should be large enough to give the most economical operation of the system. The automatic safety controls are usually furnished but there may be some additional controls desired. The grain dryer can be set to the rate of flow to give the desired moisture content of the beans leaving the dryer.

Item "I" - Collector conveyor or spout. To move the soybeans from the grain dryer discharge to an elevator.

Item "J" - Elevator from dryer to conditioning tanks.

Item "K" - Distributing conveyor over the conditioning tanks. This conveyor has remote control discharge gates for each tank.

Item "L" - Conditioning tanks. The purpose of these tanks are: No. 1 to give the grain time to fully equalize in moisture and temperature before processing. No. 2 to give capacity to allow the shorter cleaning and drying time for the most economical operation.
No. 3 - A supply of soybeans ready at all times for the operator to draw beans from for processing.

The controls for the system of automatic supply of soybeans through the cleaning and drying operation and discharging into the conditioning tanks are located in a panel that is near the cleaner and the grain dryer. This operation is run by one man five days a week to supply conditioned soybeans to permit a twenty four hour day and seven days a week operation for the processing plant.

The next step of automation is controlled in the preparation department where one man operates the mechanized reclaiming of soybeans from the conditioning tanks to and through the entire preparation of the soybeans for solvent extraction. (Refer to drawing No. 1 at the end of this article.

Item "A-1" - Modulating Gates. There is a modulating gate discharge valve on each of the conditioning tanks that furnishes a controlled supply of soybeans to the conveyor belt.

Item "A-2" - Conveying system from the conditioning tanks to the preparation department. The discharge at this point should be equipped with a magnetic separator to remove tramp iron.

Item "A-3" - Surge bin over cracking rolls. To gravity feed to automatic scale, this surge bin should have a capacity large enough to supply the required load with as long a lag period as possible. There is a top level bindicator that will close the modulating gates on the conditioning tanks with enough space left in the surge bin to accomodate the load of grain in the conveying system. When the soybeans feed out of this surge bin and reach the lower bindicator, the modulating gate will open to a pre-set position and refill the surge bin.

Item "A-4" - Automatic scales. To be used as a processing load control, the volume passing this scale is used to set the processing hourly or daily crushing rate.

Item "A-5" - Modulating gates to feed cracking rolls. The cracking rolls are driven by individual motor drives. The amp load of the roll drive motor is fed into a load monitor. By setting the load required on the roll motor, the controller will maintain a constant load passing through each machine by actuating the modulating gate. The rate of processing the soybeans in tons per day is set at this point. Whatever load passes this point must be carried on through the complete preparation and on to the solvent extraction plant.

The application of automation will generally give a more uniform load through a series of operations and at the same time you will also greatly reduce your operating cost. The outstanding savings will be in labor costs.

The operators will soon find that very little effort is needed to set the points of control for a well designed system.

The problems generally seem to be in keeping the systems clean. This can be done in the location of the controls in the cleanest possible point for accessibility to the application. Also a schedule of maintenance check will pay off in smooth operations.

SEED STORAGE TO MAINTAIN QUALITY

G. Burns Welch [1/]

After seeds have been produced and up-graded by proper processing, they must be stored in a suitable environment to retain this high quality. The retention of high seed viability and vigor is a problem encountered in many parts of the world. The humid Southern region of the United States is often a troublesome area for storing seeds in open warehouses. In any humid locality, it is necessary to provide an environment that will minimize the metabolic activity of the seed particularly if they are to be stored for longer than one season. The equilibrium moisture content and the temperature of the seeds during storage are the two major factors that influence their longevity. If the moisture content is too high, seed deterioration can be quite rapid. Some of the deteriorative effects due to moisture and a favorable temperature are shown in Table 1.

Table I. Effect of moisture content on seeds during storage.

Moisture Content	Deteriorative effects that can occur during storage
35 to 60%	Germination begins
16%	Heating begins. Due to increased rate of respiration and micro-organism activity
12 to 14%	Mold growth may begin
8%	Insect activity begins

Equilibrium Moisture Content

When the vapor pressure due to the moisture in seeds is different from the vapor pressure of the atmosphere, there will be an exchange of moisture between the seeds and the atmosphere. If the vapor pressure

[1/] Dr. Welch is an Associate Agricultural Engineer with the Seed Technology Laboratory.

inside the seeds is higher than the vapor pressure of the atmosphere, the seeds will lose moisture to the atmosphere. The opposite effect will occur if the vapor pressure of the atmosphere is greater than the vapor pressure inside the seeds. This exchange of moisture will continue until the seeds reach an equilibrium moisture content, at which time there is no further exchange of moisture.

The equilibrium moisture content of seeds is influenced by the relative humidity and temperature of the atmosphere. The relative humidity has a greater effect. The equilibrium moisture content of several seeds at different relative humidities and at a constant temperature of 77^{o} F. is shown in Table II.

Table II. Equilibrium Moisture Contents at Different Relative Humidities.

Moisture Content: (Wet Basis) In Percent						
Relative Humidity (Percent)	15	30	45	60	75	90
Barley	6.0	8.4	10.	12.1	14.4	19.5
Corn, YD	6.4	8.4	10.5	12.9	14.8	19.1
Rice, rough	5.6	7.9	9.8	11.8	14.0	17.6
Sorghum	6.4	8.6	10.5	12.0	15.2	18.8
Soybeans	-	6.2	7.4	9.7	13.2	-
Wheat, white	6.7	8.6	9.9	11.8	15	19.7

Source: ASAE Yearbook, 1965.

If the temperature is increased 20^{o} F., the seed moisture content will be reduced approximately 2%. Conversely, a 20^{o} F. reduction in temperature will increase seed moisture approximately 2%.

Effect of Relative Humidity and Temperature on Seed during Storage

The results of a storage study in which sorghum seed were stored at different relative humidities and temperatures are shown in Table III. These data show that the relative humidity has a more pronounced effect on seed longevity than temperature. The data also indicate that, as the moisture content of the seed increases, the temperature must be decreased for safe storage, and vice versa.

Table III. Germination percentages of sorghum seed after various intervals of storage at different temperatures and relative humidities.

Relative Humidity %	Temperature °F.	Months of Storage 0	2	4	6	8	10	12
20	50	95.2	93.5	94.2	95.7	95.7	94.7	96.5
	68	95.2	94.0	94.2	94.7	95.0	96.5	95.7
	86	95.2	93.2	92.5	95.2	93.0	94.0	94.5
40	50	95.2	94.2	93.7	95.0	95.0	96.2	95.0
	68	95.2	93.0	93.7	92.7	93.7	93.0	94.7
	86	95.2	93.0	93.7	95.5	93.2	95.2	92.0
60	50	95.2	93.2	93.2	95.2	93.5	94.5	97.2
	68	95.2	92.2	94.5	94.7	95.0	93.7	92.2
	86	95.2	92.5	94.2	89.2	89.5	86.2	75.2
80	50	95.2	92.7	92.3	56.7	47.5	44.5	38.0
	68	95.2	56.5	47.2	39.2	10.5	0.0	0.0
	86	95.2	45.0	0.0	0.0	0.0	0.0	0.0
100	50	95.2	85.5	44.0	22.7	0.0	0.0	0.0
	68	95.2	41.0	0.0	0.0	0.0	0.0	0.0
	86	95.2	1.0	0.0	0.0	0.0	0.0	0.0

There are three general rules of thumb that are commonly used in seed storage: (1) for safe storage conditions, the sum of the percent relative humidity plus temperature in degrees Fahrenheit should not exceed 100; (2) for each one percent decrease in moisture content, the storage life is doubled; (3) for each 10° F. decrease in temperature, the storage life is doubled. According to these rules, seeds stored at 8% moisture content will maintain good viability twice as long as seeds stored at 9% moisture content. Seeds stored at 60° F. will maintain good viability twice as long as seeds stored at 70° F. There is also a complementary effect between the two factors; therefore, theoretically, seeds stored at 8% and 60° F. will maintain good viability four times as long as seed stored at 9% moisture and 70° F.

Control of Relative Humidity and Temperature In a Seed Storage Room

Because the relative humidity is often too high for safe seed storage, it is necessary to provide some means for reducing it to a safe level in a storage room. The relative humidity in a storage room can be controlled by mechanical refrigeration, a dessicant type dehumidifier, or a combination of the two.

Before discussing the principles of dehumidification by mechanical refrigeration, it would be relevant to take a look at how the properties of air will change with an increase or decrease in temperature. Referring to Figure 1, we see that one pound of dry air at 80^{o} F. and standard atmospheric pressure will occupy a volume of 13.6 cubic feet. If this one pound of air is heated to 110^{o} F., its volume will increase to 14.4 cubic feet. If the temperature is decreased, it will occupy 13.1 cubic feet at 60^{o} F. For each 40^{o} F. change in temperature, the volume will change roughly one cubic foot.

When air contains the maximum amount of water vapor possible without any of the water vapor condensing, it is said to be saturated. The amount of vapor contained in one pound of air at saturation is influenced by the temperature of the air. Referring again to Figure 1, you can see that one pound of air at 80^{o} F. would contain .022 pounds of water at saturation. If the air is heated to 110^{o} F. and then saturated, it would contain .059 pounds of water. At 60^{o} F. and 40^{o} F., the water-holding capacity is decreased to .011 and .005 pounds of water vapor, respectively. This shows that as the temperature of air is decreased, its water-holding capacity is also decreased.

Another term used when referring to amount of water vapor in the air is relative humidity. This is the ratio of the amount of moisture actually in the air to the amount the air would contain if it were saturated. For example, suppose the air temperature is 80^{o} F. and the relative humidity is 50%. This means the air contains .011 pounds of water vapor which is one-half the amount it is capable of holding at saturation. What would happen to the relative humidity if this same air is heated to 110^{o} F. or cooled to 60^{o} F. without any change taking place in the amount of water vapor? First, let us calculate the relative humidity at 110^{o} F.

$$\text{R. H.} = \frac{.011}{.059} = 18.7\%$$

At 60° F. the relative humidity would be

$$R.H. = \frac{.011}{.011} = 100\% \text{ fully saturated}$$

At 40° F., the air would still be fully saturated and .006 pounds of water would be condensed. This condensation occurs because the air at 80° F. and 50% R.H. contains twice the amount of moisture it is capable of holding at 40° F.

These examples show why the relative humidity in a storage room will increase as the temperature is lowered unless some means is provided for removing the moisture from the air.

Dehumidification by mechanical refrigeration operates on the principle that the water vapor in the atmosphere will condense when it comes in contact with a surface at a sufficiently low temperature. This is basically the same reason that moisture will accumulate on the outside of an iced tea glass. The temperature at which condensation occurs is referred to as the dewpoint. To accomplish dehumidification with a refrigeration system, the cooling coils must be a few degrees below the dewpoint for the desired combination of relative humidity and temperature (Figure 2). For example, suppose we wish to maintain and atmospheric condition of 60° F. and 50% R. H. in a storage room. Referring to a psychrometric chart (page), we find that the dewpoint for this combination of temperature and relative humidity is 40° F. The refrigeration system would be designed to have a coil temperature a few degrees below the dewpoint. Theoretically, any time the relative humidity goes above 50%, moisture will condense on the coils and drain out until the relative humidity is decreased to 50%.

Let us now consider another example in which the desired atmospheric conditions are 40° F. and 50% R.H. Referring again to the psychrometric chart, we find the dewpoint to be 25° F., which is below freezing. The moisture that collects on the coils will freeze and build up a layer of ice on the coils. When the system is operating with a coil temperature below freezing, it is necessary to provide some type of heating system to defrost the coils. The system can be controlled with a time clock to stop periodically the refrigeration compressor and turn on the heat system to defrost the coils.

The design of a refrigeration system for both cooling and dehumidification is a very technical problem. It is of utmost importance that the different components in the system be well balanced. Anyone desiring to use refrigeration dehumidification at temperatures below 65° F. should seek the advice of a competent refrigeration engineer.

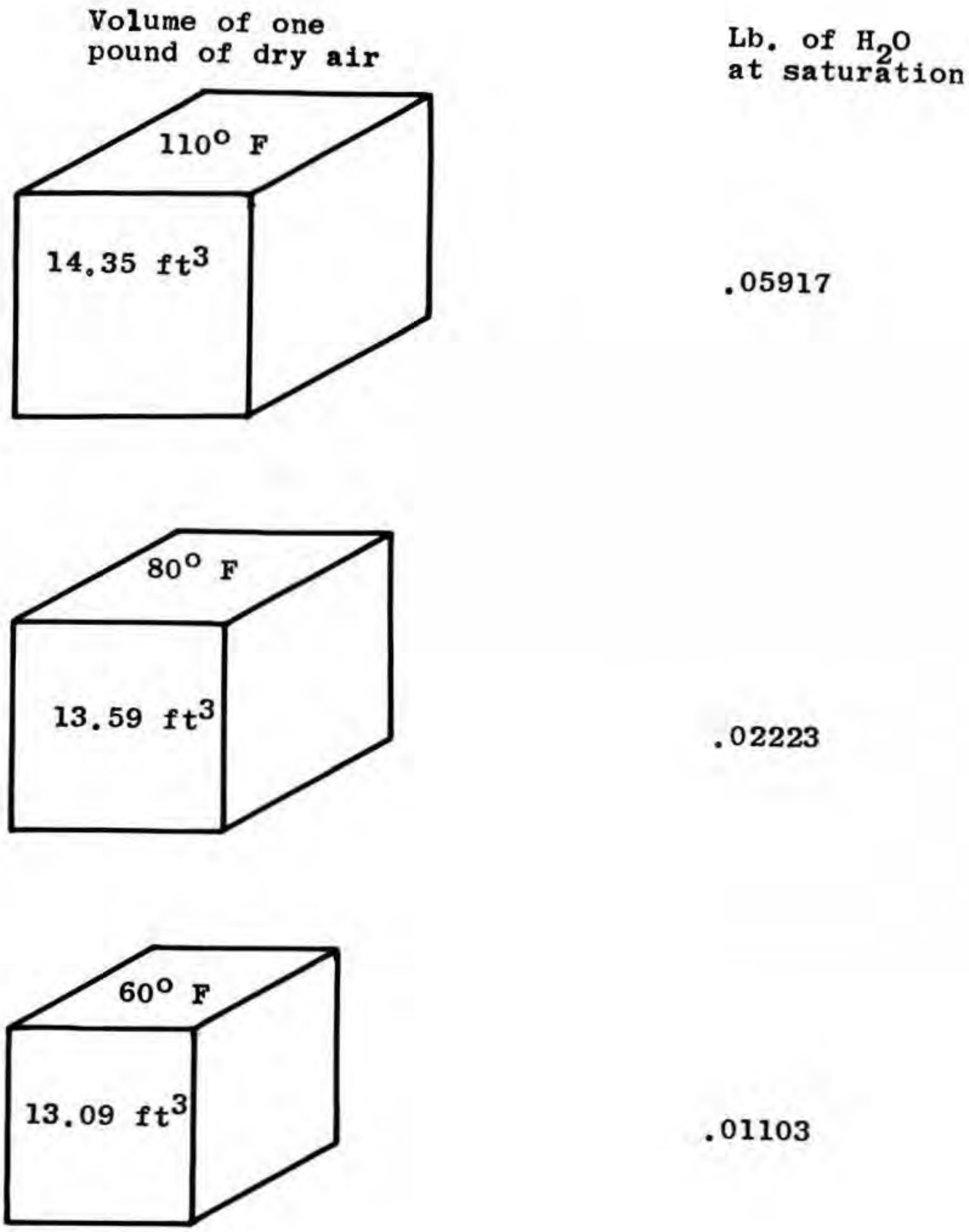


Figure 1. Properties of air. The volume and water holding capacity varies with the temperature.

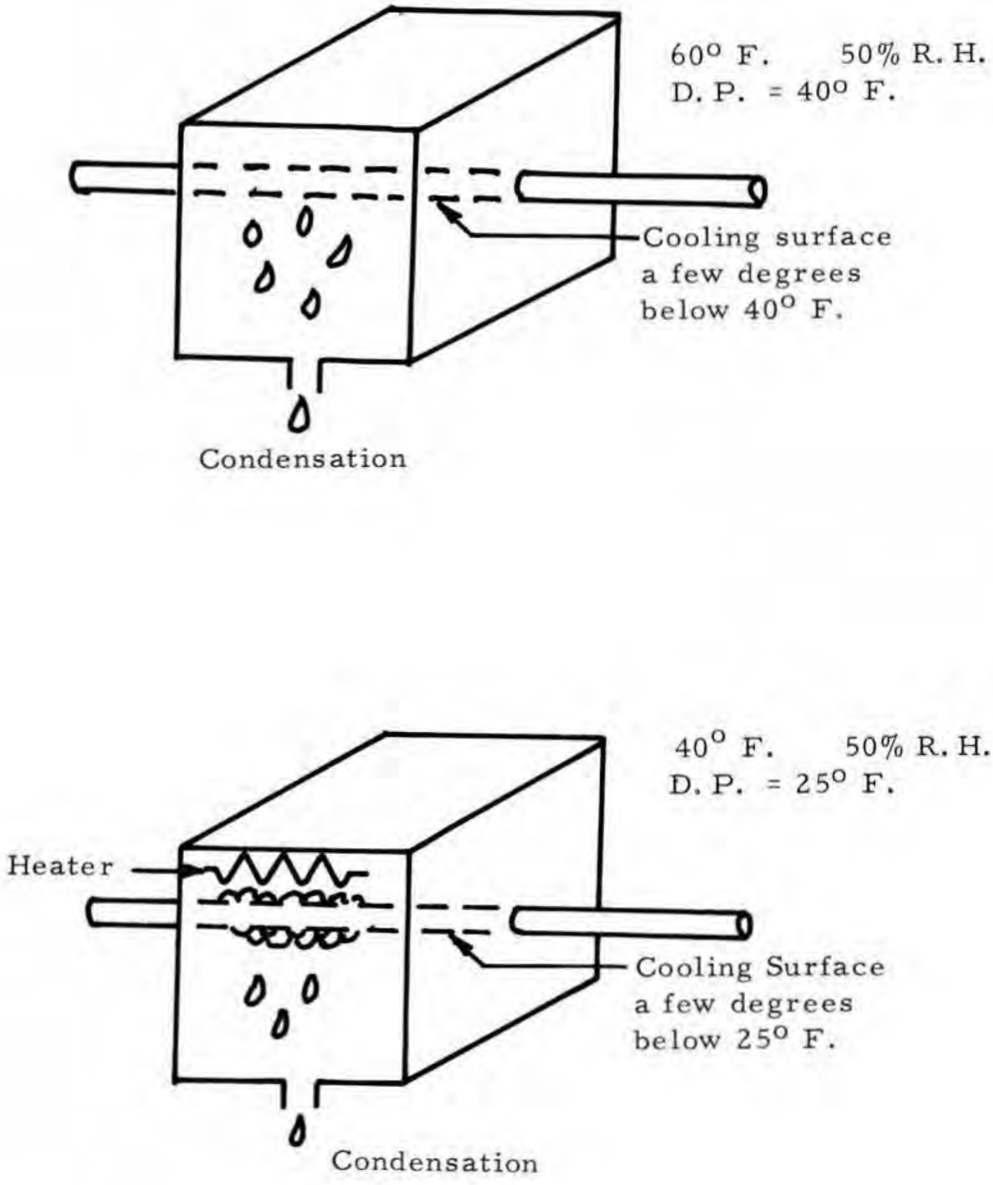


Figure 2. To maintain a particular temperature and relative humidity, the temperature of the cooling coil must be a few degrees below the dewpoint temperature.

Another method for controlling the humidity in a storage room is by the use of a desiccant dehumidifier. This type dehumidifier operates on the principle that the air in the storage area is passed through a bed of dry desiccant such as silica gel. This is a highly porous material capable of absorbing as much as 40% of its own weight in water vapor. The dehumidifiers commonly used on storage applications consist of two beds of desiccant about four inches thick. While one bed is drying air from the storage room, the other bed is being reactivated (Figure 3). This is accomplished by passing outside air, which has been heated, through the moist bed to drive out the moisture. A humidistat can be used to control the dehumidifier to maintain the desired relative humidity. This type dehumidifier can operate over a wide range of temperatures from minus 40^{o} F. to plus 175^{o} F. providing the proper desiccant is selected for the particular application.

A factor not to be overlooked is that a desiccant dehumidifier will add heat to the storage room. In some cases, the temperature of the air being dried increases as much as 30^{o} F. to 40^{o} F. in passing through the drying bed. This is due to the latent heat of adsorption and sensible heat gain from re-activation of the desiccant. If this results in an inside temperature higher than desired, some means of removing the excess heat must be provided. This can be accomplished by air conditioning or by putting a water-cooled heat exchanger in the discharge duct of the dehumidifier.

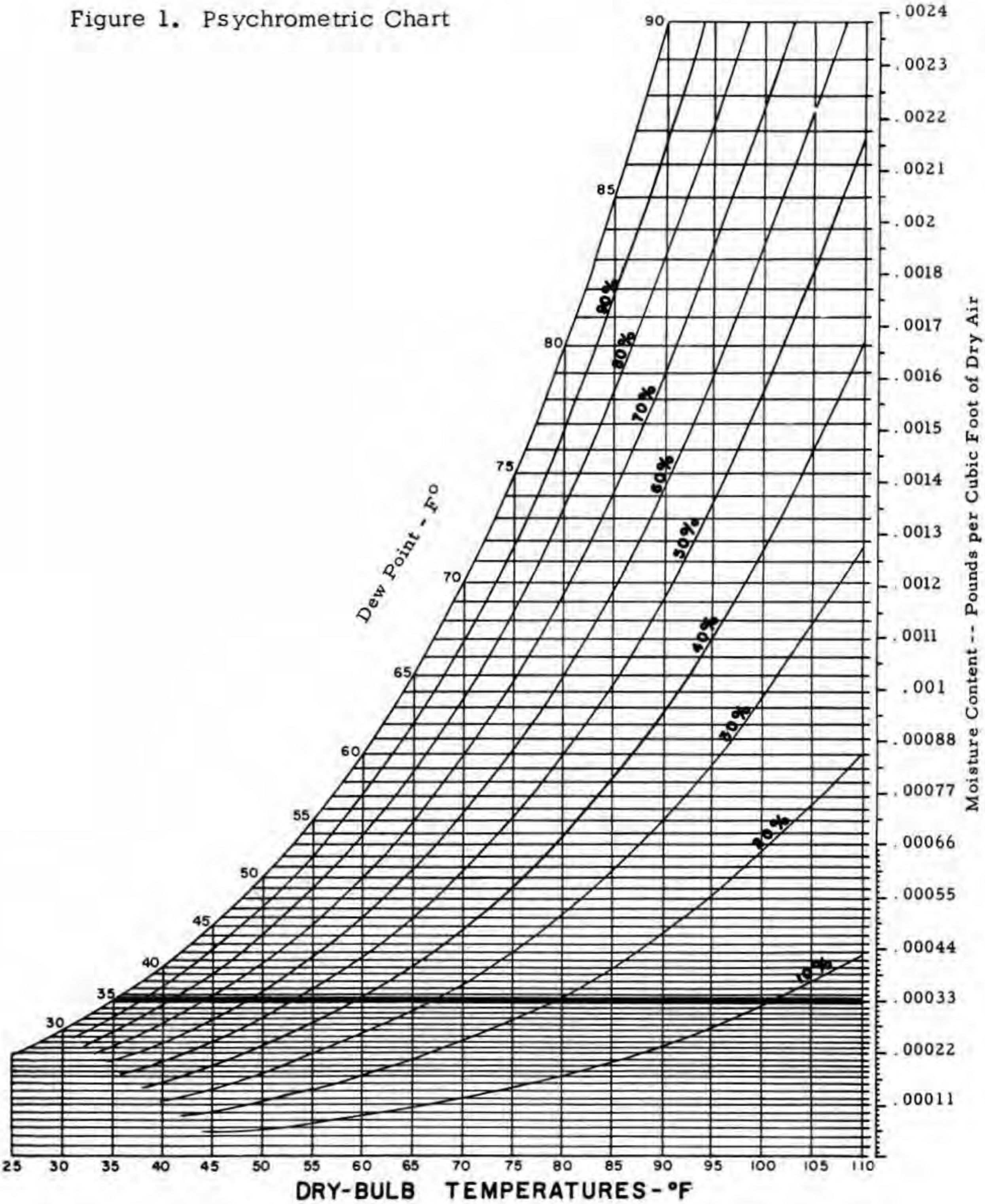
A combination of the two systems previously mentioned can be used quite satisfactorily when the desired relative humidity level is below that which can be maintained by the refrigeration system. The refrigeration system will maintain the desired temperature and will remove some of the moisture from the air. The desiccant dehumidifier then reduces the relative humidity to the desired level.

Construction of Storage Room

The type of construction is another item of great importance in a seed storage facility. Before selecting the type of construction to be used, the design conditions must be known. What are the outside atmospheric conditions and what temperature and relative humidity will be maintained inside? Once these are known, the proper thickness of insulation can be selected. A good vapor barrier should be placed on the warm side of the insulation to prevent the movement of water vapor through the wall and into the storage room.

Once the design conditions and type of construction are known, the total heat load can be calculated. This includes the heat transferred through the structure itself, product load, air changes, and heat from

Figure 1. Psychrometric Chart



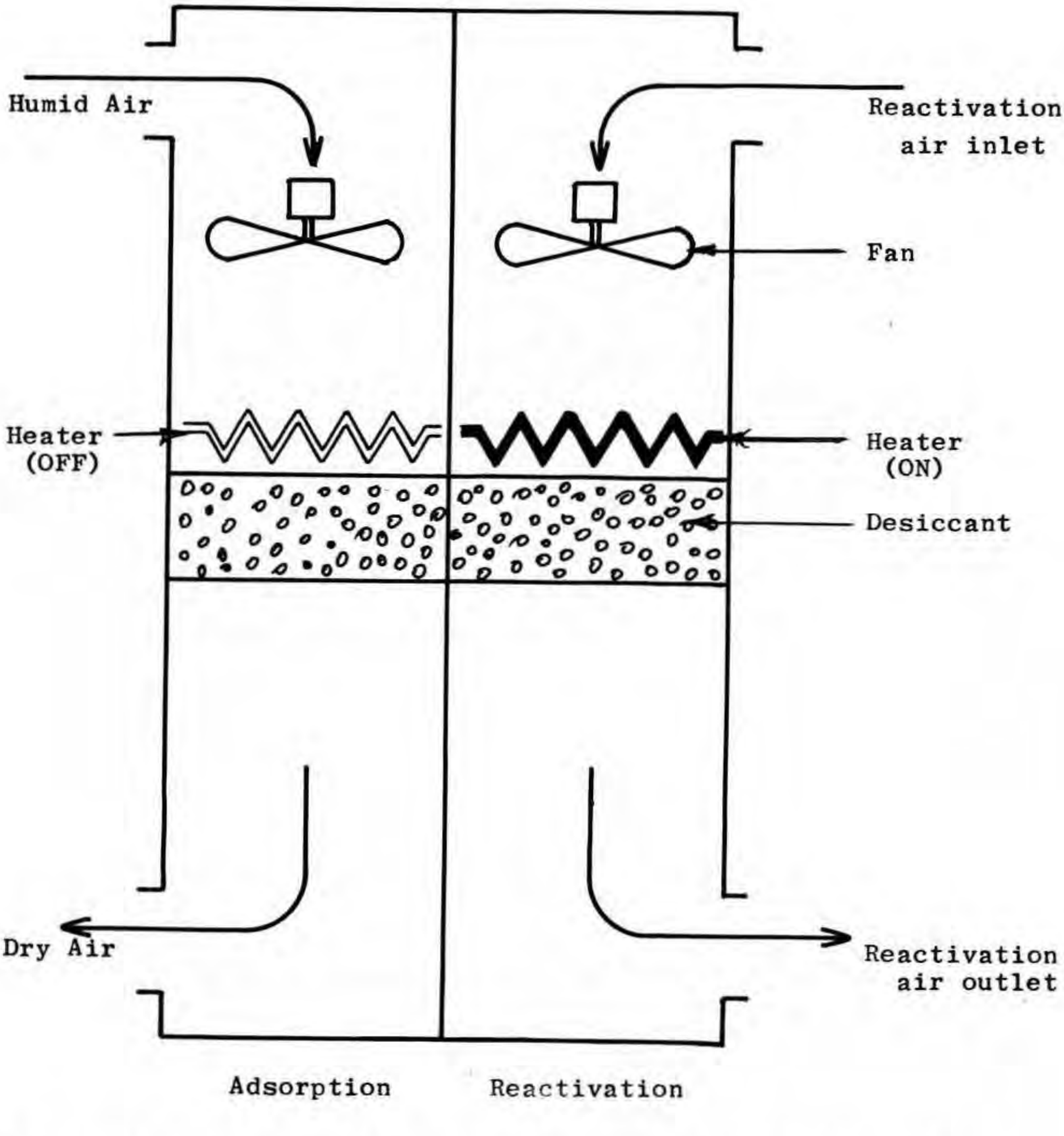


Figure 3. Schematic diagram of an adsorption dehumidifier.

lights, motors, and personnel. When the total heat load is known, the proper size of refrigeration equipment can be selected. Maximum efficiency and economy are attained only when the cooling equipment operates most of the time. This is particularly true when dehumidification is by refrigeration.

A storage room should be constructed to allow easy housecleaning. The doors and pipe opening through the wall should fit tightly to make the room as near vermin- and rodent-proof as possible.

Control of Insects

The control of insects is another factor in maintaining high quality seeds during storage. At temperatures below 50° F., damage from insects becomes insignificant. Mold growth is also inactive at lower temperatures.

When seeds are stored at temperatures above 50° F., insects can be controlled by treating the seeds with a suitable insecticide. This can be applied at the same time the seeds are treated with a fungicide.

Summary

Seeds of high quality must be stored in a suitable environment to retain their viability and vigor. A suitable storage environment is obtained when the sum of the percent of relative humidity and the temperature in degrees F. does not exceed 100. The humidity in a storage room can be controlled satisfactorily by mechanical refrigeration, desiccant dehumidifier, or a combination of the two. Relative humidity is more important than temperature in seed storage. The storage facility should be designed for easy housecleaning and also be as near vermin- and rodent-proof as possible.

PREDICTING SEED STORABILITY

James D. Helmer [1/]

Two of the most important quality problems which a seedsman faces today are seed storage and seed vigor. During the course of routine operations, a seedsman normally handles many different lots of the same kind and variety of seed. Judgements as to the relative quality of these seed lots are based primarily on the results of standard purity and germination tests.

The seedsman, however, faces several situations in which the information normally available to him concerning seed quality does not provide a suitable basis for making a decision. One such situation is a determination of which lots from among many available should be marketed first and which lots should be held for possible carry-over if the market is not strong, or as a hedge against shortage the next year. Germination percentages of the lots provide some useful information for making this decision if there is a considerable range in germination among the lots. However, germination percentages among various lots are often quite similar. Hence, a seedsman is reduced to a more or less random selection of lots for possible carry-over and he often finds the next season that several of the lots have drastically declined in germination. Such experiences involving seed lots of the same kind, variety, chronological age, and germination that do not maintain viability equally well under similar storage conditions are common to many seedsmen. The failure of a seed lot of apparent good germination to maintain that germination in storage at a retail outlet or at the wholesaler constitutes a seriour problem and one that can be most damaging to a seedsman's reputation.

It is apparent that some important aspects of seed quality are not reflected with any consistency in the information provided by standard seed tests. A high germination percentage does not necessarily mean that a seed lot will store well or that it will produce a satisfactory stand even under relatively favorable conditions.

The solution to problems related to storability and vigor of seed lies in the development of a test - other than the standard germination test - which will differentiate among seed lots with respect to storage potential and field emergence capability. It is quite possible that one test would determine both of these important attributes of seed quality.

[1/] Dr. Helmer is an Assistant Professor, Seed Technology Laboratory.

Several tests and methods have been advocated for evaluating the vigor and storage potential of seed. In most instances the methods recommended have been either too technical or tedious for economical and practical use by seedsmen. In order for a test to be successful in evaluating any aspect of seed quality, it should meet certain criteria. It should (1) be relatively simple and easy to perform, (2) be equally applicable to the various kinds and varieties of crop seed, and (3) produce the desired information in a consistent and uniform manner.

During the past few years, the Seed Technology Laboratory has been working on the development of an accelerated aging test for evaluating the storability of crop seed lots that - so far with the limited data obtained - has met the criteria indicated above.

TEST PROCEDURE

The accelerated aging test involves the exposure of small samples of seed from the available lots of the same seed kind to very adverse environmental conditions for a specific period. After accelerated aging, the percentage survival of the seed in the various samples is determined by standard germination tests.

Environmental conditions and periods of exposure required to obtain maximum differences in response among seed lots vary with the kind of seed. In general, the most satisfactory conditions are 100 percent relative humidity, temperatures of 40° to 45° C., and exposure periods of 2 to 8 days.

Accelerated aging is accomplished in an accelerated aging chamber where the desired environmental conditions are maintained.

PRELIMINARY RESULTS

Presently, the laboratory is attempting to devise accelerated aging techniques for the following kinds of seed: corn, sorghum, wheat, soybean, crimson clover, alfalfa, striate lespedeza, red clover, tall fescue, timothy, bromegrass, onion, garden bean, lettuce, radish, and watermelon.

The following tables show some of the results obtained from use of the accelerated aging technique in predicting seed storability.

Table 1. Accelerated aging and seed storage data from selected lots of tall fescue.

Lot #	Initial Germ. (%)	A.A.[a/] 84 hrs. (%)	Storage 20°-75% 18 wks.	30°-75% 21 wks.
4	95.5	94.0	95.0	94.0
12	88.0	56.0	75.0	28.0
14	93.5	86.5	94.5	81.0

a/ Germination percentage after exposure of seed for 84 hours at 42° C. - 100% R.H.

Table 2. Accelerated aging and seed storage data from selected lots of corn.

Lot #	Initial Germ. (%)	A.A.[a/] 132 hrs. (%)	Storage 20°-75% 6 mos.	30°-75% 24 wks.
22	97.5	35.0	84.5	32.5
30	99.0	96.0	98.0	98.5
31	96.0	20.0	74.0	31.0

a/ Germination percentage after exposure of seed for 132 hours at 42° C. - 100% R.H.

Table 3. Accelerated aging and seed storage data from selected data of sorghum.

Lot #	Initial Germ. (%)	A.A.[a/] 192 hrs. (%)	Storage 20°-75% 24 wks.	30°-75% 18 wks.
4	96.0	92.5	92.0	92.5
13	89.0	60.5	76.5	51.5
30	89.0	27.5	64.0	31.0

a/ Germination percentage after exposure of seed for 192 hours at 42° C. - 100% R.H.

As shown in the preceding tables, the accelerated aging technique was very effective in predicting eventual deterioration trends of the various seed lots. For example, the standard germination percentages of all 3 corn lots were above 95 percent. However, after accelerated aging for 132 hours, the germination percentage of lot 30 was still very high while lots 22 and 31 were severely reduced in germination. Thus, one would "predict" that lot 30 would maintain viability longer in storage than either lots 22 or 31. The validity of such a prediction, however, can only be vertified by actual storage of a portion of each seed lot under various conditions. As indicated, germination values after 24 weeks storage at 30° C. - 75% R.H. verified the original prediction of the storage potential of each lot. Similar comments could also be made in regards to the fescue and sorghum lots.

SUMMARY

To date, the accelerated aging technique has proved to be very effective in predicting the eventual storage behavior of various lots of the same seed kind. The key to the success of the test lies in determining the period of exposure required to obtain maximum differences in germinative response. This period of exposure varies considerably with the species of seed.

The real potential of the accelerated aging technique may be its use by seedsmen as a rapid screening technique for detecting potential "trouble" lots of seed. These would be lots which would not carry-over well in storage and in all probability would also perform poorly under field conditions. The technique is simple, easy to perform, and the results from the test are expressed as a germination percentage, a term or value understood by all in the seed trade.

MECHANICAL DAMAGE TO SEED

James C. Delouche [1/]

In their long journey from seed head to seed bed, seed are subjected to many physical and mechanical processes. Many of these processes or operations can and do cause injury. The results are cracked, chipped, scraped, cut broken or internally damaged seed. I suppose that we wouldn't be too alarmed about mechanical damage if only the physical appearance of the seed were affected. The consequences and effects of mechanical damage, however, are much more serious. Mechanically damaged seed are -

(1) more difficult to clean,
(2) lost in clean-out,
(3) lower in germination,
(4) reduced in vigor,
(5) more susceptible to chemical treatment injury,
(6) more susceptible to destructive soil organisms.

The effects of mechanical damage on the viability and vigor of seed can be <u>immediate</u>, seed are immediately rendered incapable of normal germination, or <u>latent</u>, germination is not immediately a affect but vigor, storage potential, and field value are reduced.

Seed can be severely injured without any visible evidence or signs such as ruptured seed coats, cracks, chips, etc. Internal, non-visible injuries are especially a problem in edible beans, peanuts, and soybeans.

Injury to seed can be caused by three types of "action":

(1) <u>Impacts</u> - a moving seed strikes a stationary object, or a moving object strikes a stationary seed, or both seed and object are in motion at the moment of impact.

(2) <u>Abrasions</u> - rubbing or scraping actions cause injury such as can happen in an auger with a dented housing.

(3) <u>Cuts</u> - the seed covering is cut or punctured by a sharp object such as a gin saw or some parts of a sheller.

[1/] Dr. Delouche is Agronomist, In Charge, Mississippi Seed Technology Laboratory.

Three factors influence the extent and severity of mechanical injury to seed: mechanical operations, the operator, and characteristics of the seed.

Mechanical operations

Combines, augers, elevators, pneumatic conveyors, scarifiers, debearders, processing equipment, drops in bins, etc., are all potential causes of mechanical injury. A single operation might cause only a slight amount of damage. But, since seed are usually subjected to many operations, the cumulative effect of "slight" amounts of damage at each step can be considerable.

The operator

Machines are operated by people, and it is the latter who most often have the greatest influence or the extent and severity of mechanical damage to seed. Improper selection and adjustments of equipment, faulty timing of operations, incautious operation of conveyors and equipment are the result of human error - not equipment error.

Trained operators with responsible attitudes and an appreciation fo the living condition of seed are the best insurance against mechanical damage.

Characteristics of the seed

The morphological and structural characteristics of a seed determines to a great extent its susceptibility to mechanical injury. The ideal seed would be one with a centrally positioned embryonic axis, surrounded by a "cushion" of storage tissue and enclosed with a mechanically resistant covering. Unfortunately, few seeds - if any - are structured to this ideal arrangement. In the case of the large seeded legume (beans, peas, soybeans, etc.) the embryonic axis is positioned toward one end of the seed and protected only by a thin fragil seed coat. In other important kinds of seed such as sorghum, rye, and wheat, the tip of the embryonic axis protrudes slightly beyond the tip of the seed. In both cases, the embryonic axis is very vulnerable to mechanical injury.

Very little can be done about the structural arrangement of seed. (Perhaps the breeder could "re-engineer" the seed.). Practically, those seed kinds that are structurally weak and susceptibility to mechanical damage should be recognized and greater care should be taken in the harvesting, processing, and handling of them.

There is one characteristic of seed , however, that can be controlled to some extent. This characteristic is seed moisture content. Most seedsmen are aware - or should be - that mechanical damage and seed moisture content are closely related. Seed below 12% moisture are much more easily damaged than seed with a moisture content of 12 to 18%. Above 18 to 20% moisture, seed are relatively soft and quite susceptible to bruising, gouging, or scratching. Thus, harvesting, processing and handling operations should be done - insofar as possible - at the time seed moisture content is 12 to 18%.

Minimizing Mechanical Damage

Mechanical damage probably cannot be completely prevented. It can, however, be minimized. Seedsmen who have mechanical damage problems should carefully analyze each operation from harvest to bagging to determine the major causes of the damage. After the major causes of mechanical damage are identified, the appropriate actions necessary to alleviate the condition can be planned and implemented.

SEED FACTS FROM TETRAZOLIUM TESTS

R. P. Moore[1/]

The testing of seeds of various kinds of crops by tetrazolium has provided many unusual and important insights into seed life. Many different kinds of staining symptoms have been evaluated. Many viewpoints have been analyzed. Many new things have been learned about seed life. It is indeed a pleasure for me to share some of these new views concerning seed facts from tetrazolium tests with you.

The tetrazolium method has indeed opened a door to new seed knowledge. It has permitted us to explore the inner parts of various seed structures where so many costly mysteries have remained hidden for such a long period of time. It has permitted us to expose many misconceptions about seed life.

Since time does not permit much discussion concerning man's early efforts to perfect a biochemical seed test, I am making available some reprints of an article entitled, "Tetrazolium Best Method for Evaluating Seed Life," Seedsmen's Digest 17(11):38-40. 1966. This reprint will provide many brief glimpses of major events that gradually lead to the development of the first tetrazolium test. After studying the reprint you should realize that tetrazolium testing didn't just happen and that is the main purpose of the reprint. Millions of man hours and dollars were spent by seed physiologists and other scientists as they gradually discovered and refined established segments of truth from which the tetrazolium test eventually emerged.

Many of you are aware that the tetrazolium method has not always been the recipient of the kindest words from its critics. Doubts have often been cast even upon the soundness of judgment of the promotors of the test. In spite of various kinds of criticisms, the method has slowly gained supporters and is now being used for some rather outstanding economic advantages, much to the surprise and regret of the critics. In the meantime the method also has been especially useful in diagnosing causes for seed weaknesses and for recommending corrective measures.

[1/] Dr. Moore is Professor of Crop Stands, North Carolina State University, Raleigh, North Carolina.

The Tetrazolium Method

The method involves the use of a colorless solution that reveals, by staining characteristics, the location of normal and weak, as well as of live and dead tissues. Under the guidance of a qualified person, the test is especially informative and useful.

Many persons frequently infer that the test distinguishes dead from living seeds and that it is strictly a staining test. Neither view is exactly correct. The test does distinguish strong, weak and dead tissues within a seed. It reveals in commercial seed lots that the seeds consist of various mixtures of strong, weak and dead tissues. A distinct division between seeds that are completely alive and those that are completed dead is of minor concern. Analysts, however, need to be aware as to which parts of a seed must be alive and intact for a seed to be considered germinative. Analysts must also observe the stained seeds for presence of weak tissues, fractures, bruises, insect damage, etc.

Seed Preparation

If not already moist, seeds must be slowly softened with water prior to testing. Many helpful insights into seed life have been gained even from a careful study of this essential phase of conditioning seeds for a tetrazolium test. We have discovered, for example, that dry seeds of many species tend to fracture readily if moistened rapidly. We have thus gained a good insight as to what has been happening to mature seeds of many crops that were left exposed for even short periods to adverse weather conditions.

Dry seeds of many crops were found to react normally in a tetrazolium or growth test only if first softened slowly in a lightly moistened germination media. It is convenient to do this moistening overnight and at a temperature of approximately 80-90° F.

The seeds thus slowly moistened, react most normally when placed in lukewarm water for completion of swelling prior to staining. After swelling the seeds are suitably prepared for absorption of the tetrazolium stain. Detailed information concerning these and other steps are being made available in reprints of the following articles:

1. Tetrazolium Testing Techniques - Proc. 38th Annual Meeting Soc. Com. Seed Technologists. Pages 45-51. 1960.

2. Tetrazolium Testing Guide - Seed Technologists News 31(2): 18-21. 1962.

An experienced analyst can make many short cuts in techniques and still obtain acceptable results. A new analyst would do well to adhere rather closely to a prescribed set of procedures until the test is mastered. Guidance from a competent analyst can also prove helpful and is strongly recommended.

The Testing Solution

The chemical used is commonly called tetrazolium. The specific chemical powder is purchased under the name 2,3,5-triphenyl tetrazolium chloride (TTC). It costs approximately 25¢ per gram. We purchase our supply of chemical from the Nutritional Biochemicals Corporation, 21010 Miles Avenue, Cleveland 28, Ohio. Other reliable sources are also available.

The testing solution is easily prepared by mixing approximately 1 1/4 grams of powder to approximately 1 pint of tap water. The solution will keep for several months in a dark bottle. Only sufficient solution need be used with each test to cover the seeds. The solution is discarded after each use and the seed covered with water. The cost of the chemical used in one test is of minor importance, oftentimes less than one cent. Labor is the important consideration.

Staining

When water-moistened, living embryo cells or tissues absorb the testing solution, a carmine-red water-insoluble particle gradually develops and intensifies. The hydrogen released during respiration is responsible for the production of this pigment. Dead cells or tissues do not release hydrogen and thus do not stain or at least do not produce a normal color. Living microorganisms will stain, and, if present in sufficient quantities, may at first cause some concern. The color and physical condition of the tissue will then be abnormal.

Living cells or tissues that have been damaged by heat, aging, mechanical injury, etc., will be revealed by color variations that an experienced analyst can soon learn to recognize. The test has many uses. Some of these uses are now to be discussed.

Predicting Potential Germination Percentage

Potential germination percentage refers to seeds that are capable of germinating and producing countable seedling under favorable growth testing condition. The potential thus establishes the upper limit to be expected in a growth test. Because of dormancy, infection or improperly managed growth tests - a considerable difference may exist between total and potential germination percentages. Such differences do not necessarily mean that the results of either test are wrong. Each test provides a different measurement that must be understood. The failure of a person to understand the true relationship between potential germination percentage and total germination percentage has been the major cause of the majority of criticisms made against tetrazolium tests. This misunderstanding has greatly delayed the use and acceptance of the test.

Evaluating Soundness of Germinative Seeds

The same test used for predicting the potential germination percentage can be used for evaluating the soundness vigor (or energy) of the germinative seed. For a measure of soundness, the individual germinative seeds are separated into two or more classes depending upon the location and nature of weak and dead tissues. Some analysts use only two classes of germinative seeds, namely: 1) sound or essentially sound, and 2) obviously unsound but germinative.

We have found it useful to separate germinative seeds into 5 classes as shown in Table 1.

Table 1. Detailed evaluation of seed soundness revealed by tetrazolium tests.

Germinative seeds		Seed lots		
		A	B	C
		Percentage of Seed in Classes		
1	(Best)	9	0	0
2		58	6	4
3	(Average)	22	24	5
4		3	38	8
5	(Weakest)	2	26	11
Potential Germination Percentage (1-5)*		94	94	28
Energy (1-2)		67	6	4
Energy (1-3)		89	30	9

Table 1. Continued.

Non-germinative seeds			
6 (Critical)	4	6	23
7	2	0	39
8 (Dead)	0	0	10

* An estimate of total germination percentage from standard growth tests of fungicide treated seed

This 5-class system requires slightly more effort than the 2-class system. The 5-class system provides the basis for a sliding scale series of evaluations. First, the percentages of germinative seeds are divided into each of the 5 classes. From these percentages various summaries can be made to provide information for 1-2, 2-3 and 1-4 levels of soundness. The 1-5 summary provides potential germination percentage.

Information concerning the percentages of germinative seeds at different levels of soundness can be used in many ways. It furnishes a basis for predicting or establishing:

1. The behavior of different seed lots to different levels of adverse germination conditions.
2. The storage behavior of different lots at different times.
3. The need for effective fungicide treatment.
4. The goodness of seed lots with acceptable germination percentages.

Diagnosing Causes for Seed Weaknesses

No other test approaches the suitability of the tetrazolium test for revealing the causes for seed weaknesses. Aging, internal mechanical injuries, freeze injuries, heat damage, weather exposure damage, insects and disease damage, etc. are commonly recognized. Even calcium deficiency symptoms are frequently noted in peanuts.

Quality Control

By being of short duration and highly informative, the tetrazolium test plays a very important role in quality control programs. The test permits the intelligent acceptance, rejection or handling of seed lots.

It provides excellent guidance in harvesting blending and other processing operations.

The test also stands ready to assist breeding programs in upgrading seed quality. It reveals that slight changes in the nature of seed coats or the shape of seed could be quite helpful in avoiding certain types of critical injuries. Cotton, for example, in the Southeastern area could be greatly benefited by a water impermeable seed coat or even by a stronger seed coat. Recessed embryos would be helpful for peanuts, sorghums, wheat and rye. Snapbeans, soybeans and lima beans quality could be improved by breeding for more water resistant seed coats.

Summary

The tetrazolium test provides a cheap, rapid method for the evaluation of individual structures of individual seeds. The test can be completed within 24 hours, and with moist seed even with 2 hours or less. It requires a minimum of equipment and space.

The tetrazolium test is especially useful and reliable in providing potential germination percentages and germination energy (soundness of germinative seeds). The test can be used to a good advantage in quality control programs and in diagnosing causes for germination difficulties.

Basic to all other factors mentioned, the test can open up many new insights into seed life and can teach even the most experienced seedsmen many new things about the "life" of their business. The tetrazolium test along with growth tests can remove most so-called "mysteries" associated with germination problems. The tetrazolium test can provide a good defense against competitors who have been making regular use of it. The offensive use of the test can provide even greater economic advantages.

SEED QUALITY TESTS AND THEIR RELATION TO SEED PERFORMANCE

Don F. Grabe [1]

One of the jobs of quality control is to minimize the amount of deterioration that occurs during seed production. This requires constant checking with sensitive tests that can detect small amounts of deterioration.

Many kinds of tests have been developed for measuring seed deterioration. Some of these are based on observations made during germination and seedling growth: seedling growth rate, cold test performance, emergence through a layer of crushed brick, respiration rate of germinated seedlings, speed of germination, and germination after subjecting the seeds to stress conditions. Other tests are based on detailed examinations of the seeds: determination of enzyme activity, the tetrazolium test, and measurement of electrical conductivity. Brief descriptions of some of the tests now in the forefront are as follows:

<u>The cold test</u> (Figure 1) for corn determines how well seeds withstand seed rotting organisms under cold, wet soil conditions. It is the only vigor test now in routine use in this country. Seeds are planted in a mixture of sand and unsterilized soil, held at 50° F for 7 days, then transferred to warm temperatures to germinate. This test reflects the amount of mechanical damage in corn seed and the effectiveness of fungicide applications.

<u>Length of primary root</u> (Figure 2) of seedlings germinated in upright rolled towels is a measure of seedling growth rate. A variation of this method is to grow the seedling in soil for a time before taking dry or fresh weights of the seedlings. Speed of germination is essentially a measure of these same characteristics.

<u>GADA</u> (glutamic acid decarboxylase activity) (Figure 3) is one of several tests of enzyme activity. Glutamic acid solution is added to finely ground seeds. The amount of carbon dioxide evolved from this mixture in 30 minutes is an index of the enzyme activity present in the seeds. Seeds with the highest rate of carbon dioxide evolution are the most vigorous.

<u>The tetrazolium test</u> is also based on enzyme activity. Vigor ratings are obtained by close observation of staining patterns and the

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[1] Dr. Grabe is an Associate Professor of Botany at Iowa State University, Ames, Iowa.

physical condition of the embryo. Tests which measure the activity of enzymes are among the quickest vigor tests to make.

Changes in permeability (Figure 4) of certain kinds of seeds indicate decreasing vigor. Permeability can be measured by soaking seeds in distilled water and then measuring the electrical resistance of the water. Low resistance means that the seeds have deteriorated, allowing materials to leach from the seeds into the water.

Survival of seeds under accelerated aging conditions is an index of longevity in commercial storage. Seeds are placed in an atmosphere of 100% humidity for 4 or 5 days. A germination test is then made to determine survival.

Respiration rate of germinative seedlings can be used as an index of vigor. Seeds are germinated and the amount of carbon dioxide given off by the seedlings is measured. The more carbon dioxide evolved, the greater the vigor of the seedlings.

The brick gravel method is one of the older vigor tests used in European countries. Germinating seeds are covered with a layer of crushed brick and the ability of seedlings to penetrate this restrictive layer is a general measure of seed vigor.

Microscopic examination for mechanical damage is a simple and effective test. Fast green or other stains may be used to make the cracks more visible.

These and numerous other tests are fully described in the literature. With this arsenal of tests available, the job now is to determine which are most suitable for use in quality control programs.

What Are The Best Quality Control Tests?

Several criteria need to be considered in selecting the tests to incorporate in a quality control program. These include (a) cost, (b) time involved, (c) personnel available, and (d) the particular aspect of quality to be tested.

Most of the tests that have been proposed do a reasonably good job of detecting differences in quality between seed lots. Most of these tests have been aimed at predicting difficulties in establishing stands under adverse field conditions and considerable experimental evidence is available on this point. We do not know if these tests can be used to measure losses in yield potential and storability of seed lots.

In order to predict potential performances, we must have more than arbitrary tests for "vigor". We must first of all know what levels of deterioration impair various aspects of performance. We must find out in what ways seeds deteriorate physiologically and then relate the condition of the seed to specific performance. The most useful vigor tests will be those that prove to be most closely related to crop performance.

Effect Of Seed Deterioration On Performance

During the past several years, we have attempted to obtain information on the effect of seed deterioration on three aspects of crop production: stand establishment, yield, and storability. Our objectives are to (a) determine the levels of deterioration that seriously affect performance, (b) associate plant responses and storability with the physiological condition of the seed, and (c) determine the feasibility of adapting this information in quality control work.

So far we have concentrated on corn, oats, and soybeans. We frequently use artificially aged seed to obtain suitable research material. Although the lots we used in these studies exhibited various degrees of deterioration, most had a high germination percentage and would be considered of marketable quality.

Stand Establishment

Field emergence data indicate that seed lots of similar germinability may not always produce the same number of seedlings in the field. One example of this is illustrated in Figure 5. In this case, soybean seeds one, two and three years old were planted in the field. Field emergence of one-year old seed was almost equal to germination percentage. Two and three-year old seeds were susceptible to soil-borne seed rotting organisms and stands were as much as 50% lower than germination. When fungicide treatment was applied, field emergence was nearly equal to germination.

Yields

We have long suspected that crop yields can be lowered by small losses in seed quality that cannot be detected by germination tests. To study this, we conducted several yield trials with corn and oat seed of different vigor levels. Different levels of deterioration were obtained both by artificial aging and natural storage. Vigor ratings were made on the basis of seedling growth rate and glutamic acid decarboxylase enzyme activity. All yields were based on equal plant populations. Under these experimental conditions, we have been able to demonstrate yield differences in the neighborhood of 10% for both corn and oats.

Figure 1. The cold test.

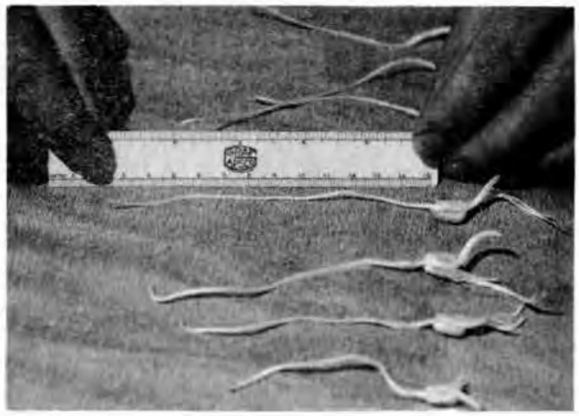

Figure 2. Measurement of seedling growth rate.

Figure 3. The GADA test.

Figure 4. Measurement of electrical conductivity.

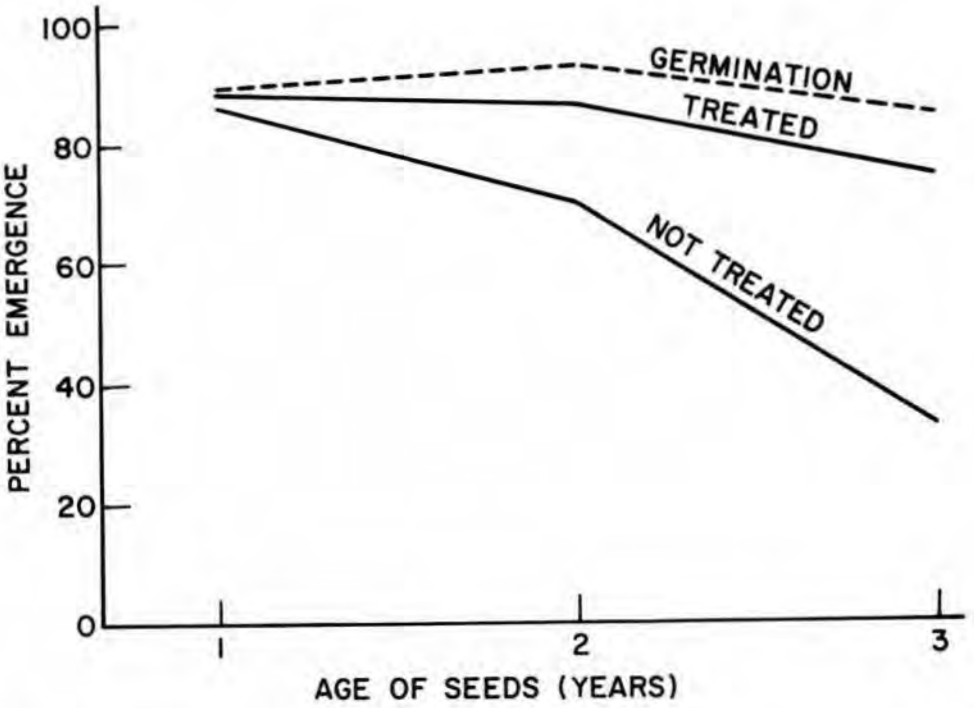

Figure 5. Effect of seed age and fungicide treatment on field emergence of soybean seedlings.

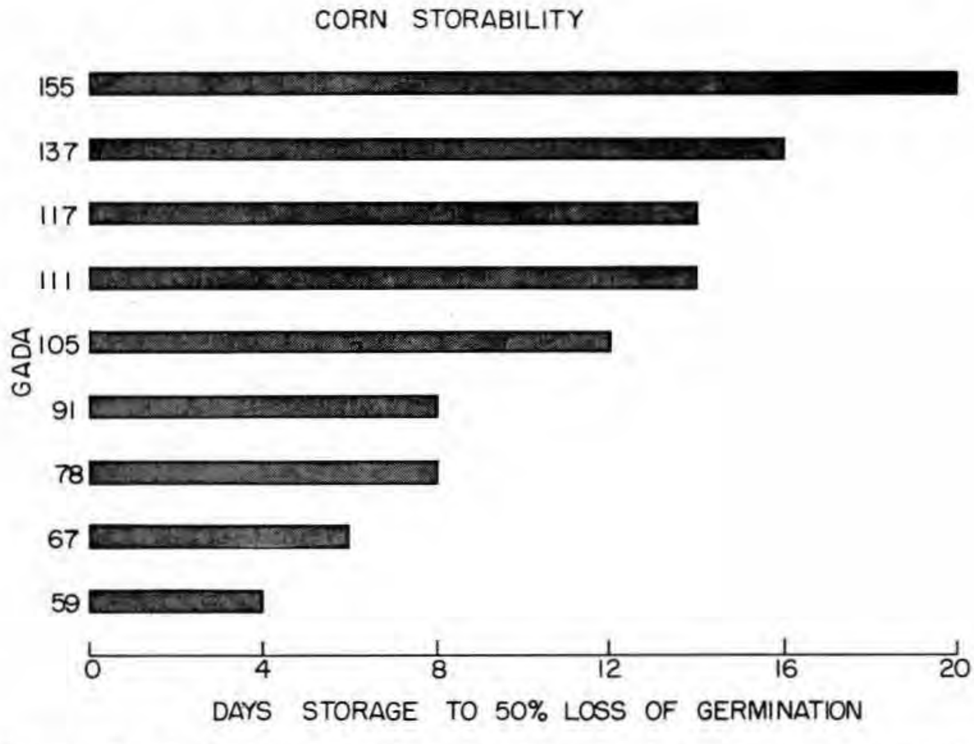

Figure 6. Relationship of glutamic acid decarboxylase activity (GADA) to corn seed storability. Seed lots with the highest enzyme activity possessed the greatest storage potential.

Data from one experiment with corn are given in Table 1 to illustrate this relationship.

Table 1. Effect of Seed Vigor on Relative Corn Yields*

Storage Conditions			Vigor	Relative
Temperature	Moisture	Germination	Level	Yield
77° F	11%	96	High	100
77° F	14%	95	Medium	98
77° F	17%	93	Low	93

* Yields were based on equal numbers of plants per plot.

Three seed lots were artifically aged by maintaining them at 11, 14 and 17% moisture sealed storage at 77° F. After enzyme activity had decreased, but before germinability was impaired, the seeds were removed from storage and maintained at a low moisture content until planting. The seeds with lowest enzyme activity (stored at 17%) yielded 7% less than the seeds with highest enzyme activity (stored at 11%).

Storability

We have also felt that longevity of seed lots in storage is governed by the physiological condition of the seed at thebeginning of storage. Experiments with corn have proven this to be true. In one storability study, nine lots of one seed corn hybrid were placed under adverse storage conditions to determine their relative storage life. They were analyzed for germination, cold test, and glutamic acid decarboxylase activity before storage. The lots were nearly identical in regard to germination and cold test performance, but varied greatly in enzyme activity. As indicated by the bar graph in Figure 6, storage longevity of the lots was in direct proportion to the amount of original enzyme activity. Germination and cold test gave no indication of potential storability differences.

Use Of Vigor Tests In Quality Control

Different kinds of tests are probably needed to rate seed lots according to their potential for stands, yields, and storage life. For example, in one series of experiments, a lower yield of corn was not related to cold test performance. On the other hand the cold test was a better indicator of potential stand establishment than was enzyme activity or seedling growth rate. Enzyme activity shows great promise as an indicator of relative storage longevity of seed lots.

When the appropriate tests are perfected, seedsmen will be able to use quality control tests to monitor the quality of their seed production in much the same way that manufacturers control the quality of the goods they produce. Some of these tests have already proven themselves in the laboratory and are ready for field testing under commercial conditions.

AN EFFECTIVE QUALITY CONTROL PROGRAM

C. D. Harrington[1/]

Scope of Subject Matter

Because Quality Control embraces all aspects of seed production it would be well at the start to outline the general area of this discussion. We will not concern ourselves here with the genetic purity of the seed crops under discussion. This is the domain of the plant breeder and of stock maintenance and control personnel.

Neither will we concern ourselves with agronomic factors affecting seed quality except for purposes of illustration. This responsibility of the field department is too large a subject to cover in this report without neglecting our principal theme.

Our area of discussion will concern itself primarily with the need, scope, organization, and operation of a company service designed to control the quality of seed from the time it is delivered to the plant in field-run condition until it is shipped to the customer in final processed form.

I would like to review with you a more or less generalized program which can be adapted to fit normal quality control requirements of most seed processors and to illustrate this review with slides and data on some quality control procedures developed by the Asgrow Seed Company for the production and processing of graden pea seed.

Organization of the Program

The first step an organization must take to get the ball rolling is an administrative decision to improve its quality control program and to provide a policy outline of its purpose and scope. These depend in large part upon the type or organization involved. For example, if a State or Federal department is engaged in the production of seed of the best possible quality for use as breeder stock, then high processing standards may be set to obtain this quality level. If, on the other hand, a commercial seed house is engaged in the production of seed, the company objective would be to set its quality standards at a level which will permit it to produce a uniformly high standard of seed quality at a reasonable profit. And this, gentlemen, is quite an undertaking.

[1/] Dr. Harrington is Manager, Quality Control Department, Asgrow Seed Company, Twin Falls, Idaho.

A progressive organization which decides to set up a formal quality control program does not really start from scratch. It already has an active program of some sort involving a number of people. These include those who sample crops in the warehouse, those who make decisions on processing procedures, those who check the processed product for market suitability, and those who buy and sell the seed during the normal course of operation.

The best place to start, therefore, in the implementation of the company decision, would be to review and to standardize those quality procedures already in use, including the reorientation of individuals involved to the necessity for unvaried compliance in carrying out these procedures. This first effort toward improving the company's quality control effort is sound management procedure because it demonstrates to personnel already involved how to do a better and more consistent job with familiar routines and does not arouse opposition as might be the case if a request were made to switch to a more complex series of new quality control procedures without some advance preparation.

After they have become familiar with the more disciplined routines, the position is reached where new or needed improvement in procedures will be accepted. A satisfactory vehicle for this step would be a small manual designed and written for a two-fold purpose: (1) to improve the technical knowledge of your warehouse samplers, millmen, and sample room analysts and, (2) to introduce more reliable equipment and procedures than those presently being used. To illustrate this step let us examine the table of contents of a manual of this type written in 1954 to standardize sampling and sample analysis procedures at nine Asgrow branches engaged in the production of garden pea seed.

Table of contents

1. Sampling theory
2. Sampling and sample analysis equipment
3. Types of crop samples
4. Classification of tare types
5. Sample analysis procedures
6. Quality control forms

Establishing Standards

Now all this may sound very involved and it would be if an attempt were made to switch over to a new program like this in one step. But the truth is that if you wish to obtain a uniform standard of quality your people must learn the rules and use the tools necessary for its measurement. For purposes of illustration let us see what it takes to set up and operate an acceptable processing control program. For this purpose we will skip the first 3 subjects mentioned in the table of contents for the sample room manual because it is obvious that this group is familiar with the sampling theory and with the tools and equipment used in drawing and analyzing various types of crop samples. Let us review, then, a suitable method for the classification of tare types and establishment of processing standards using the garden pea as the sample species:

TARE TYPES IN GARDEN PEA SEED

Free Foreign Material
- Trash
- Buds & Berries
- Free weed
- Dirt
- Clod
- Rock

Adhering Foreign Material
- Muddy
- Greasy
- Adhering weed seed
- Water stain
- Fungus stain
- Moldy-rotted

Mechanical Damage
- Crack
- Hairline crack
- Chipped
- Broken or split

Insect Injury
- Weevil sting
- Weevil window
- Weevil cut
- Chewed

Physiological Tare
- Burned
- Shrivel
- Physiological spot
- Weather check
- Loose hull
- Bleach

Mixtures and Off-types
- Smooth-wrinkled
- Canner-freezer
- Commercials
- Crop offs
- Crop rounds
- Field hybrids

Having learned to recognize most of the common types of tare in garden pea seed, what do we do about it? The answer: evaluate and tabulate the answers to the following questions about each:

1. When did it get into the crop?
2. Can something be done to prevent its entry in the first place?
3. Can it be removed in total or in part by routine processing procedures?
4. Can it be removed in total or in part by a specialized processing procedure?
5. Does it defy removal by known processing methods?
6. Have customers complained about it?
7. How much will the customer tolerate if all of it cannot be removed?

With the above information recorded for each type of tare, the relative importance of each as a possible source of customer complaint is catalogued and its processing removal characteristics are learned. This is all the information needed to begin writing a set of processing standards for garden pea seed.

Processing standards are tabulations of acceptable tolerances for each type of tare in the crop which must be met before it can be placed in trade channels as a standard quality product. As an example let us prepare a set of processing standards for free foreign material in peas.

It is obvious here that tare like plant trash, free weed seed, and dust should have a tolerance near zero since these types are easily removed by air and screening in ordinary milling.

How about dirt clods? In normal milling clods larger or smaller than the crop seed are removed by scalping and screening so that only crop-size pieces remain. The presence of a few clods the size of the crop will cause no planting difficulty because they will flow through the drill with the seed. The principal objection to the presence of crop-sized clod is that the customer is paying for this weight at the seed price and will complain if too many are present.

Soft volcanic rocks or smooth surfaced pebbles of a round or blocky configuration react much like clods. With hard sedimentary rock, however, the pieces may be the same diameter as the crop but much longer and may fall through the scalping screens lengthwise, thus remaining in the crop. These can cause damage from jamming in the gates or fluted feeds of drills. Another bad feature of rock is its unfortunate habit of accumulating in the bottom of the drill box due to its heavier specific gravity characteristics than the pea seed. By the time the customer has planted a few acres the accumulation of rocks in the drill may produce a violent complaint even though the crop itself averages only a few pieces per bag.

Because the customer will object to paying for crop-sized clod and rock at pea seed prices and wants nothing in the crop capable of damaging his planter the goal is to set tolerances for crop-sized clod and rock at levels low enough that the customer will not be likely to make an issue out of it and high enough that it can be met without excessive milling or remilling. Here you must pick your own level and try it on for size: like 1/4 of 1%, 1/10 of 1%, 1/16 of 1% or what have you? For long rock, however, the tolerance must be very low, preferably zero.

One by one we evaluate the different tare types and compile a preliminary set of tolerances which we hope will be acceptable to most customers and with which we can live. These are not hewn in stone. Changes will be made because of processing problems and customer complaints, but after 2-3 years a reasonable and workable set of processing standards will evolve.

Up to this point we have been talking about physical and physiological tare present in the crop. The other side of the coin involves factors associated with crop performance. Among these are (1) germination, (2) vigor, (3) moisture content. Setting standards for germination is easy because we have a base in the Federal minimum germination standards which the USDA lists in its "Rules and Regulations Under the Federal Seed Act" for all vegetable seed. The germination standard which you first select for your company should be above the minimum Federal germination standard but conservative, since the average level for the respective varieties and crops which you grow will be determined not by decision but by your general proficiency as an organization to reach and maintain these levels. You may also wish to formalize a set of germination standards for purchase of seed crops from growers, or dealers.

With respect to vigor we must candidly recognize that vegetable seed may vary in vigor from crop to crop for many reasons associated with genetic makeup, exposure to unfavorable agronomic factors during growth and maturation, seed size, physiological maturity when harvested, moisture content, physiological age, etc. For many vegetable species a fair estimate of the vigor of a lot may be ascertained by use of first count procedures which have been set up by the Association of Official Seed Analysts in their "Rules for Testing Seeds". For many species first count data is not a usable measure of vigor. This is a field of active current research.

<u>Activation of Centralized Checking Procedures</u>

Now we have:

(1) People at each processing plant capable of drawing and analyzing samples in a standard manner, using the same procedures and nomenclature.

(2) A set of processing and performance standards to control the quality level of the plant output.

Now we need a checking system to make sure that seed processed by each plant meets the established quality standards. This requires use of a master form for recording the data of all sample analyses run on each crop throughout its processing history. This record is used by the processing supervisor to guide successive processing operations and subsequently by quality control to check the final processed crop for adherence to established company standards.

When processing is completed a copy of this record is forwarded to quality control (Q.C.) headquarters with a representative sample of the final processed crop. Here the tare levels and other pertinent data listed on the crop analysis record are cross-checked against the sample and against permissible tolerances and performance standards in order to reach a final decision on its acceptability. A second form is then used to report back to the processing plant (and to Administration and Sales) whether the crop was found to be above or below standard.

Problem Crop Upgrading Procedures

Results of all laboratory tests for purity, germination, vigor, dormancy, moisture content, etc., should be scrutinized routinely by quality control headquarters so that tests failing to meet minimum standards may be red-flagged for remedial action with minimum loss of time.

With most seed crops the majority of germination problems are due to physiological injury resulting from exposure to adverse agronomic or weather conditions during maturation and harvest. Many procedures have been developed for upgrading germination performance of various species. One of the most successful involves differential air flotation of sized segments of the crop. We will illustrate this technique with an actual upgrading study of a pea seed crop.

With peas low germinations are usually associated with presence of variable amounts of two types of tare. The first is burn and shrivel of relatively immature elements of the crop due to drought, high temperature or other conditions contributing to premature ripening of the seed. Since immature seed is principally involved, burn and shrivel is concentrated in the smaller seeded elements of the crop. If the crop is sized with a series of 3 or more screens and the sizes tested separately for germination a typical seed-size and germination distribution pattern results. Germination of the respective sizes can then be improved by using air flotation to lift out the lightest and most shriveled seed.

The second type of tare is loose hull which usually appears in relatively mature elements of the crop following exposure to free moisture of sufficient amount and duration to swell the seed. On redrying the seed coat forms a loose hull around the cotyledons, becoming extremely susceptible to mechanical damage.

Since mature seed is principally affected by the loose-hull condition, and the condition itself further accentuates seed size, loose hull is usually concentrated in the larger seeded elements of the crop. Sizing over screens with subsequent testing for germination produces a typical germ distribution pattern opposite to that of shriveled crops.

The presence of both types of tare in the same crop produces the expected intermediate pattern with low germinations at both size extremes.

With these relationships in mind, a standard procedure for checking samples of low germinating crops for upgrading feasibility becomes immediately apparent. Samples of crops, red-flagged by Q.C. for substandard germination performance, may be submitted to Q.C. headquarters for germination upgrading studies, further processing being held in abeyance pending outcome of the tests. Results may be reported back to the branch with recommendations as to the best processing method for upgrading the crop.

To recapitulate, a workable quality control program must have a set of standards for each factor contributing to seed quality. The basic quality standards may be listed as follows:

Basic Seed Quality Standards

Performance Factors
- Germination
- Vigor

Processing Factors
- Moisture Control
- Tare tolerances
- Standard processing methods
- Upgrading routines
- Treating procedures

A group of quality control procedures are then needed to insure adherence to the established standards. Principal procedures involved in this program are:

Quality Control Procedures

1. Standard sampling and sample analysis techniques
2. In-plant processing control
3. Centralized checking of current crop for adherence to standard
4. Centralized checking of carryover for continued adherence to standard
5. Identification and upgrading of problem crops

Prizes and Contributions

Winners List:

<u>Bean Guessing Contest</u> - portable tape recorder
Mrs. Carl Thorp, Thorp Seed Co., Clinton, Illinois

<u>Prize Drawings</u>
Transistor Radio - Virgil Frevert, Crippen Mfg. Co., Alma, Michigan
Plano Tackle Box - Joe Dudney, Tennessee Crop Imp. Assoc., Nashville, Tennessee
Instamatic Camera - E. Berkeley Glenn, Va. Dept. of Agriculture, Richmond, Virginia
Electric Razor - Carl Thorp, Thorp Seed Co., Clinton, Illinois

<u>Registration Refunds</u> for bringing more than 9 other people -
J. C. Hackleman - Ill. Crop Imp. Assoc., Urbana, Illinois
Robert Rawlings - Ark. Rice Growers Assoc., Stuttgart, Arkansas

<u>Plus</u>

Twenty six winners of one of the following prizes:

1. "Seed Processing and Handling" Handbook #1 - Seed Tech. Lab.
2. Two dollar bill
3. Two pre-copper half dollars

The following firms contributed the money for purchasing the prizes:
Seedboro Equipment Company, Chicago, Illinois
Sanders Seed Company, Cleveland, Mississippi
Stults Scientific Engineering Corp., Springfield, Illinois
Hulsey Seed Laboratory, Decatur, Georgia
The Wax Company, Amory, Mississippi
Delta and Pine Land Company, Scott, Mississippi
Burrows Equipment Company, Evanston, Illinois

These companies purchased the 130 dozen doughnuts, 70 gallons of coffee and 40 cases of "cokes" consumed by the participants:
Gustafson Manufacturing Company, Minneapolis, Minnesota
Universal Dynamics Corporation, Alexandria, Virginia
Crippen Manufacturing Company, Alma, Michigan
A. T. Ferrell & Company, Saginaw, Michigan
Morton Chemical Company, Chicago, Illinois
Carter-Day Company, Minneapolis, Minnesota
Sutton, Steele and Steele Inc., Dallas, Texas

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REGISTRATION LIST
1967 SEEDSMEN'S SHORT COURSE

ALABAMA

1. Don Allen
Stegall-Sylvest Seed Company
Montgomery, Alabama

2. Robert H. Loe
Ala. Crop Imp. Association
Auburn, Alabama

3. Gurnia M. Moore
State Seed Analyst
Montgomery, Alabama

4. Paul B. Young
Alabama Crop Imp. Association
Auburn, Alabama

ARKANSAS

5. Mrs. D. D. Barris
Jacob Hartz Seed Co., Inc.
Stuttgart, Arkansas

6. Miss Jane Barris
Jacob Hartz Seed Co., Inc.
Stuttgart, Arkansas

7. H. E. Ellis
Empire Seed Company
Rogers, Arkansas

8. Leon Foster
Corning Grain Drier
Corning, Arkansas

9. Bill Fox
University of Arkansas Rice Branch
Stuttgart, Arkansas

10. Richard A. Graves
Pioneer, Inc.
Wilmot, Arkansas

ARKANSAS (CONT'D)

11. James Hammil
Dumas Grain Drier
Dumas, Arkansas

12. Harry Hardwick
Wheatley Grain Drier
Wheatley, Arkansas

13. Hubert Hatfield
Hazen Grain Drier
Hazen, Arkansas

14. Merlin Hendricks
Des Arc Grain Drier
Des Arc, Arkansas

15. Seth Henry
Univ. of Ark. Rice Branch
Stuttgart, Arkansas

16. B. B. Lackey
McGehee Grain Drier
McGehee, Arkansas

17. Joe Mahon
Jonesboro Grain Drier
Jonesboro, Arkansas

18. Francis Mason
Bradford Grain Drier
Bradford, Arkansas

19. Ralph Miller
Empire Seed Company
Rogers, Arkansas

20. E. L. Moore
Arkansas Rice Growers
Stuttgart, Arkansas

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ARKANSAS (CONT'D)

21. Robert Rawlings
    Arkansas Rice Growers
    Stuttgart, Arkansas

22. Fred Roth
    Weiner Grain Drier
    Weiner, Arkansas

23. Vernon Simpson
    Stuttgart
    Arkansas

24. Stanford Sivils
    Pioneer, Inc.
    Wilmot, Arkansas

25. Wiley C. Tester
    Arkansas Seed Laboratory, Inc.
    North Little Rock, Arkansas

26. Mrs. Wiley C. Tester
    Arkansas Seed Laboratory, Inc.
    North Little Rock, Arkansas

27. Hugh Tidwell
    Jonesboro Grain Drier
    Jonesboro, Arkansas

28. Arthur Wilson
    Arkansas Rice Growers
    Stuttgart, Arkansas

29. Bobby Wilson
    Stuttgart Grain Drier
    Stuttgart, Arkansas

CALIFORNIA

30. Lloyd E. Arnold
    Arnold-Thomas Seed Service
    Fresno, California

CALIFORNIA (CONT'D)

31. Robert Knowles
    Peto Seed Company
    Saticoy, California

32. Mrs. Robert Knowles
    Peto Seed Company
    Saticoy, California

COLORADO

33. Don Kessinger
    Gates Rubber Company
    Denver, Colorado

34. William D. Munroe
    Oliver Manufacturing Co.
    Rocky Ford, Colorado

DELAWARE

35. L. L. Stirland
    DuPont de Nemours & Co.
    Wilmington, Delaware

WASHINGTON, D. C.

36. Donald S. Douglas
    Soil Conservation Service
    Washington, D. C.

GEORGIA

37. Harry Brim
    Sasser
    Georgia

38. Jacob C. Garrison
    Soil Conservation Service
    Americus, Georgia

39. W. A. Horton
    Stephens Inc.
    Dawson, Georgia


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GEORGIA (CONT'D)

40. Earl Jones
Jones Grain Company
Sasser, Georgia

41. Pete Kellam
Asgrow Seed Company
Atlanta, Georgia

42. Jim Lanford
Asgrow Seed Company
Atlanta, Georgia

IDAHO

43. Dr. C. D. Harrington
Asgrow Seed Company
Twin Falls, Idaho

ILLINOIS

44. Fred Bergmann
Bergmann-Taylor Seeds
Trenton, Illinois

45. Mrs. Fred Bergmann
Bergmann-Taylor Seeds
Trenton, Illinois

46. J. Gordon Bidner
Funk Bros. Seed Company
Bloomington, Illinois

47. Clement Colgan
FS Service, Inc.
Cisco, Illinois

48. Mrs. Clement Colgan
FS Service, Inc.
Cisco, Illinois

49. A. F. Crow
Crow Hybrid Corn Company
Milford, Illinois

ILLINOIS (CONT'D)

50. Bernard Dalquist
Funk Bros. Seed Company
Normal, Illinois

51. Mrs. Bernard Dalquist
Funk Bros. Seed Company
Normal, Illinois

52. C. R. Finley
Funk Bros. Seed Company
Bloomington, Illinois

53. J. C. Hackleman
Illinois Crop Imp. Association
Urbana, Illinois

54. Mrs. J. C. Hackleman
Illinois Crop Imp. Association
Urbana, Illinois

55. George Keith
Illinois Crop Imp. Association
Urbana, Illinois

56. James L. Lamb
Farmer City Grain Company
Farmer City, Illinois

57. Mrs. James L. Lamb
Farmer City Grain Company
Farmer City, Illinois

58. Harold Laswell
Crop Improvement Association
Urbana, Illinois

59. J. Cole Morton
Farm Seeds
Ridgefarm, Illinois

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ILLINOIS (CONT'D)

60. Mrs. J. Cole Morton
Farm Seeds
Ridgefarm, Illinois

61. William Sago
FS Service, Inc.
Cisco, Illinois

62. Mrs. William Sago
FS Service, Inc.
Cisco, Illinois

63. Z. A. Stanfield
Funk Bros. Seed Company
Bloomington, Illinois

64. Sid Stephens
Morton Chemical Company
Chicago, Illinois

65. Carl E. Thorp
Thorp Seed Company
Clinton, Illinois

66. Mrs. Carl E. Thorp
Thorp Seed Company
Clinton, Illinois

67. Lyle Van Horn
Van Horn Hybrid, Inc.
Cerro Gordo, Illinois

68. Leo G. Windish
The Windish Seed Co. & Feed Mills
Galva, Illinois

69. Mrs. Leo G. Windish
The Windish Seed Co. & Feed Mills
Galva, Illinois

INDIANA

70. Francis R. Beck
Beck's Superior
Atlanta, Indiana

71. Mrs. Francis R. Beck
Beck's Superior
Atlanta, Indiana

72. John Gerard
Indiana Crop Imp. Assoc.
Lafayette, Indiana

73. Bob Haniford
Indiana Crop Imp. Assoc.
Lafayette, Indiana

74. Charles Hendrix
Indiana Crop Imp. Assoc.
Lafayette, Indiana

75. Clyde Hoppes
Mitchell Farms
Peru, Indiana

76. Mrs. Clyde Hoppes
Mitchell Farms
Peru, Indiana

77. Don Kell
Indiana Crop Imp. Assoc.
Lafayette, Indiana

78. Lester L. McNees
ACME-Goodrich Seeds
Farmland, Indiana

79. Mrs. Lester L. McNees
ACME-Goodrich Seeds
Farmland, Indiana

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INDIANA (CONT'D)

80. James Rayl
Indiana Crop Imp. Assoc.
Lafayette, Indiana

81. Ammon Swope, Jr.
Purdue University
Lafayette, Indiana

82. Mrs. Ammon Swope, Jr.
Purdue University
Lafayette, Indiana

IOWA

83. Dr. Don F. Grabe
Iowa State University
Ames, Iowa

KENTUCKY

84. Frank Honchell
Sunrise Feed Service
Kevil, Kentucky

85. Miller Levi
Seed Farms, Inc.
Georgetown, Kentucky

86. Mrs. Miller Levi
Seed Farms, Inc.
Georgetown, Kentucky

87. Miss Ann Miller Levi
Seed Farms, Inc.
Georgetown, Kentucky

88. L. C. Patton
Lewis Seed Company
Louisville, Kentucky

89. Mrs. L. C. Patton
Lewis Seed Company
Louisville, Kentucky

LOUISIANA

90. E. E. Brown
E. E. Brown Instrument Co.
Shreveport, Louisiana

91. H. G. Gremillion
Louisiana Seed Company
Alexandria, Louisiana

92. Mrs. H. G. Gremillion
Louisiana Seed Company
Alexandria, Louisiana

93. Horace Lofton
Louisiana Seed Company
Alexandria, Louisiana

94. Mrs. Horace Lofton
Louisiana Seed Company
Alexandria, Louisiana

95. John Meredith, Jr.
Southern Seedsmen's Association
Shreveport, Louisiana

96. Mrs. John Meredith, Jr.
Southern Seedsmen's Association
Shreveport, Louisiana

97. Dave Petitjean, Jr.
Delrico, Inc.
Crowley, Louisiana

98. E. H. White
Terral-Norris Seed Co., Inc.
Lake Providence, Louisiana

99. Mrs. E. H. White
Terral-Norris Seed Co., Inc.
Lake Providence, Louisiana


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LOUISIANA (CONT'D)

100. Mr. M. L. Woodruff
E. E. Brown Instrument Co.
Baton Rouge, Louisiana

MARYLAND

101. Herbert Everett
USDA Soil Conservation Service
Beltsville, Maryland

MASSACHUSETTS

102. W. J. McKelvey
Pride of the Valley, Inc.
Boston, Massachusetts

MICHIGAN

103. Vergil D. Frevert
Crippen Mfg. Company
Alma, Michigan

104. Jim Henderson
A. T. Ferrell & Company
Saginaw, Michigan

105. Mrs. Jim Henderson
A. T. Ferrell & Company
Saginaw, Michigan

MINNESOTA

106. W. S. Acheson
Gustafson Manufacturing Co.
Minneapolis, Minnesota

107. George Durkot
Carter-Day Company
Minneapolis, Minnesota

108. Donald A. Johnson
Northrup King & Company
Minneapolis, Minnesota

MINNESOTA (CONT'D)

109. Felix Norman
Hart Carter Americas, Inc.
Minneapolis, Minnesota

110. Thomas W. Oben
Land O'Lakes Creameries
Minneapolis, Minnesota

MISSISSIPPI

111. Dr. Frank Bonner
U.S. Forest Service
State College, Mississippi

112. T. A. Bown
Soil Conservation
Jackson, Mississippi

113. Jim Brooks
Soil Conservation
Jackson, Mississippi

114. Frank E. Burns
Burns Brothers Company
Bogue Chitto, Mississippi

115. Ted Cheshire
La. Seed Co. of Miss.
Jackson, Mississippi

116. Miller Flowers
Miss. Seed Imp. Assoc.
State College, Mississippi

117. Wesley F. Freeland
U.S. Forest Service
Stoneville, Mississippi

118. W. T. Gilbert
W. R. Grace Company
Columbus, Mississippi

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MISSISSIPPI (CONT'D)

119. W. W. Guerry
Miss. Seed Imp. Assoc.
State College, Mississippi

120. Elbert D. Hickey
Salmon Sales Company
Clarksdale, Mississippi

121. Bob Kimbriel
Farmers Elevator
Leland, Mississippi

122. Louis A. King
Delta & Pine Land Company
Scott, Mississippi

123. Kenneth McClain
Delta & Pine Land Company
Scott, Mississippi

124. James McShan
H. C. McShan Company
Schlater, Mississippi

125. Mrs. James McShan
H. C. McShan Company
Schlater, Mississippi

126. Chester Milner
Miss. Seed Imp. Assoc.
State College, Mississippi

127. Guy Neal
Riverside Elevator of Greenville
Greenville, Mississippi

128. Heywood Norman
Mississippi Federated Coop.
Jackson, Mississippi

MISSISSIPPI (CONT'D)

129. James Oliver
Farmers Elevator
Leland, Mississippi

130. Noble Pace
Columbus
Mississippi

131. N. L. Pugh
Riverside Industries
Marks, Mississippi

132. Alex Ramsey, Jr.
Ramsey Seed Farms
Mt. Olive, Mississippi

133. Perry Smith
Mississippi Federated Coop.
Jackson, Mississippi

134. Jamie Taylor
Farmers Feed & Supply
Leland, Mississippi

135. L. D. Ulrich
Mississippi Federated Coop.
Jackson, Mississippi

136. G. F. Vaughn
Miss. Dept. of Agric. and Commerce
Jackson, Mississippi

137. Jack Wilson
Hollandale Seed & Delinting Company
Hollandale, Mississippi

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MISSOURI

138. Charles J. Black
MFA Seed Division
Marshall, Missouri

139. Forest Buchanan
MFA Seed Division
LaBella, Missouri

140. S. A. Geringer
Todt Industrial Supply
Cape Girandeau, Missouri

141. Dr. Walter H. Grimes
Chemagro Corporation
Kansas City, Missouri

142. Carl E. Park
Park View Acres
Clinton, Missouri

143. Mrs. Carl E. Park
Park View Acres
Clinton, Missouri

144. H. C. Todt
Todt Industrial Supply
Cape Girardeau, Missouri

MONTANA

145. Loren Wiesner
Grain Inspection Laboratory
Montana State University
Bozeman, Montana

NEBRASKA

146. Vearl L. Jensen
Morrison Quirk Grain Corp.
Hastings, Nebraska

NEW JERSEY

147. Stanley Berg
Howe Richardson Scale Co.
Clifton, New Jersey

NEW MEXICO

148. Nelson Clayshulte
Agriculture Products
Mesquite, New Mexico

149. Ed Foreman
Agriculture Products
Mesquite, New Mexico

NEW YORK

150. E. Wilbur Scott
Joseph Harris Company
Rochester, New York

151. Olen Thompkins
New York Foundation Seed Stocks
Ithaca, New York

NORTH CAROLINA

152. Robert Burris
N. C. Dept. of Agriculture
Asheville, North Carolina

153. R. G. Gurley
Gurley Milling Company
Selma, North Carolina

154. Mrs. R. G. Gurley
Gurley Milling Company
Selma, North Carolina

155. Earl J. James
FCX Lumberton Wholesale Service
Lumberton, North Carolina


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NORTH CAROLINA (CONT'D)

156. M. G. McKenzie, Jr.
N. C. Dept. of Agriculture
Orrum, North Carolina

157. Dr. R. P. Moore
North Carolina State Univ.
Raleigh, North Carolina

158. Bruce Shands
N. C. Dept. of Agriculture
Raleigh, North Carolina

159. A. D. Stuart
North Carolina State Univ.
Raleigh, North Carolina

OHIO

160. Harold Martin
Hebron
Ohio

161. Mrs. Harold Martin
Hebron
Ohio

PENNSYLVANIA

162. Clarence S. Bryner
The Pennsylvania State Univ.
University Park, Pennsylvania

163. Vincent J. Palau
Mercator Corporation
Reading, Pennsylvania

SOUTH CAROLINA

164. C. M. Chapman
Chapman Seed Plant
Pelzer, South Carolina

165. Mrs. C. M. Chapman
Chapman Seed Plant
Pelzer, South Carolina

SOUTH CAROLINA (CONT'D)

166. Donald B. Clark
Coker's Pedigreed Seed Co.
Hartsville, South Carolina

TENNESSEE

167. J. L. Carnes
Chemagro Corp.
Memphis, Tennessee

168. R. E. Cobble
Tenn. Crop Imp. Assoc.
Nashville, Tennessee

169. David T. Dailey
E. I. DuPont de Nemours
& Co., Inc.
Memphis, Tennessee

170. Joe Dudney
Tenn. Crop Imp. Assoc.
Nashville, Tennessee

171. Bill Wallace
Hagan Mfg. Company
Memphis, Tennessee

TEXAS

172. Duane Griffith
Pioneer Sorghum Company
Plainview, Texas

173. Delbert Langford
Baker Castor Oil
Plainview, Texas

174. Carlton A. Robinson, Jr.
Paymaster Seeds
Plainview, Texas

175. Mrs. Carlton A. Robinson, Jr.
Paymaster Seeds
Plainview, Texas

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TEXAS (CONT'D)

176. Ken Skarien
Seedsmen's Digest
San Antonio, Texas

177. Mrs. Ken Skarien
Seedsmen's Digest
San Antonio, Texas

178. James L. Thomas
Texas Hybrid Seed Company
Crosbyton, Texas

179. John Willard
Wilson County Peanut Company
San Antonio, Texas

180. Jack Willis
Conlee Seed Company
Waco, Texas

181. William Crawford Young
Soil Conservation
Fort Worth, Texas

VIRGINIA

182. Bernard W. Chudoba
Virginia Dept. of Agriculture
Richmond, Virginia

183. E. Berkeley Glenn
Virginia Crop Imp. Association
Richmond, Virginia

184. R. C. Lanier
Virginia Crop Imp. Association
Amelia, Virginia

185. Mrs. R. C. Lanier
Virginia Crop Imp. Association
Amelia, Virginia

VIRGINIA (CONT'D)

186. Harry K. Rust
Virginia Dept. of Agriculture
Richmond, Virginia

WASHINGTON

187. John Butterfield
Stokely Van Camp, Inc.
Spokane, Washington

188. Mrs. John Butterfield
Stokely Van Camp, Inc.
Spokane, Washington

PUERTO RICO

189. Aurelio Sierra-Bracero
USDA Soil Conservation
Mayaguez, Puerto Rico

LIST OF PROCESSING EQUIPMENT

IN THE SEED TECHNOLOGY LABORATORY

Air and Screen Cleaners

Clipper, Model Super X-29D	A. T. Ferrell and Company 1621 Wheeler Street Saginaw, Michigan
Clipper, Model M-2B	" "
Crippen, Model H-534-A	Crippen Manufacturing Co. Alma, Michigan
Crippen, Model NW-334	Crippen Manufacturing Co. Alma, Michigan
Vac-A-Way, Farm Model	J. W. Hance Mfg. Co. Westerville, Ohio

Aspirator

Pneumatic Separator	Electric Sorting Machine Co. 5234 Glenmont Drive Houston, Texas

Blender

Ross TRH 1/2 ton size Ultra Rapid Turbo Square Mixer	Ross Machine & Mill Supply, Inc. 12 N. E. 28th Oklahoma City, Oklahoma

Buckhorn Separator

Sutton, Steele and Steele	Sutton, Steele and Steele, Inc. 1031 South Haskell Dallas 23, Texas

Color Separators

Mandrel, Model B350	Electric Sorting Machine Co. 5234 Glenmont Drive Houston, Texas

Color Separators (cont'd)

Sortex, Model G414	Sortex Company of N. America, Inc. Lowell, Michigan

Corn Graders

Morecorn Grader, Model 2SA	Universal, Incorporated 245 South Washington Hudson, Iowa

Conveyors

Burrows Belt Conveyor Model R-13-3/4HE	Burrows Equipment Company 1316 Sherman Avenue Evanston, Illinois
Clipper Vibrating Conveyor	A. T. Ferrell & Company 1621 Wheeler Street Saginaw, Michigan
Universal Belt Conveyor Model H-2	Universal, Incorporated 245 South Washington Hudson, Iowa
Uveyor U-belt Conveyor Model, 1/2 inch unit	Uveyor Box 3272 Jacksonville, Florida

Debearder

Clipper	A. T. Ferrell & Company 1621 Wheeler Street Saginaw, Michigan

Dehumidifiers

Dryomatic, Model 105	Dryomatic Corporation Box 591 Alexandria, Virginia

Dehumidifiers (cont'd)

Una-dyn, Model A30LT	Universal Dynamics Corporation 4200 Wheeler Avenue Alexandria, Virginia

Electrostatic Separator

Carpco, Model HL118	Carpco Research & Eng. Co. P. O. Box 3272 Jacksonville, Florida

Elevators

Burrows Bucket Type, Model 50	Burrows Equipment Company 1316 Sherman Avenue Evanston, Illinois
Clipper "Series 100"	A. T. Ferrell & Company 1621 Wheeler Street Saginaw, Michigan
Gordonbilt Airlift, 1-H. P.	Gordon Machinery Corporation P. O. Box 1452 Maryville, California
John F. Grisez	John F. Grisez Company Crows Landing, California
Lift-Master Airlift, 2 H. P.	Holzinger Brothers 10140 South Shoemaker Ave. Sante Fe Springs, California
Seedburo Bucket Type Model 200	Seedburo Equipment Company 618 West Jackson Boulevard Chicago, Illinois
Universal Bucket Type Model B2	Universal, Incorporated 245 South Washington Hudson, Iowa
Universal Bucket Type Model C2	" "

Gravity Tables

Forsberg, Model 40-V	Forsberg, Incorporated Thief River Falls, Minnesota
Oliver, Model 50-A	Oliver Manufacturing Company Rocky Ford, Colorado
Sutton, Steele & Steele Model AX-250	Sutton, Steele & Steele, Inc. 1031 South Haskell Dallas 23, Texas

Huller and Scarifiers

Clipper, Eddy-Giant	A. T. Ferrell & Company 1621 Wheeler Street Saginaw, Michigan
Crippen, Model S	Crippen Manufacturing Co. Alma, Michigan

Length Graders

Carter Disc Separator Model 1522	Carter-Day Company 655 19th Avenue, N. E. Minneapolis, Minnesota
Carter Disc Separator Model 1547	" "
Carter Disc Separator Model 1827	" "
Hart Uni-Flow Cylinder Separator, Model 3	" "
Superior Length Grader (Cylinder) Model C-56	Superior Division Daffin Corporation 121 Washington Avenue, South Hopkins, Minnesota

Magnetic Separators

John F. Grisez	John F. Grisez Company Crows Landing, California

Mixers

MacLellan Batch Mixer Model 1	Burrows Equipment Company 1316 Sherman Avenue Evanston, Illinois

Roll Mills (Dodder)

Clipper, 10 rolls	A. T. Ferrell & Company 1621 Wheeler Street Saginaw, Michigan
Warsco, 8 rolls	W. A. Rice Company Jerseyville, Illinois

Scales

Apex Bagging Machine Model D-100	Burrows Equipment Company 1316 Sherman Avenue Evanston, Illinois
Fairbanks-Morse 1000# Platform Scales	" "
Fairbanks-Morse 2500# Warehouse Scales	" "
Waymatic	Waymatic Welding and Fabricating Company Fulton, Kentucky
Howe-Richardson UNIPAK	Howe-Richardson Co. Clifton, New Jersey

Scalper

Clipper, Model 1297-1	A. T. Ferrell and Company 1621 Wheeler Street Saginaw, Michigan

Seed Treaters

Gustafson Mist-O-Matic Model M100	Gustafson Manufacturing Co., Inc. 6600 S. County Road 18 Hopkins , Minnesota
Gustafson Mist-O-Matic Model M400	" "
Panogen Automatic Model MC	Morton Chemical Company 110 North Wacker Drive Chicago, Illinois
Panogen Automatic Model US 60-C	" "

Spiral Separator

Krussow Double Spiral	Cleland Manufacturing Company 2800 Washington Avenue, North Minneapolis, Minnesota

Width and Thickness Grader

Carter Precision Grader	Carter-Day Company 655 19th Avenue, N. E. Minneapolis, Minnesota

LIST OF LABORATORY MODEL

SEED PROCESSING AND TESTING EQUIPMENT

Air and Screen Cleaner

Clipper, Office Model	A. T. Ferrell & Company 1621 Wheeler Street Saginaw, Michigan

Aspirator

Superior, Fractionating	Carter-Day Company 655 19th Avenue, N. E. Minneapolis, Minnesota

Dielectric Heater

Thermex High Frequence Unit Model CP 10 A254	Votator Division, Chemetron Corp. Box 43 Louisville, Kentucky

Dockage Tester

Carter, Model XT 1	Carter-Day Company 655 19th Avenue, N. E. Minneapolis, Minnesota

Electrostatic Separators

Carpco, Model HP-16	Carpco Research & Eng. Co. P. O. Box 3272 Jacksonville, Florida
Coronatron	Ding's Magnetic Separator Co. 4740 West Electric Avenue Milwaukee, Wisconsin

Gravity Tables

Forsberg	Forsberg, Incorporated Thief River Falls, Minnesota

Gravity Tables (cont'd)

Sutton, Steele & Steele Model V-135A	Sutton, Steele & Steele , Inc. 1031 South Haskell Dallas, Texas
Oliver Stoner	Oliver Manufacturing Company Rocky Ford, Colorado
Kvarnmaskiner Laboratory Cleaning Plant Type KM	Aktiebolaget Kvarnmaskiner Box 7015 Malmo, Sweden

This plant consists of the following equipment:

Scourer (Huller)
Air Separator (Aspirator)
Shaking Sieve Sifter(2 Screen Cleaner)
Table Separator (Gravity Separator)
Trieur (Cylinder Separator)

Length Graders

Carter, Test Cylinder	Carter-Day Company 655 19th Avenue, N. E. Minneapolis, Minnesota
Carter, Test Disc	" "
Kvarnmaskiner, "Pedigree" Cylinder	Aktiebolaget Kvarnmaskiner P. O. Box 7015 Malmo, Sweden
Superior, Test Cylinder	Carter-Day Company 655 19th Avenue, N. E. Minneapolis, Minnesota

Magnetic Separator

Gompper-Maschinen Gesellshaft "Lilliput"	Buderich bei Dusseldorf Grunstr 32, Postfach, Germany U. S. Distributor: Ulbeco, Incorporated 484 State Highway 17 Paramus, New Jersey

Moisture Testers

Burrows Moisture Recorder	Burrows Equipment Company 1316 Sherman Avenue Evanston, Illinois
Motomco Moisture Meter Model 919	Motomco, Incorporated 89 Terminal Avenue Clark, New Jersey
Steinlite Moisture Tester Model, RCT,S,G	Seedburo Equipment Company 618 West Jackson Boulevard Chicago, Illinois
Tag-Heppenstall	Western Electric Instrument Corp. 614 Frelinghuysen Avenue Newark, New York
Universal, Model EH	Burrows Equipment Company 1316 Sherman Avenue Evanston, Illinois

Roll Mill(Dodder)

W. A. Rice	W. A. Rice Seed Company Jerseyville, Illinois

Scarifier

Forsberg, Sample-Seed Model	Forsberg, Incorporated Thief River Falls, Minnesota

Screens

Complete set of Clipper 9"x9" Hand Screens	A. T. Ferrell & Company 1621 Wheeler Street Saginaw, Michigan

Seed Treater

Calkins	Calkins Manufacturing Company Spokane, Washington

Magnetic Separator (cont'd)

Grisez	John F. Grisez Company Crows Landing, California

Spiral Separator

Krussow Spiral	Cleland Manufacturing Company 2800 Washington Avenue, North Minneapolis, Minnesota

Thresher

Head Thresher	Allen Machine Shop Ames, Iowa

Width and Thickness Grader

Carter Test Precision Grader	Carter-Day Company 655 19th Avenue, N. E. Minneapolis, Minnesota

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Additional equipment includes: bag holders, sewing machines, seed probes, germinators, ovens, purity boards, seed dividers, seed counters, balances, microscopes, seed sample cabinets, the Vitascope, and other laboratory equipment.

Some of this equipment was contributed by:

Burrows Equipment Company
E. L. Erickson Products
Gustafson Manufacturing Company
Paul Hattaway Company
Redhead Bagholder Corporation
Seedburo Equipment Company