Sixth Annual Dry Bean Conference

Held at Los Angeles, California January 2-4, 1963

THE SIXTH ANNUAL DRY BEAN RESEARCH CONFERENCE was held January 2-4, 1963, in Los Angeles, Calif. It was attended by bean growers, shippers, and processors from various growing areas in the United States and by research and extension workers from State and Federal agencies. Its purpose was to present results of current research and development pertaining to the production, marketing, and utilization of dry beans and to afford an opportunity for exchange of information and discussion of problems. Principal topics were new developments in the dry bean industry, diseases of bean plants, and flatulence research.

Sponsors of the conference were the National Dry Bean Council, the U.S. Department of Agriculture, and State Agricultural Experiment Stations. Merle Wolverton, California Lima Bean Advisory Board was General Chairman. M. J. Copley, Director, and A. H. Brown, Assistant Director, Western Utilization Research and Development Division, Agricultural Research Service, USDA, Albany, Calif. were program co-chairmen. The advice and assistance of F. Regis Dailey, Chairman of the National Bean Council, Gordon W. Monfort, Manager of the California Lima Bean Advisory Board, and William A. McCormack are gratefully acknowledged.

This report was prepared in the Western Utilization Research and Development Division, Agricultural Research Service, USDA. Copies are available on request from Western Regional Research Laboratory, Albany 10, Calif., headquarters of the Division.

CONTENTS

Report of Conference on Dry Bean Research

NUTRITIONAL VALUE OF DRY BEANS

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Throughout the world legumes are recognized as an excellent food. In fact, other nations consume legumes in far larger quantity than is customary in the United States (Table 1). In our northern States, according to the USDA 1955 survey, only 3 grams of legumes (excluding peanuts) were eaten daily per capita--0.1 ounce-- and only 0.5 ounce in the South, where beans are a more customary or preferred food. In Central and South American countries consumption of 2 to 3 ounces a day is not uncommon. The average consumption of legumes in Africa was found to be about 40 grams--or about 1.4 ounces--although in some areas consumption was as high as 1 lb. 5 oz. (Ruanda) and in others nearly one pound. Similarly, in India, Burma, and Ceylon, the average intake was about 1.5 ounces but some laborers engaged in road work ate over a half pound a day.

Table 1. Consumption of dry legumes in various countries as ascertained by diet surveys1/

Country	Grams per capita per day	Remarks
United States	8	North 6, South 17
Mexico	42	-----
Venezuela	80	Rural workers
	89	Urban workers
Guatemala	44	Poor Ladinos
	57	Other Ladinos
	51	Poor Indians
	58	Other Indians
Togoland	13 to 140	-----
Countries (13) South of Sahara	10 to 150	-----
India	14 to 114	Per consumption unit
Japan	5.5 to 7.8	Exclusive of 44 to 65 g. of soya and its products
Haiti	30	-----

1/ Data for USA are from Household Consumption Survey, 1955, Reports 2, 3, and 4, U.S. Department of Agriculture. Other data are reported from various sources by Patwardhan, V.N., Amer. J. Clin. Nutrition 11:12, 1962.

As shown in Table 2, the legumes all contain a large amount of protein, 20 to 35 percent. With respect to the essential amono acids -- the protein components that man cannot make in his own body from other sources -- legumes provide a large amount of lysine but insufficient quantities of tryptophan and of the sulfur-containing group, methionine and cystine. Therefore, the quality of legume protein is poorer than that of most animal products.

Table 2. Composition of dry legumes[1/]

Nutrient	Common beans and peas	Soybeans	Peanuts
Protein, %	20-25	33-35	26
lysine, %	1.71	1.58	1.10
tryptophan, %	0.21	0.52	0.34
methionine and cystine, %	0.46	1.19	0.73
Fat, %	1-2	16-18	43
Carbohydrate, %	57-65	35-36	24
Thiamine, mg. %	0.3-0.9	0.8-1.1	0.8-1.1
Niacin, mg. %	1.5-3.1	2.2-2.3	15.6-16.0
Riboflavin, mg. %	0.1-0.3	0.3	0.1
Iron, mg. %	4.5-8.4	5.0-8.0	1.3-1.8
Calcium, %	0.05-0.25	0.22	0.77

1/ Data in Tables 2-4 are from "Food Composition Tables for International Use," FAO Nutritional Studies No. 11, 1954 and "Amino Acid Content of Foods," USDA Home Econ. Res. Rpt. No. 4, 1957.

Although common beans and peas contain little fat, only 1 to 2 percent, other species, such as soybeans and peanuts, provide large amounts of this nutrient. These seed oils are high in the polyunsaturated fatty acids and relatively low in saturated acids. Carbohydrate content varies, being lower in the high-fat varieties.

Legumes are a good source of the vitamins thiamine and niacin, are relatively lower in riboflavin content, and very low in vitamins A, C, and B_{12}. Content of iron is variable but generally good, whereas calcium content is low.

Some nutrient losses are sustained in preparation and processing of legumes. Water-soluble nutrients may be leached out by soaking and washing and heat-sensitive nutrients destroyed by prolonged cooking and canning. For example, 70 percent of thiamine may be lost in canning dry beans.

Although good foods in their own right, the legumes are outstanding as inexpensive sources of the nutrients likely to be in short supply in diets based largely on cereals and root crops. Examples of this supplementary capability are given in Table 3.

It may be observed that addition of beans, in the amount commonly eaten, 40 or 120 grams, to diets providing 1800 calories from rice can correct the shortages of protein, tryptophan and lysine, thiamine, and niacin. Such a diet will remain low in methionine, riboflavin, vitamins A and C, and calcium. These needs can be met completely by consumption of 1-1/2 lbs. of dark green leaves or a combination of leaves, milk, meat, and eggs.

A similar situation exists with respect to a corn-based diet. The combination of corn and beans is lower in tryptophan but somewhat better than rice and beans with respect to methionine. In this case, a further supplement of one pound of leaves, or a combination of leaves and animal products, will suffice.

A diet in which 1600 to 1800 calories are consumed as wheat is adequate in content of the major nutrients provided by legumes, and of tryptophan and

Table 3. Supplementary value of beans (Phaseolus vulgaris) in diets based largely on rice or corn (underlined values indicate shortage of the nutrient.)

Nutrient	Milled rice 1.1 lb. (500 g.)	Plus beans 1.4 oz. (40 g.)	Plus beans 4.2 oz. (120 g.)	Lime-treated corn, yellow tortilla 1.9 lb. (857 g.)	Plus beans 1.4 oz. (40 g.)	Plus beans 4.2 oz. (120 g.)	Desired amount
Calories	1800	1936	2209	1800	1936	2209	2300+
Protein, g.	33.5	42.3	60.0	39.4	48.2	65.9	60-70
Tryptophan, g.	0.36	0.44	0.61	0.21	0.29	0.46	0.5
Lysine, g.	1.32	1.97	3.29	0.98	1.63	2.95	1.6
Methionine, + cystine, g.	1.05	1.23	1.58	1.27	1.45	1.80	2.2
Thiamine, mg.	0.40 1/	0.62	1.05	1.29	1.51	1.94	1.2
Riboflavin, mg.	0.15 1/	0.22	0.37	0.43	0.50	0.65	1.5
Niacin, mg.	8.0 1/	8.8	10.5	8.6	9.4	11.1	17 2/
Vitamin A, I.U.	None	12	36	171	183	207	5000
Vitamin C, mg.	None	1	4	0	1	4	70
Calcium, g.	0.08	0.13	0.24	1.68 3/	1.73	1.84	0.8

1/ If converted rice is used, content will be, in mg: thiamine, 1.1; riboflavin, 0.20; and niacin, 19.0. 2/ Niacin equivalents = niacin plus (tryptophan, mg. ÷ 60). Rice plus 120 grams of beans yields 21 mg. of niacin equivalents; corn plus 120 grams of beans, 19 mg. 3/ If lime treatment is not used, only 0.37 grams of calcium will be provided.

Table 4. Value of a wheat diet

Nutrient	Wheat, whole 1.2 lbs. (539 g.)	Wheat, whole 1.1 lbs. (484 g.)	Wheat, 0.8 lb. (368 g.) + beans 4.2 oz. (120 g.)	Desired amount
Calories	1800	1617	1638	2300+
Protein, g.	65.8	59.0	71.4	60-70
Tryptophan, g.	0.8	0.7	0.8	0.5
Lysine, g.	1.8	1.6	3.2	1.6
Methionine + cystine, g.	2.4	2.2	2.2	2.2

methionine as well (Table 4). Addition of 120 grams of beans to a wheat-based diet, however, allows these nutrient requirements to be fulfilled with less wheat, improves the total protein content, and adds variety to the menu. As with other cereal-legume diets, sources of vitamins A, C, and riboflavin and of calcium are required.

Although the legumes are excellent foods they do contain some toxic substances. Fortunately, most of these are inactivated or reduced to safe levels by the usual cooking or processing procedures. However, two diseases are associated with consumption of certain legumes in some parts of the world: favism with Vicia faba (broad beans); and lathyrism with Lathyrus spp. (grass peavine, other) and, possibly, with Vicia sativa (vetch). In the case of favism, an important factor is an underlying hereditary defect in red blood cells; the precise etiology of lathyrism is still unknown.

NUTRITIVE VALUE OF NAVY BEANS

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In view of the importance of navy beans in total production and consumption in the U.S.A., it is important to study the nutritive value of this bean in detail. The results of proximate analysis show that navy bean is a good source of protein.

In vitro digestibility studies of raw and autoclaved navy bean flour by the action of digestive enzymes indicate that digestibility of raw bean by trypsin is increased by autoclaving. The increase in digestibility is maximum when bean is autoclaved for 5 minutes at 120°C. and minimum with autoclaving for 4 hours at 120°C.

The biological studies were carried out with young albino rats. Rats were fed casein as the standard reference protein and raw bean at the 10 percent protein level. Rats on a raw navy bean diet lost weight right from the beginning and died within 20 to 26 days. Rats fed autoclaved beans showed improved growth although not comparable to that of rats on a casein diet. The growth-promoting value is maximum when beans are autoclaved for 5 minutes at 120°C. and minimum for beans autoclaved for 4 hours at 120°C.

To find out whether the ill effect of raw navy bean could be overcome by inclusion of a good-quality protein, raw and autoclaved navy bean flours were mixed with casein in different proportions and fed to rats at the 10 percent protein level. The decrease in weights of rats was found to be proportional to the increase in the percentage of raw navy bean flour in the mixture.

Navy bean is deficient more or less in practically all essential amino acids, the maximum deficiency being that of methionine. Supplementation of raw navy bean flour with the essential amino acids even at the optimum level given by W. C. Rose did not support the growth of rats. Rats fed on the bean flour autoclaved for 5 minutes at 120°C., when supplemented with either methionine alone or along with other amino acids, show improved growth comparable to that of rats on casein diet.

Biological value of pulses is increased after germination, but in the case of navy beans no beneficial effect of germination was observed on its nutritive value. The effect of supplementation of raw bean flour with vitamin B_{12} and antibiotics on growth of rats was also studied. It was observed that antibiotics together with vitamin B_{12} and methionine supplementation support growth to a limited extent.

Thus, from all these experiments it might be concluded that (1) low nutritive value of raw navy beans is not due to the deficiency of amino acids, (2) but to the presence of toxic a factor or factors which are destroyed or inactivated after autoclaving, and that (3) autoclaved beans support the growth of rats and, when supplemented with methionine, they result in growth comparable to that of rats on a casein diet. Further work is in progress to isolate and to characterize the toxic factor or factors.

PROPERTIES OF ISOLATED DRY BEAN PROTEINS

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Last year I reported on methods of extraction and precipitation of the proteins of dry beans. Two procedures for obtaining bean proteins were compared. Protein was extracted at pH 7.0 or with 2 percent sodium chloride solution and the globulins were precipitated by adjusting the pH 7 extract to pH 3.8 or by dialyzing the sodium chloride extract. The lyophilized protein prepared by extraction at pH 7.0 and precipitation at pH 3.8 contained 11.9 percent of nitrogen, and the lyophilized filtrate contained 6.0 percent of nitrogen. Lyophilized protein extracted with a 2 percent solution of sodium chloride and precipitated by dialysis contained 14.6 percent of nitrogen, and the soluble protein contained 10.1 percent nitrogen. Sodium chloride solution extracted less high-molecular-weight nonprotein impurities than did water at pH 7.0 and was used in the present studies.

Ritthausen and Osborne extracted proteins from dried beans with sodium chloride solutions and then precipitated part of the extracted proteins either by diluting the solution with water or by saturating the solution with ammonium sulfate. Waterman, Johns, and Jones later separated the sodium-chloride-extracted proteins into three proteins--phaselin, phaseolin, and conphaseolin--by fractional precipitation with ammonium sulfate.

We isolated bean albumins and conphaseolin and phaseolin by a modification of the procedure of Waterman, Johns, and Jones. Finely ground bean seeds were extracted with 2 percent sodium chloride solution. The extract was dialyzed against distilled water to remove the sodium chloride. Globulins, which precipitated, were removed by centrifugation and the soluble albumins were dried by lyophilization. Ammonium sulfate was added to the dissolved globulins to bring the solution to 35 percent saturation. Conphaseolin precipitated and was removed by centrifugation. More ammonium sulfate was added to make the solution 55 percent saturated, and the protein that precipitated was removed and discarded. Phaseolin was precipitated from the solution by adding ammonium sulfate to 80 percent saturation.

Isolated bean proteins and protein fractions were studied by paper electrophoresis. Proteins were separated on Whatman No. 3MM filter paper in a Spinco Model R electrophoresis cell using a diethylbarbiturate buffer of pH 8.6. Protein bands were dyed with bromophenol blue. Most proteins of the albumin fraction migrated towards the anode or did not migrate, but the principal globulin band migrated towards the cathode. The main band migrated in a similar way for total globulins, conphaseolin, and phaseolin. Phaseolin differed from conphaseolin only in that it had no strong non-mobile band nor any band that migrated towards the anode.

Various bean proteins were chromatographed on diethylaminoethyl (DEAE) cellulose columns. Protein, dissolved in 0.01M phosphate buffer of pH 7.6 was applied to the column and eluted with 0.01M phosphate buffer until the first protein was eluted (about 250 ml.). A salt gradient was then applied by allowing buffer containing 0.3M sodium chloride to replace buffer flowing from the mixing chamber. Ten-ml. samples were obtained, and the optical density was determined in the Beckman DU spectrophotometer at 280 mμ.

The principal protein of bean albumins was eluted at about tube No. 10. Three other proteins with peaks at tubes 45, 58, and 66 were eluted with increasing sodium chloride concentration. Total globulins contained a small amount of protein that emerged with a peak at tube No. 10 and a large amount that emerged between tubes 50 and 70 with a peak at tube 60. Several other poorly resolved peaks were observed between tubes 50 and 70 in the early studies, but in later separations, when refrigerated columns and fraction collectors were used, only one peak was obtained starting at tube 50 and ending at tube 70.

Conphaseolin was separated by chromatography on DEAE-cellulose into a fraction that emerged at about tube 10 and fractions that emerged with peaks at tubes 40, 50, and 60. The tube 40, 50, and 60 peaks were not resolved when the refrigerated column was used in later work. Phaseolin was separated on the DEAE-cellulose column into two small fractions that emerged at tubes 10 and 35 and a large fraction that emerged with a peak at tube 55. The tube 35 peak was not obtained when refrigeration was used in a later study.

The protein eluted at tube 10 appears to be albumin, and when it was obtained from conphaseolin and phaseolin, it was present in them as an impurity. Most of the protein of both conphaseolin and phaseolin was eluted between tubes 40 and 60. We are still trying again to separate further the protein emerging in this region, but we have not yet been successful since we started using refrigeration. None of the electrophoretic or chromatographic data presented has shown any difference between conphaseolin and phaseolin that could not be explained from albumin contamination.

To explore the possibility that there are no differences between conphaseolin and phaseolin, amino acid determinations were made on the bean proteins by the chromatographic procedure of Moore and Stein. Proteins were hydrolyzed with 20 percent hydrochloric acid by heating in the autoclave at 121°C. for 6 hours. Cystine, serine, threonine, tryptophan, and valine were concentrated in the albumin fraction. The globulin fraction contained a lower concentration of cystine and tryptophan and a higher concentration of leucine and phenylalanine than whole beans. The amino acid content of conphaseolin and phaseolin were quite different. Conphaseolin contained 3.5 times as much cystine and 7 times as much tryptophan as phaseolin, and phaseolin contained more aspartic acid, glutamic acid, isoleucine, leucine, and phenylalanine than conphaseolin. It appears highly improbable that albumin contamination of conphaseolin could be the cause of these differences in amino acid content.

CHEMICAL AND PHYSICAL CHANGES ASSOCIATED WITH PROCESSING OF LARGE, DRY LIMA BEANS

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The principal objectives of the chemical investigations on large, dry Lima beans have been to attempt to discover chemical properties which may be related to: (a) variations in the cooking rate and other physical properties and (b) the flatus-inducing properties generally associated with the ingestion of recipes containing dry beans.

Based on the subjective judgments that hydrated, dry beans require longer cooking and produce greater flatus than their immature, green counterparts, emphasis has been given to comparisons of the chemical properties of fresh immature green and dry mature white Lima beans. A number of chemical differences have been discovered, including variations in quality or quantity of several sulfur-containing nitrogenous constituents. Several of these have been tested pharmacologically and appear to produce effects that support the premise that they may be related to the flatus-inducing properties of dry beans. However, the proof of a relationship between chemical composition and physical characteristics, such as cooking rates, is predicated upon the availability of sensitive, precise, and convenient objective methods for estimating these chemical and physical properties. Satisfactory chromatographic and ion-exchange techniques have been developed for the measurement of chemical changes. The Mattson-Morris bean cooker (see speech by H. J. Morris in this report) provides one technique for the estimation of the cooking rates of beans during immersion in boiling water. A supplementary technique, which provides some additional information on the cooking rates of dry Lima beans, has been developed during the past year. The procedure employs the L.E.E.-Kramer automatic recording shear press.

Beans held in boiling water for varying lengths of time were cooled to ambient temperature, divided into 100-gram samples, and evaluated for tenderness under the shear press. It was found possible to estimate the relative tenderization rates of seed coats and cotyledons independently in a single determination and thereby obtain information on the relative importance of each tissue in the cooking process. The measurement of the total work required to shear whole beans was found to be the most satisfactory and reproducible measure of the cooking rates of hydrated dry Lima beans. It was shown that immature green beans require only about 60 percent as much time to reach the same tenderness as the hydrated mature Lima bean. In addition, it was shown that a control sample of Lima beans containing 9.9 percent moisture required only about one-fifth the time required to cook beans which contained 13.3 percent moisture and had been allowed to stand for 5 months at 90°F.

All previous work had failed to demonstrate a clear sensitive relationship between the chemical properties of dry beans and their cooking rates. However, during the past year, it has been demonstrated that the proteins, which comprise an important portion of the bean, undergo significant changes during maturation of the bean as well as during storage at 90°F. and at an elevated moisture level. In addition profound changes were observed in the proteins during cooking. Therefore, for the first time a definitive, major chemical change has been found which appears to be associated with cooking rates of dry beans. This work has provided not only a basis for attempts to modify the factors related to bean tenderization but also the background for the ultimate development of processes for the preparation of quick-cooking and precooked bean products.

COOKING QUALITIES OF DRY BEANS

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In the third century B.C., Theophrastus (7) referred to beans as "cookable" or "uncookable" and he also recognized that certain conditions of climate may cause this variation. He stated that "In the district of Philippi, if the beans while winnowed are caught by the prevailing wind of the country, they become uncookable, having previously been cookable."

In 1936 Edna B. Snyder (6) at Nebraska Agricultural Experiment Station stated that "there appears to be a popular idea that old beans are difficult to cook." She also stated that "beans stored under laboratory conditions of temperature and moisture became so hard that they could <u>not</u> be cooked satisfactorily." She received several lots of beans from a local cannery with the report that they could not be softened satisfactorily for canning.

In 1927 Bigelow and Fitzgerald (1) of the National Canners Association reported that "generally, when beans are processed at 240°F. till well cooked and soft, it may be assumed that they are sterile. On the other hand, after the product is known to be sterile, it is often necessary to continue processing to soften the beans." This statement has been difficult to understand, since all the beans used in our research have cooked satisfactorily in less than the time required for sterilization.

Several years ago we studied the effect of moisture content on the keeping qualities of six varieties of beans (4). Following a standard cooking procedure the samples were appraised subjectively by a panel of trained judges for flavor and texture. As the study progressed the highest-moisture samples of each variety received lower texture scores, which meant the beans were not adequately cooked by the procedure that was satisfactory initially. In contrast the lower moisture samples remained good in quality. These results indicated that moisture content of beans plays an important role in their quality maintenance, but since the results were based on subjective appraisal the magnitude of the change was not assessed.

A comprehensive study was conducted by Paul Muneta (5) recently at the Idaho Experiment Station under contract with the Western Regional Research Laboratory to learn whether cooking times of different legumes are correlated with their composition. Of many factors studied the one found to be correlated with cooking time was moisture in the highest-moisture samples. One Michelite and one pinto sample containing 13.4 and 12.6 percent moisture, respectively, required more than twice the cooking requirement of all the lower-moisture samples. However, all samples were over a year old when data were obtained; hence the results may not reflect freshly harvested cookability.

All these observations indicated the importance of moisture in the processing quality of beans. The observations, however, have been mostly qualitative, and generally subjective in nature; hence they have not enabled an accurate quantitative appraisal of the role moisture plays in changes in processing quality of beans.

Sometimes an advance in methodology stimulates and facilitates work in a needed area. An experimental bean cooker made in our shops, based on the principle reported by Mattson of Sweden (3), has made it possible for us to study objectively the cooking characteristics of beans. Since acquiring this facility we have been studying changes in the processing quality of beans as a function of their moisture content. Results of this study follow.

Experimental Procedure

Material. Sanilac, pinto, and large Lima beans were obtained as quickly after harvest as practical from major growing areas. Each variety was adjusted to five moisture levels (Table 1) in the 8 to 14 percent range by mill drying or exposure to humid air as required. Samples of each moisture level were held at 70°F. and 90°F. The cookability of freshly harvested beans was compared with cookabilities at intervals after harvest.

Table 1. Varieties and moisture contents

	Moisture, %	Approx. R.H., %
	6.5	11
	8.1	25
Pintos	10.2	43
	13.3	63
	14.4	70
	8.1	25
	10.6	49
Sanilacs	11.5	55
	13.3	63
	14.2	68
	8.0	25
	9.9	40
Large Limas	11.4	53
	12.3	58
	13.3	63

Cooking method. The design of the bean cooker makes it possible to observe the time required to soften the bean to a cooked texture. Measuring the cooking times objectively allows one to compare results obtained at different times.

The complete cooker assembly is shown in Figure 1. One unit is shown in Figure 2. The plunger is supported by the bean until the bean acquires a cooked texture. A cooking run is made by observing the rate the beans in a sample are penetrated. The results of a cooking run are illustrated in Figure 3. The percent cooked plotted against the cooking time gives an S-shaped curve. On a curve like this the most accurately established point is the time for a 50 percent cook. For this reason the 50 percent cooking time has been selected as the reference point for relative cookability of different samples. Most of the data to be presented are the averages of three cooking runs for each set of conditions.

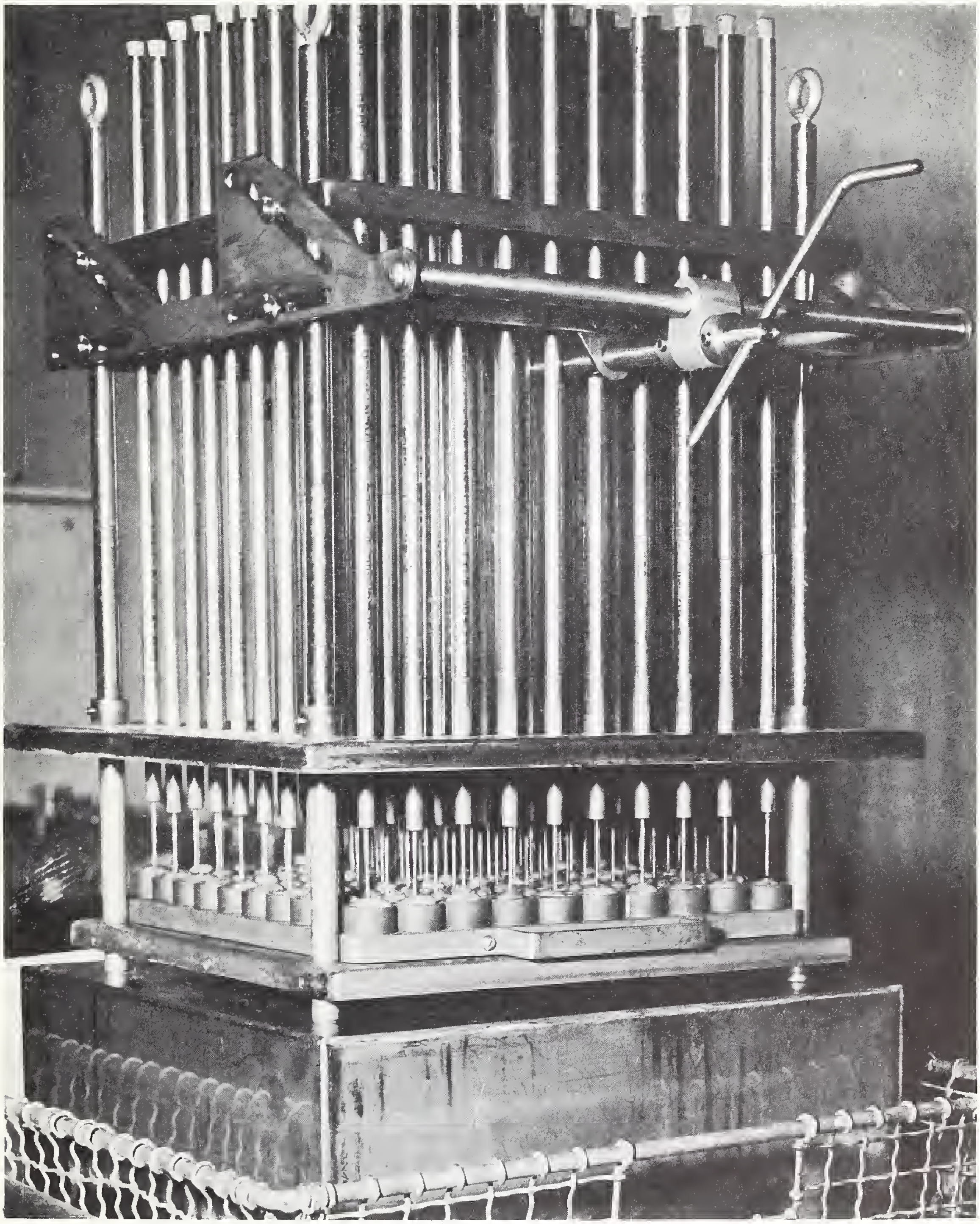

Figure 1. Complete cooker used in research. The plungers penetrate the beans when they are cooked.

Figure 2. A single unit of the bean cooker, showing plunger and bean in place.

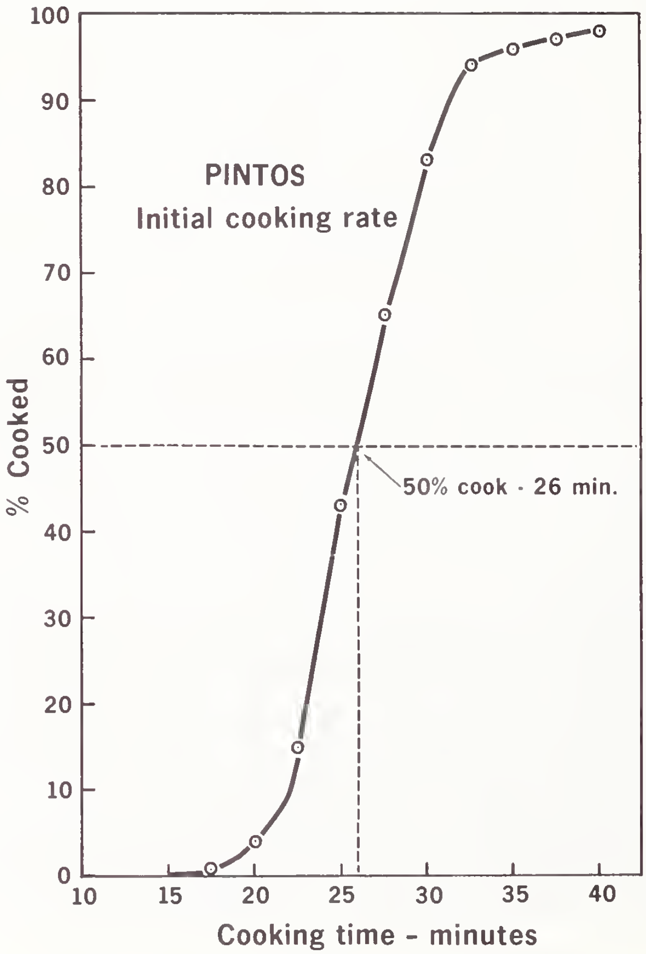

Figure 3. Typical plot of results of cooking test on a sample of pintos.

Each sample was cooked with and without prior soaking. The soaking period when used was 16 hours. Cookability changes are reflected in both soaked and unsoaked beans; therefore, in order to save time results are reported for soaked beans only. In some instances detailed data will be presented for only one variety; however, similar data are available for the other two varieties and will be shown in summary charts.

Experimental results. The cooking times for four-months-old pinto beans are shown in Table 2. The three lowest moisture samples showed no change. The highest-moisture samples changed significantly, the largest observed change occurring at 90°F. in the 14.4 percent moisture sample. Similar data for sanilacs are included in Table 2. Again the largest changes occurred in the highest-moisture samples at 90°F. The four-months data for large Limas (also Table 2) follow the trend observed for pintos and sanilacs. The data for these three varieties indicate clearly that little change occurs in the cooking requirements of low-moisture beans in four months, whereas in the 13 to 14 percent moisture range the cooking time may double or triple in four months at 90°F.

Table 2. Effect of moisture content on cooking time of beans held at 70° and 90°F. for 4 months

	Moisture, %	Minutes for 50% cook	
		70°F.	90°F.
Pintos	6.5	24	27
	8.1	24	27
	10.2	24	27
	13.3	27	34
	14.4	37	44
Sanilacs	8.5	25	31
	10.6	28	33
	11.5	30	40
	13.2	33	60
	14.2	--	80
Large Limas	8.0	12	14
	9.9	12	18
	11.4	13	23
	12.6	14	35
	13.3	16	43

Results for pintos after nine months at 90°F. are shown in Figure 4. Data for the complete cooking runs are plotted to help you visualize the magnitude of the results. Here again the three lower-moisture samples changed very little and are all similar in cooking characteristics. Contrasted with these are the results for the two highest-moisture samples. The time for 50 percent cook for the 13.3 percent moisture sample was about three times those for the lowest-moisture sample. Furthermore about 20 percent of the beans did not cook, even with prolonged heating. The 14.4 percent moisture sample showed much larger loss in cookability than the 13.3 percent sample. The 50 percent cook time was about 5 hours. Nearly one-half the beans failed to cook during an 8-hour day.

The data for pinto beans held at 90°F. can be viewed in another way as shown in Figure 5. Here the minutes for 50 percent cook are plotted against storage time. These curves indicate the rate of change in cookability for the respective moisture levels. They emphasize the value low moisture content has on retention of good cookability.

Still another way to view these data is to plot percent moisture against time for 50 percent cook as shown in Figure 6. In addition to showing the relationship between percent moisture and changes in cookability, the value of storing beans at a lower temperature is indicated by the lower curve. Thus where it is not possible to lower the moisture content sufficiently to prevent severe loss in cookability, lowering the temperature <u>may</u> offer a means of retarding the rate of change.

Perhaps sufficient selected data have been presented to indicate the changes in processing quality that may result at different moisture levels. All the data for the three varieties have been summarized in Figures 7, 8, and 9. These bar graphs illustrate the time for 50 percent cook, initially and at two time intervals for each sample at each temperature. Again it is apparent that moisture content and storage temperature play a most important role in relation to changes in processing quality of dry beans. Figure 7 shows summary data for pintos, Figure 8 for sanilacs, and Figure 9 for large Limas. The same pattern of change was observed for sanilacs as for pintos. The results for Limas are similar to those for pintos and sanilacs. All results presented thus far were obtained on soaked whole beans. To establish the relative importance of the seedcoat versus the cotyledons in changes in cookability, two samples were cooked with and without the seedcoat intact. The results are shown in Figure 10 and Table 3. With the seedcoats intact pinto beans of 6.5 and 14.4 percent moisture held 11 months at 90°F. showed an 11-fold difference in the 50 percent cook time; without the seedcoat the cotyledons showed a 10-fold difference. Thus changes in the cotyledons are responsible for most of the changes in cookability of the high moisture sample.

Table 3. Pintos stored 11 months at 90°F.

Moisture, %	Soaked - Cooked: With seedcoat	Soaked - Cooked: Without seedcoat	Ratio
	Minutes for 50% cook		
6.5	29	16	Approx. 2
14.4	320	160	2
Ratio	Approx. 11	10	

<u>Discussion</u>. The three varieties used in these studies were selected as fairly representative of dry beans in general. Since the same pattern was observed for all three varieties, one would expect that other varieties would behave in like manner. In addition to loss in cookability, other changes are known to occur in high-moisture beans. Our earlier work (4) showed that high-moisture beans developed off flavor, increased in fat acidity, and showed a loss in their phosphatase and catalase activities. Some of these earlier

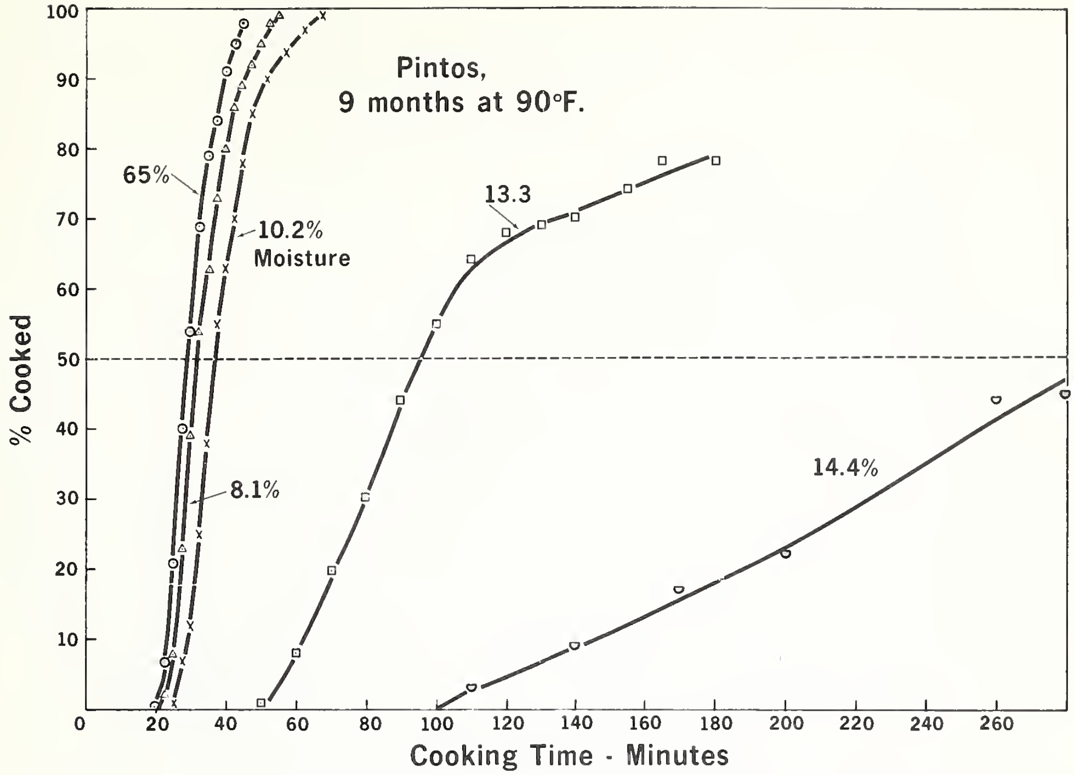

Figure 4. Cooking-test results on pintos held 9 months at 90°F. at varied moisture contents.

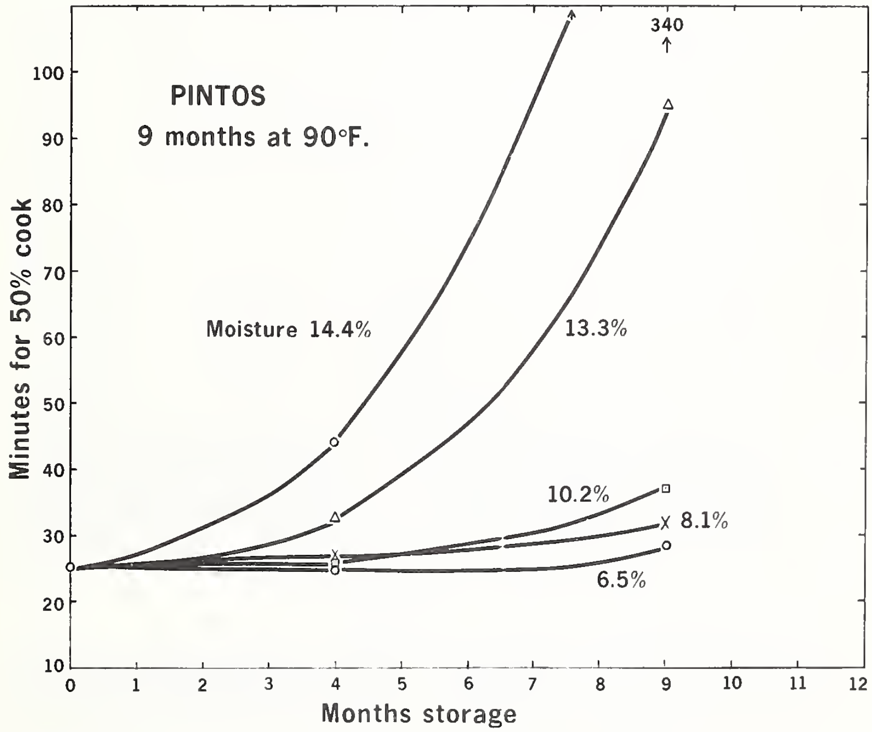

Figure 5. Results shown in Figure 4 are here plotted against time required for a 50 percent cook.

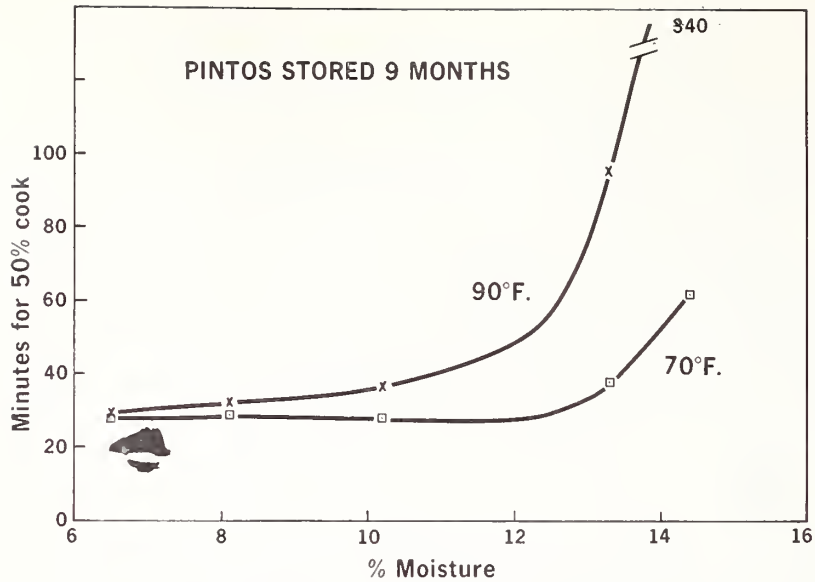

Figure 6. Results with moisture content plotted against time for a 50 percent cook.

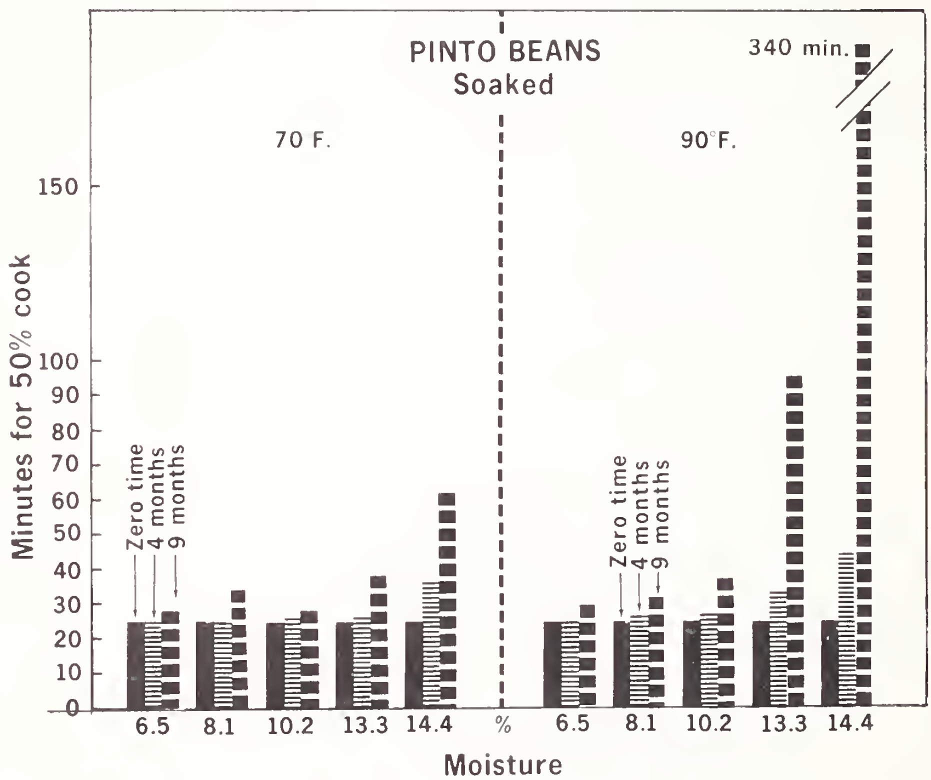

Figure 7. Summarized data for pintos.

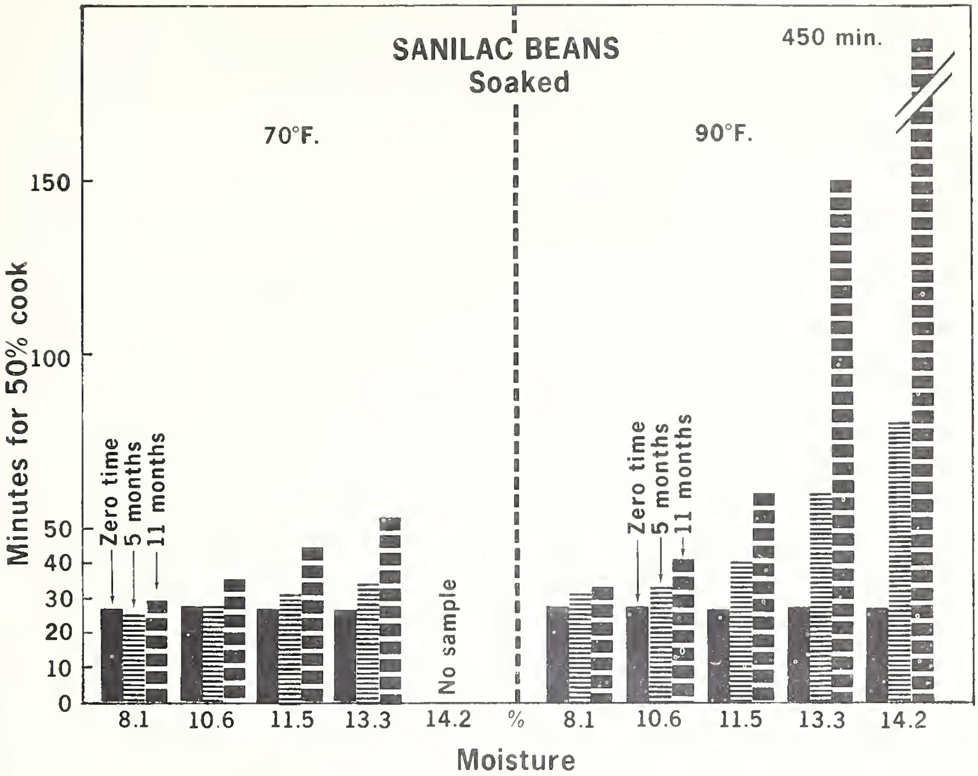

Figure 8. Summarized data for sanilacs.

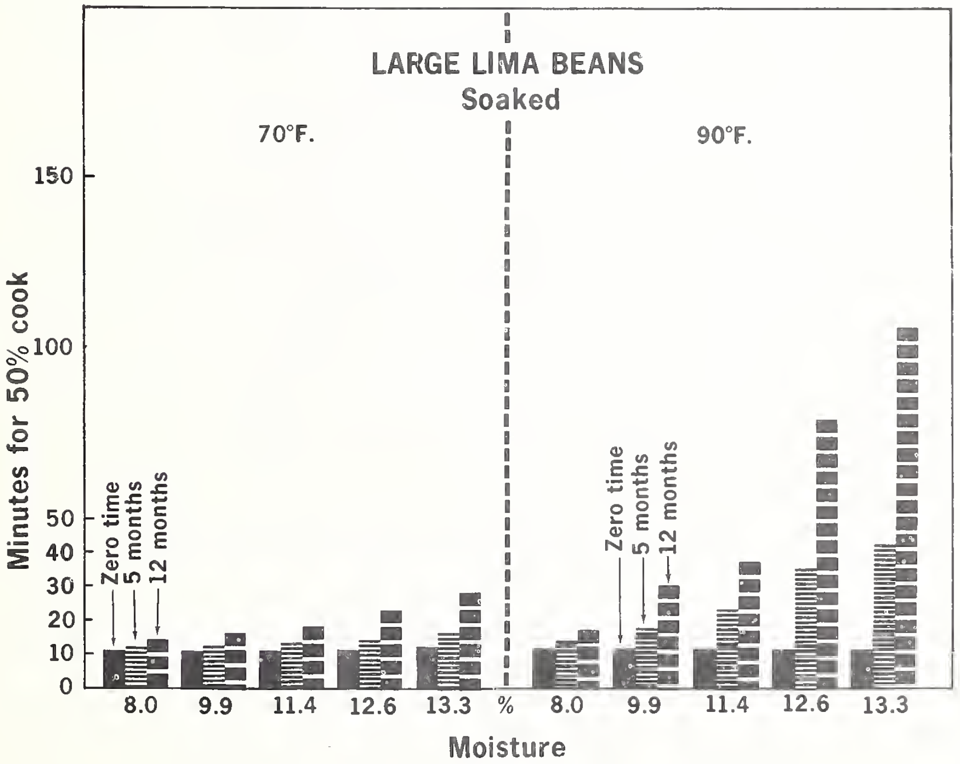

Figure 9. Summarized data for large Limas.

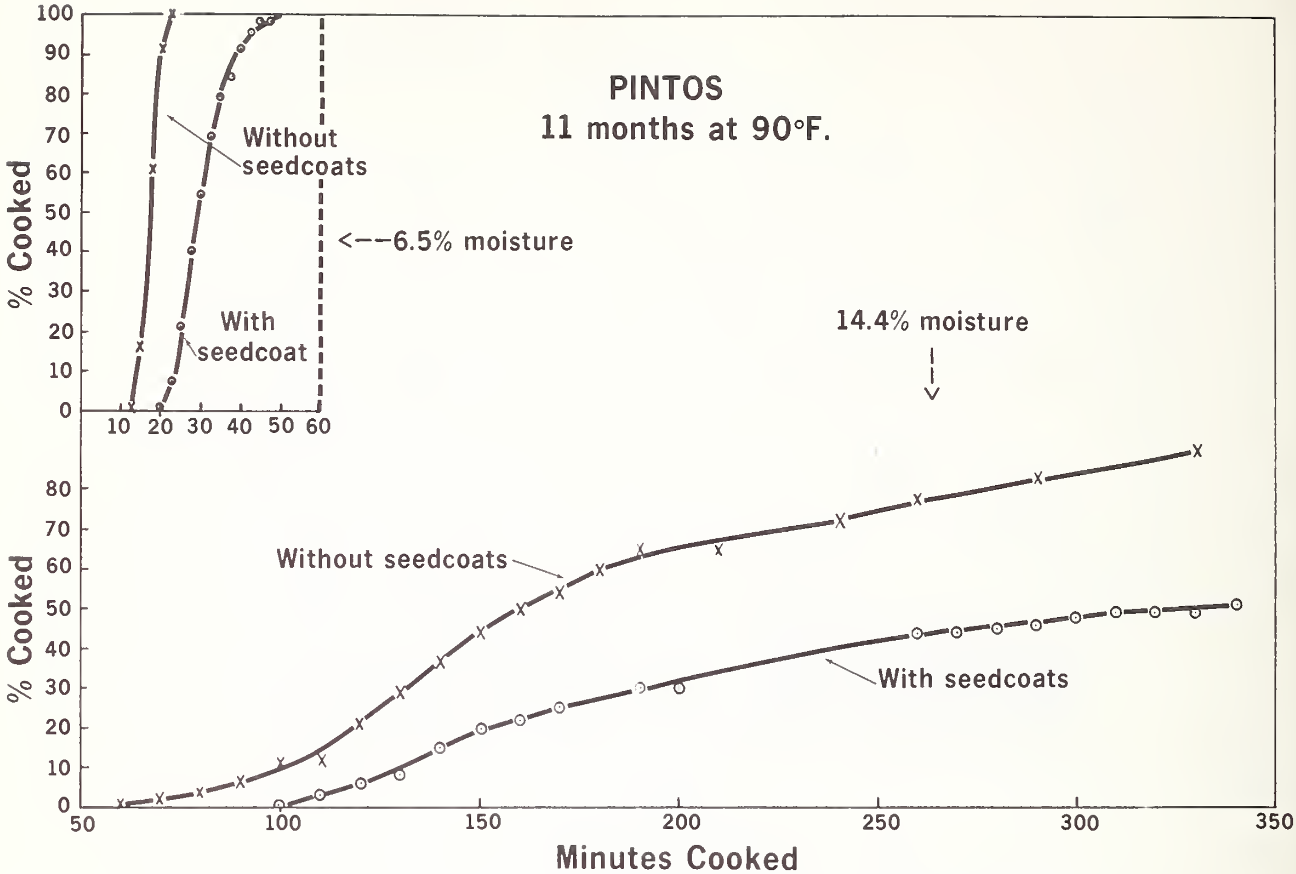

Figure 10. Cooking tests with and without seedcoats intact.

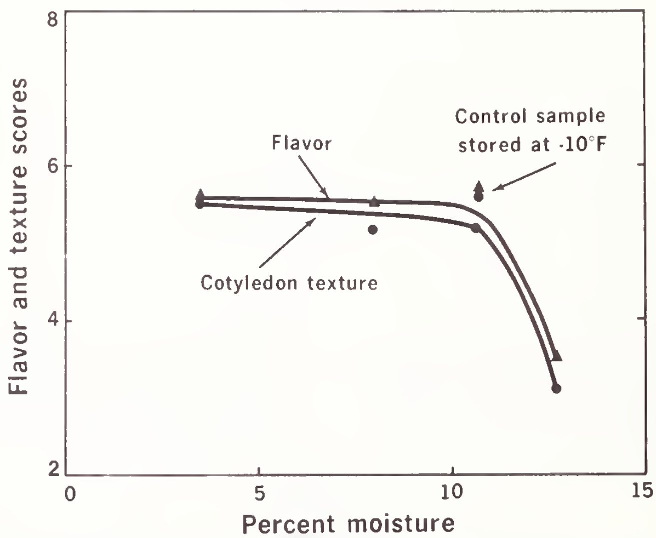

Figure 11. Effect of moisture content on flavor and texture of Great Northerns stored a year at 77°F.

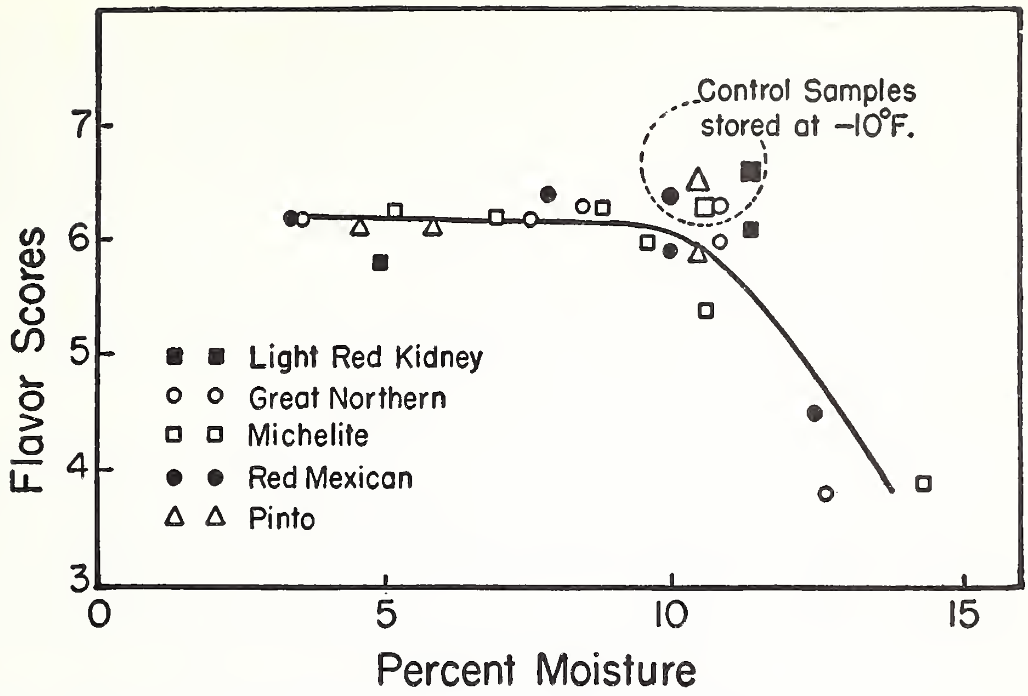

Figure 12. Flavor scores vs. moisture content, beans stored 2 years at 77°F.

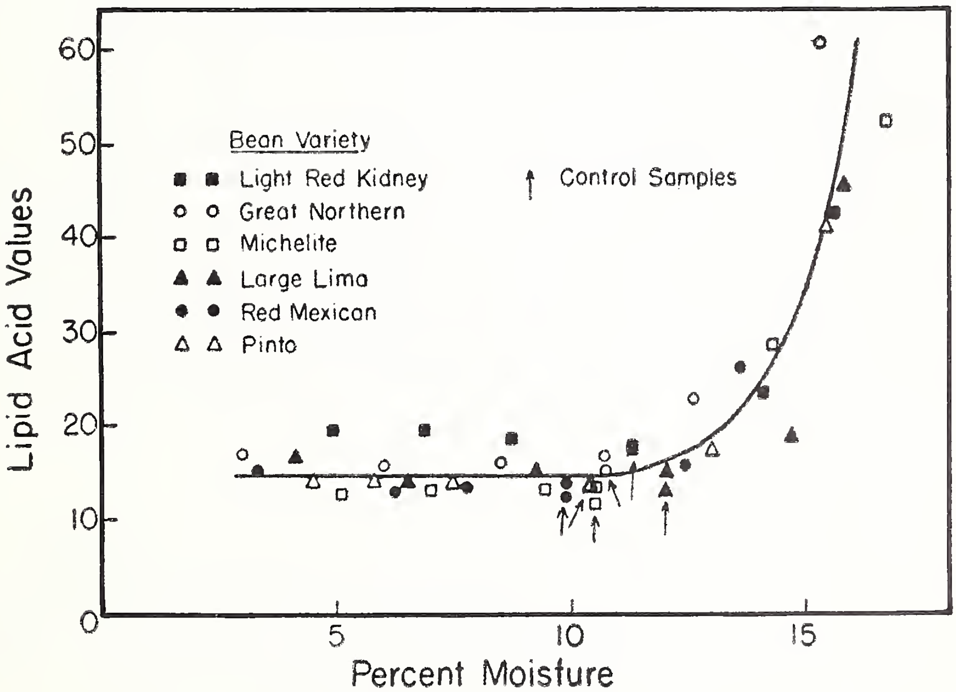

Figure 13. Lipid acid values vs. moisture content, beans stored 2 years at 77°F.

results are shown in Figures 11, 12, and 13. Figure 11 shows the flavor scores of Great Northern beans stored one year at 77°F. Below 10 percent moisture the flavor was retained almost as well as in the control sample stored at -10°F. There was a significant change in flavor as the moisture increased. Figure 12 summarizes the flavor results for five varieties stored two years at 77°F. Again all these data indicate the advantage of low moisture in maintenance of good flavor.

The fat acidity values for six varieties stored two years at 77°F. are shown in Figure 13. In the moisture range where beans retain good flavor, the fat acidity remains fairly constant but shows large increases in beans that develop much off flavor.

The cookability data, flavor results, and changes in lipid acidity all indicate the complexity of the changes that can occur in beans as the moisture content increases. Since changes in these quality factors are not apparent from the appearance of the beans, their appraisal is much more difficult than visual signs of deterioration such as mold growth. These unseen changes however may greatly impair the processing quality of beans. Such changes no doubt were responsible for the complaint a canner reported to Mrs. Snyder (6) at the Nebraska Experiment Station, for several lots of beans. The complaint was that "they could not be softened satisfactorily for canning." Mrs. Snyder also reported that some beans stored in the laboratory "became so hard that they could not be cooked satisfactorily." Another example is the statement in the National Canners Association bulletin by Bigelow and Fitzgerald (1) that "after the product is known to be sterile, it is often necessary to continue processing to soften the beans."

Another aspect that should be considered is nutritive value. Even though I may be getting out of my field in discussing nutrition, I would like to call attention to the recognized relationship between cooking time and nutritive value. E. M. Lantz (2) of the New Mexico Experiment Station reported that thiamine destruction was increased by long cooking of pinto beans. The biological value of proteins is usually impaired by excessive heating; hence beans that require a prolonged cooking time would probably be less nutritious than quicker cooking beans. Finally I would like to suggest that you eat as many beans as you can, and what you can not eat, can, but do it while they have good quality.

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WHAT'S NEWS IN THE DRY BEAN INDUSTRY

Ella Lehr Nisja
Home Economics Director, Idaho Bean Commission

The biggest news in the dry bean industry today is that BEANS ARE IN THE NEWS! It is of special interest to growers, dealers, and marketers of dry beans, and to research workers as well, that women's television program directors are showing their audiences how to make "Burgundy Beans." Radio folk, with hints on cooking and serving, are helping their listeners to "know beans when the bag's open." Newspaper food editors from Alaska to Hawaii and across the nation head their pages "Beans are welcome tasty bargains," "Piggy bank bean pot -- a good hearty favorite," "Dry beans a bonus in good eating qualities," "Buckaroo beans a barbecue favorite," "Poppa's specialty -- Caesar salad with beans," "A dish for gourmets -- fabulous red bean soup."... Women's service magazines are devoting pages to alluring recipes and pretty pictures in full color using

-- yes, dry beans! Bean features are appearing in publications of the mass-feeding field: Restaurant Management, Institutions, Fast Foods, and the like.

It is of more than special interest to the IDAHO BEAN COMMISSION when food features are captioned "Farm fields in Idaho are full of beans," "Idaho beans are versatile," "Chili beans, Sun Valley-style second to none," "Idaho's bean bag biggest in the nation" (though the food editor did take a slight bit of liberty in her copy!). When a lead paragraph reads "If you aren't acquainted with Idaho's dappled beans known as "pintos," a pot of Buckaroo Beans made with this western favorite will provide a perfect introduction and lead you into meeting others of the famous Idaho Bean Family."... when television recipes mention "Idaho's unusual large white Great Northern Beans" and radio girls introduce "The Bean Family of Idaho.".. when a publication features an Idaho restaurant's savings on meat if a hearty bean dish is alongside on the buffet table, and another gives credit to the IDAHO BEAN COMMISSION for illustration, recipe and factual materials... and when mail bags bring in hundreds of post-cards asking for the booklet mentioned in the daily newspaper, free for the asking, "BEANS MAKE THE MEAL -- a Collection of Whole-Meal Bean Dishes from the Bean Commission of Idaho, U.S.A." ... well, we are convinced that dry beans are in the news.

All this has not come about overnight, nor will it continue without the long-range planning which has been back of the IDAHO BEAN COMMISSION'S promotion program since its inception two and a half years ago. For, despite Boston's stately tradition -- "the home of the bean and the cod" -- and despite too the part which dry beans played in establishing our western frontiers, interest in bean dishes has declined steadily over the years, suffering a severe status setback indeed from the bean-eating days of the depression.

In this era of TV dinners, quick mixes, instant foods, countless taken-for-granted items in cans, in jars, in freezer sections -- ready to serve with little more than a twist of the wrist -- and with more and more women working outside their homes, it takes a bit of doing to get Mrs. Homemaker to give even a passing glance at the poorly displayed packages of dry beans on her grocer's shelves. And yet, because of women's inherent creative ability, desire for the unusual and for eating pleasure for family and friends, she is always on the alert for something new and different.

Beans aren't new. But they can be different! From the variety of materials sent by the IDAHO BEAN COMMISSION to the various channels of communication (the best of which has long been "Tell-a-Woman,") women have learned that dry beans are versatile, adaptable, economical, nutritious, and just plain (and fancy) good eating! Never underestimate the power of a recipe! And also the type of chit-chat that tells her the modern methods of cooking beans -- quick, convenient, accommodating. The serving of dry beans has been up-dated to fit into modern living -- barbecues, buffet meals, porch or pool-side suppers, cooking for two or twenty. Travel has sharpened interest in foreign cookery. Beans can well provide a "cook's tour." Beans have been shown in reducing diets - high protein, you know. Table appointments for bean menus range from paper plates to an elegant silver chafing dish. Our beans do not go in for class distinction. Nor should they!

All of this stimulation by way of appeal to the home consumer is bringing about another reaction -- a heartening interest in the use of dry beans in the meal planning of the mass-feeding field. For smart operators realize that now the appearance of bean dishes on the menus of their eating establishments will be met with the type of approval which means a merry jingle of the cash register. The low cost of beans, their happy alliance with so many foods, their versatility, ease of preparation, and their popularity are all important items in today's high operating costs in this bean eating field -- neglected except by canners of baked beans, chili beans, bean soups. There's no end to the possibilities of selling dry beans in this field -- with the proper approach of course. The IDAHO BEAN COMMISSION is doing some road work!

New bean products. Here in this area of mass-feeding as well as in the home consumer field is where the possible new bean products will indeed make NEWS -- welcome to all connected in any way with the dry bean industry. Initiated by the Western Utilization Research and Development Division of the Agricultural Research Service of USDA at Albany, California are two types of new products using dry beans -- (1) Quick-cooking Beans -- really quick cooking; and (2) Instant Bean Powders -- and they are just that.

The quick-cooking bean project was taken on by the IDAHO BEAN COMMISSION and the products developed to a completely satisfactory stage by the Stanford Research Institute. The process was patented by the Commission and work is in the development period for commercial production. The possibilities of these products need no comment, I am sure. They will draw additional interest to our regular dry bean promotion on Idaho's famous Pink, Red and Great Northern Beans.

The instant bean powders are of extreme interest, offering uses far beyond the soup field which is one of the first things thought of. Just stir a given quantity of any one of the varieties of Bean Powders into boiling water, the amount of water varying with the intended use. Soup, yes -- it's good and instant! A little less water and one has a puree which may be of mashed potato consistency and can replace mashed potatoes as a meat accompaniment, giving an additional bonus over the usual vegetable service of high protein! Served piping hot with a dollop of butter atop, here is a dish which may be served with meat, fish or fowl. This puree is perfect for fried and re-fried beans which, incidentally, should not be confined to Mexican menus.

From the work which I have done with these powders, here are some of the results:

1. Bean dips. We make a robust bean dip using the pinto or red bean powder, cheese, butter, and green chiles that's a real "prairie fire" but mighty tasty with cool beverages.
2. Bean breads. Bean puree is used like mashed potatoes in the making of yeast rolls -- delicious and nutritious. Puree or the powder itself can be used in quick breads.
3. Bean casserole dishes. These range from the fragile souffle to hearty custard combinations with little or no meat in them but sufficient for a main course dish.
4. Bean powders as protein extenders. Excellent meat loaves and meat balls have been made with a bean powder used in place of bread crumbs or rolled

oats of the usual recipe. The homemaker will be quick to see that she is extending the protein of her meat dish at a very low cost.

5. Bean powders for thickening of gravies and sauces. For the coatings of chops, chicken, etc., in place of flour or crumbs. The more uses a homemaker can find for a product, the more likely she is to buy it.

6. Bean powders as meat replacements. Croquettes are one of these, Bean Custard in a Pastry Shell another. There are many others. In these dishes, we dutifully use some small amount of animal protein -- cheese, a little meat, either as an ingredient or as a sauce to make of the bean dish a completely usable protein.

With interest in bean products such as these two, there will be more to come. But with the daily addition of new products of all kinds to our grocers' shelves, there is a need for great care in the development of really fine products, in the merchandising and in their promotion. They will be successful only with a general acceptance of dry beans on menus. This means that everyone connected in any fashion with the dry bean industry must work toward consumer interest and -- sales! And he must be proud of the food in which he has any part in producing.

We in Idaho are very proud of our beans -- naturally. For Nature herself has seen to it that Idaho has top growing conditions for this fabulous crop -- climate, high altitudes, rich volcanic ash soil. Man has provided controlled moisture conditions through irrigation and tender, loving care. Sun, Soil, and Water -- wouldn't these add up to plump perfect beans with finer flavor, high nutritive value, real eating pleasure! Here's to GOOD EATING -- with beans!

CURRENT RESEARCH ON FLATULENCE

Horace K. Burr
Western Regional Research Laboratory, USDA, Albany, California

A major problem of the dry bean industry is the reputation which beans have of being "gassy," or causing flatulence. It appears certain that a great many people avoid eating beans, or eat fewer than they would like to, because they dislike the after-effects. The Western Utilization Research and Development Division has attacked this problem through research, some of it carried out in our own facilities, and some through research contracts with the University of Illinois and Stanford Research Institute.

Professor F. R. Steggerda (U. Ill.) conducted the first extensive, quantitative studies in this area. Among other things he established beyond question that (1) eating beans does cause flatulence in man; (2) the amount of intestinal gas released is roughly proportional to the amount of beans in the diet; (3) prolonged cooking (canned baked beans) does not reduce the flatulence effect in comparison to minimum cooking (canned pork and beans); (4) homogenizing cooked beans so as to rupture cell walls does not reduce their tendency to cause flatulence; (5) dry Lima beans cause as much gas as dry common beans; and (6) on a continuous bean diet a human subject shows a very large increase in the amount of intestinal carbon dioxide and substantial increases in hydrogen, methane, nitrogen, and oxygen. Under a new research contract Dr. Steggerda is now developing simpler and more rapid methods of measuring flatulence and is studying the basic physiological mechanism involved.

Workers at Stanford Research Institute found that there is a sharp rise in the concentration of hydrogen in the exhaled breath a few hours after human subjects eat beans. This coincides with the appearance of flatulence and feelings of distress. They also observed an increase in breath methane, but this occurred 18 to 42 hours after the bean meal and was most pronounced only in subjects with slow intestinal motility.

In our research at Albany, Calif., cooked beans are being separated into various classes of compounds by successive extractions with different solvents and testing each fraction for flatulence activity both in experimental animals and with human volunteers. Each active fraction will then be further separated into subfractions for testing. In this way the constituents responsible for flatulence will be isolated and their chemical identity determined. So far we have found that the activity is not soluble in ether (a fat solvent) but can be completely extracted from beans with 60 percent alcohol.

In addition to this systematic approach to the problem, individual sulfur-containing compounds previously isolated from Lima beans by our scientists at Pasadena are being tested with experimental animals. The techniques used in this work have been improved so as to make possible quantitative measurements of the gas and/or liquid accumulated in the animal's intestines. Several of the sulfur compounds and gross fractions from beans are being found to produce gas as well as such evidence of intestinal irritation as more rapid contractions, increased blood supply, and the accumulation of mucus.

Of several recipes reputed to reduce the flatulence-producing tendencies of beans, three have been given a preliminary test with human volunteers. None appears to be effective, but these tests need to be confirmed by repetition with additional subjects. Just why eating beans causes flatulence remains a fascinating and baffling question, but we are confident that through research we shall find the answer to the mystery and a solution to the practical problem.

EFFECTS OF CERTAIN DRUGS ON FLATUS PRODUCTION WHILE ON BEANS

F. R. Steggerda
Department of Physiology and Biophysics, University of Illinois, Urbana

In previous studies it was shown that when adult male subjects changed from a low-flatulence-producing diet to one that contained over 50 percent pork and beans, the hourly volume of flatulence production was markedly increased and most of the excess gas was carbon dioxide.

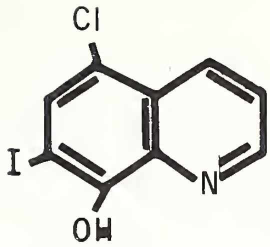
This same general trend was observed in later experiments on five other male subjects and served as a basis for the observations to be reported here. The average data show that the hourly flatulence production was 12 cc. per hour, but on a diet containing 37 percent pork and beans the average flatulence production increased to 111 cc. per hour. It was also observed that the percentage of flatus carbon dioxide of the control diet was very seldom above 10 to 12 percent, whereas, when the subjects were on diets consisting of pork and beans for six days, the flatus often contained 40 to 60 percent carbon dioxide.

The origin or mechanism of production of these high concentrations of carbon dioxide has been a subject of much concern and discussion. On the basis of a number of experiments it seems logical to the author that the high concentrations of carbon dioxide can be accounted for as coming from the high bicarbonate secretions of the pancreas, and that when beans are consumed they either stimulate the flow of pancreatic secretion or in some way decrease the time allowed for the normal absorption of the carbon dioxide from the gastro-intestinal tract into the blood stream. This hypothesis does not support the more prevalent belief that the carbon dioxide concentration levels of flatus are closely associated with the microfloral populations of the gastro-intestinal tract and that beans may in some way be involved in the mechanism. Hedin and Adachi refer to this possibility in their recent 1962 publication (1).

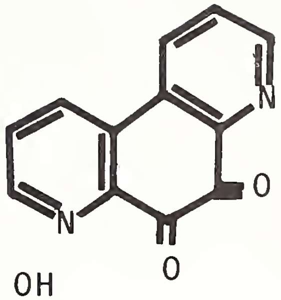
To test the validity of the proposed mechanism further in humans, an experiment was designed in which flatulence and its chemical composition were first recorded on five subjects who consumed diets containing 37 percent pork and beans for 6 days and then continued for another 6 days on the same diet with the daily addition of 8 tablets of Mexaform (supplied by Ciba Pharmaceutical Products, Inc., Summit, N. J.). This preparation consists of a mixture of 3 synthetic compounds: Vioform and Entobax with antibacterial and antiprotozoal activity, respectively, and Antrenyl, an antispasmodic (2). The compound is said to exert a curative effect upon various types of infectious enteritis by causing a marked increased stimulation of the normal bacterial flora of the intestinal tract, thus suppressing the growth of various pathogenic micro-organisms. Whatever the exact mechanism of action of the Mexaform may be, it is logical that if it does increase the microfloral population of the intestine and if carbon dioxide production does bear a direct relationship to the microflora of the intestine, one should get an increased production of carbon dioxide over and above that which could be obtained when consuming pork and beans alone without the addition of the drug.

Components of Mexaform

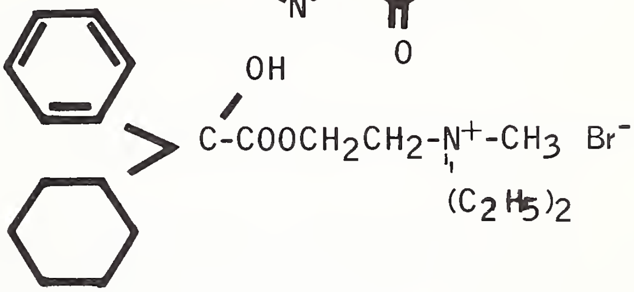
Vioform



Entobax



Antrenyl



The actual results on five adult male subjects showed that when Mexaform was consumed along with the pork and beans diet for 6 days there occurred a marked inhibition of flatulence. The gas volume was no more than that collected when the subjects were on the nonflatulence-producing diets or the so-called basal diets. The average weight of the fecal volumes passed by the subjects each day were observed to be 81.2 grams on the basal diet with an increase to 138.9 grams when on the 37 percent pork and bean diet. However, when the subjects were on the 37 percent pork and bean diet plus the Mexaform tablets the average daily weight of the fecal volume increased to 310.6 grams. The latter figure definitely indicates that the microflora population has increased.

In more recent experiments 3 of the 5 subjects who served in the original Mexaform experiment also were available for testing to note which of the three components of Mexaform (Vioform, Entobax, or Antrenyl) was the responsible agent for "shutting off" the flatulence. The results of this series of experiments definitely show that Vioform is the responsible agent.

In conclusion, the results indicate that flatulence production in human subjects by beans can be inhibited by means of a drug known as Vioform, a constituent of Mexaform which is often prescribed for certain types of intestinal enteritis. It would appear that the drug, although capable of causing marked stimulation of the microflora population of the intestine, has no effect on the carbon dioxide production. It is our present belief that the excess flatulence, heavily laden with carbon dioxide, can be explained on the basis of the biocarbonate secretions from the pancreas, and that Vioform in some way inhibits this mechanism.

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INTESTINAL EFFECTS OF DRY BEAN EXTRACTS IN THE HUMAN

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The greatest limitation to intensive investigation of the flatulence problem associated with certain foods has been the lack of a reliable technique for the measurement of the flatus produced in man. This paper reports results obtained with a simple, inexpensive, portable apparatus worn by the human subject. The principle is based upon the quantitative measurement of carbon dioxide, one of the major components of human flatus, and the simultaneous determination of flatus composition by gas chromatography. Thus the total gas released in a given period can be determined from the percent composition and the weight of carbon dioxide (Figure 1). Likewise methane, hydrogen, nitrogen, and oxygen are calculated.

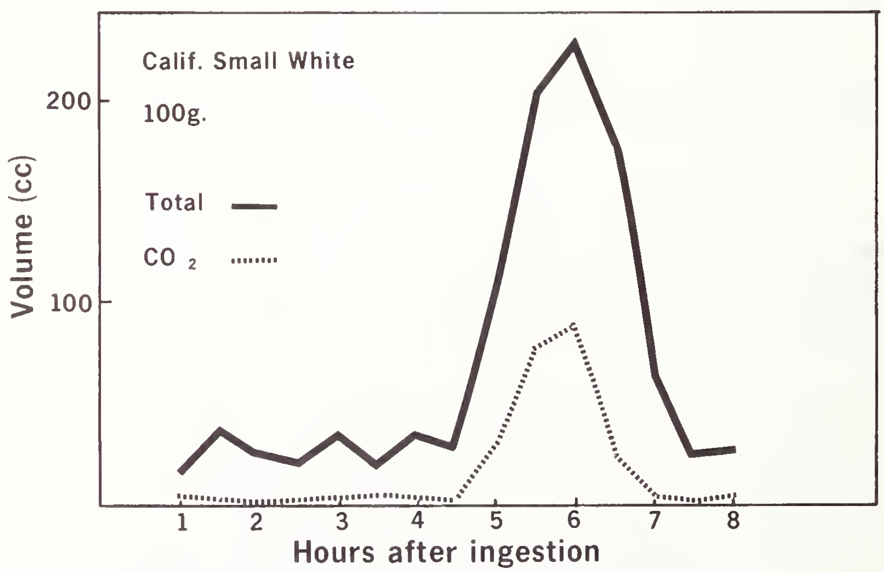

Figure 1. Human flatulence from a bean meal.

The proportions of these gases in human flatus vary between subjects on a bean diet. One subject produced appreciable quantities of methane, hydrogen, and carbon dioxide. By comparison, another subject produced methane, a greater amount of hydrogen and less carbon dioxide. Yet another subject produced no measurable methane. Of oxygen and nitrogen in human flatus, which have been attributed to swallowed air, oxygen volume remains almost constant while nitrogen perhaps doubles in volume on a bean diet. This point must be investigated further. The gases whose presence in human flatus has been explained by intestinal microbiological fermentation, methane, carbon dioxide, and hydrogen vary significantly in volume following the ingestion of a bean meal. The volume of carbon dioxide produced per hour can increase twenty-fold on a bean diet as compared to a basal diet. Hydrogen may increase half this much. Methane volume increases ten-fold at peak gas production.

With this analytical procedure, we can examine several interesting questions associated with the solution of the problem of human flatulence. In our laboratory we are primarily interested in identifying the factor or combination of factors responsible for flatulence. We propose to do this by successive chemical extraction of cooked beans and the determination of the flatulence activity of each bean fraction. By choice of chemical solvents so that at each step the major portion of the activity is concentrated in one chemical fraction, the flatulence principle can be systematically isolated and finally identified. We have found that after first extracting cooked beans with ethyl ether and then 60 percent ethanol, only the alcohol-soluble fraction has the major portion of the flatulence activity (Figure 2). The ether fraction and residue are inactive when ingested by man.

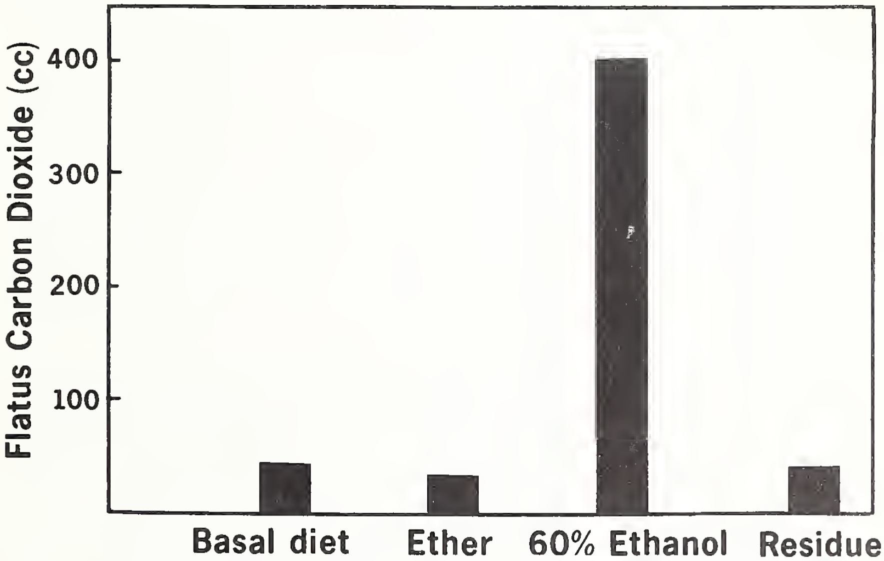

Figure 2. Flatulence from bean chemical fractions.

Another approach to a solution is the examination of certain cooking procedures or additives for their effectiveness in reducing flatulence. Using this assay technique, we have evaluated beans cooked with the addition of castor oil, baking soda, or ginger (Figure 3). None of these was effective in reducing flatulence in man.

Two questions which are always raised in a discussion of flatulence are the contribution to flatulence by man's intestinal flora and the effect of an

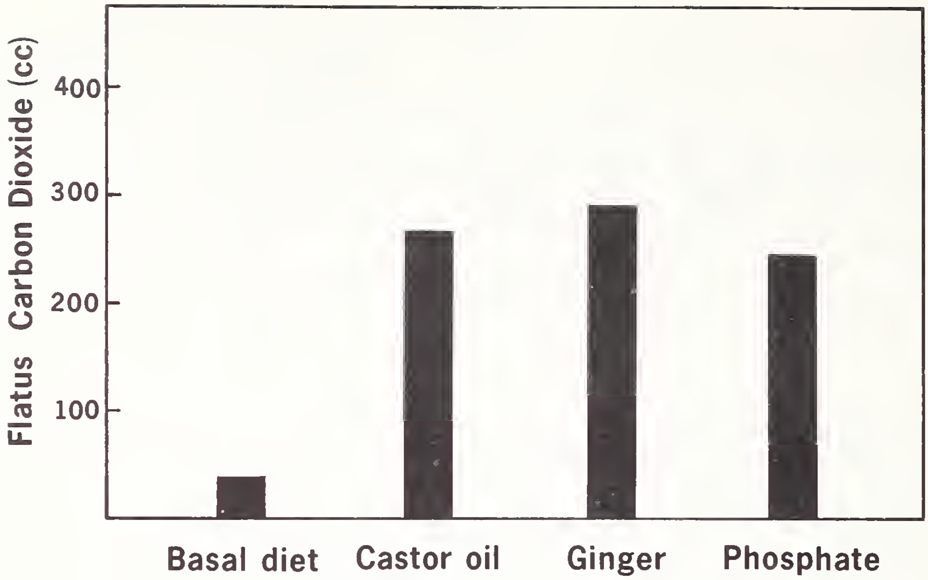

Figure 3. Comparison of cooking additives.

altered peristalsis rate. This assay technique can be applied to these and similar questions in the quest for a better understanding of human flatulence, which is the first step in the solution of the problem.

INTESTINAL EFFECTS OF DRY BEAN EXTRACTS IN THE RAT

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In the June 17, 1961, issue of Journal of American Medical Association, the Council on Foods and Nutrition issued a report on "Diet as Related to Gastrointestinal Function." This report was submitted by a study committee "in support of the need for a broad investigation to ascertain what foods do within the human digestive system." The committee was composed of members of the American Medical Association and the American Dietetic Association. This report is pertinent to the interests of today's meeting because it emphasizes our state of ignorance regarding the relationship of diet to gastrointestinal function. The following few comments of the committee illustrates our ignorance.

Food with a high roughage content is supposed to be "rough" on the gut while a bland food is supposed to "soothe" it like a salve. Such correlations, in the committee's opinion, are entirely unwarranted in most instances. If a given food produces gastrointestinal symptoms, or decreases existing symptoms, it presumably must do so by altering the structure, the secretions, the vascularity, or the motility of the digestive tube. Aside from studies on the effect of foods on gastric secretion, the committee concluded that nearly total ignorance on these points prevails. Hyperemia (increased vascularity) due to "irritation" by a food has not been documented except in the case of black pepper. Very little is known about the production of mucus in response to dietary items. In the case of the popular conviction that certain foods are "gas producers" the committee stated that "the measurement of rectal gas expelled does not necessarily correspond to intestinal gas formation, since unknown amounts of gas may be absorbed... Finally, if the quality and quantity of rectal gas appears changed following ingestion of a certain food, the responsible mechanism may not be merely fermentative. The food may have influenced the amount of air swallowed, or the amount of gases diffusing between blood and bowel, two factors generally believed of major importance in accounting for intestinal gas."

The committee's report concluded with an emphatic statement of "the basic difficulty with dietotherapy as related to gastrointestinal structure and function: ignorance as to what happens to an individual food item in the gut, as to its effect on the alimentary tube, and as to the real explanation of symptoms that might follow its ingestion."

The food item of interest to this meeting is beans. Perhaps the direct observations on the appearance and behavior of the intestinal tract of experimental animals given beans and bean extracts in our Pharmacology Laboratory will answer some of the difficulties pointed out by the A.M.A. committee.

When albino rats were fed high dietary levels of beans for a few days, sacrificed, and the intestinal tract examined, it was noted that the small intestine had the appearance of being inflamed (hyperemic) as compared with control rats on a bean-free diet. This observation suggested the presence of an irritant in the beans. A chemical constituent characteristic of the legume family is saponin. Chemical tests showed the presence of saponin in dried beans. As pharmacologists we knew that most saponins cause irritation to mucus membranes. This could account for the intestinal inflammation noted in rats fed high dietary levels of beans.

More direct tests for the effects of bean saponin were made in the following manner. Beans were exhaustively extracted with ethyl ether or petroleum ether to remove fat. They were then extracted with ethyl alcohol (50 to 70 percent) to remove saponin. The residue remaining after evaporation of the alcohol contains saponin, derivatives of the amino acid cystine, and perhaps other unidentified substances, but the saponin and cystine derivatives are of primary interest. In our early experiments small amounts of the alcoholic fraction (15 to 25 milligrams) dissolved in 1 ml. of physiological salt solution were injected by means of a hypodermic syringe directly into the upper end of the exposed small intestine. Two experimental conditions were used. In one the rats were sacrificed, and in the other they were anesthetized with sodium pentobarbital. In both conditions the abdomens were opened to expose the digestive tract, and the abdominal areas were submerged in physiological salt solution kept at body temperature. In the case of the sacrificed rats, injection of the alcoholic fraction usually caused an increase in peristalsis of the intestine as compared with sacrificed control rats. There was, of course, no evidence of inflammation (hyperemia), since blood flow was stopped. In the anesthetized rats the circulation was intact, and hyperemia and distension of the intestine as compared with anesthetized controls were frequently observed. Extensive production of mucus was largely responsible for distension of the intestine, although cutting of submerged intestinal loops occasionally allowed escape of minute gas bubbles or revealed them entrapped in the heavy mucus secretion. Effects on peristalsis in anesthetized rats were seldom observed because of the inhibitory action of the anesthetic.

The production of hyperemia was even more evident in the following experiment on anesthetized rats. After opening the abdomen to expose the intestine three ligatures were applied to the small intestine so as to provide two intestinal segments with equal blood supply. After intravenous injection of Evans Blue dye, the alcoholic fraction was injected into the lumen of one intestinal segment, and an equal volume of solvent into the control segment. Evans Blue is a colloidal dye which slowly escapes from blood capillary walls into the surrounding tissue. The marked bluing of the experimental segment in contrast to the control segment gave marked confirmation of the increased vascularity resulting from the irritant action of the alcoholic fraction.

In other experiments on anesthetized rats, ligatures were similarly applied to provide two intestinal segments with equal numbers of arterioles. When the number of arterioles is equal but in excess of 35 in each segment, the lengths of the segments are practically equal. Under these conditions the segment injected with the alcoholic fraction and the control segment injected with solvent could be removed after development of distension due to mucus production and weighed. The statistically significant increases in weights of the experimental segments reflected the marked production of mucus.

Thus far the summary of experiments on anesthetized rats concerned rats anesthetized with sodium pentobarbital, which inhibits peristalsis. Under these conditions mucus production and inflammation are the most pronounced responses to the alcoholic fraction. Comparable experiments have been performed in which anesthesia was produced by urethane instead of sodium pentobarbital. Urethane does not inhibit peristalsis. Injection of the alcoholic fraction into the lumen of the upper end of the small intestine now resulted in increased peristalsis, and distension of the intestine with gas as well as mucus.

In a third experimental procedure a group of unanesthetized rats were given the alcoholic fraction of beans by stomach tube. The rats were sacrificed at various time periods, abdomens opened and the intestinal tracts examined. It was noted that maximum distension occurred about 4-1/2 hours after the administration by stomach tube. If the intestine of such an experimental rat and that of a control receiving only solvent by stomach tube are placed in a vacuum desiccator an interesting result is obtained. Both specimens are eventually dehydrated but that of the rat given the alcoholic fraction is markedly ballooned. After all, the pressure of a gas X its volume is a constant. This simple experiment provided a striking demonstration of the increased volume of intestinal gas resulting from the presence of an irritant.

Since the alcoholic fraction of beans does not provide a source of fermentable material for gas production, an explanation of gas production must be sought elsewhere. William H. Howell's Text-Book of Physiology shows the volume of pancreatic juice secreted at various time intervals over an 8-hour period following eating of a mixed diet of soup, meat, and bread. Calculation shows this volume to be approximately 600 ml. Pancreatic juice is alkaline due to its content of sodium bicarbonate. On page 752 of The Physiological Basis of Medical Practice, third edition, by Taylor and Best, it is stated that the alkalinity of the pancreatic juice is such that 10 ml. of juice is equivalent to 12.7 ml. of tenth normal sodium hydroxide. This provides a basis for calculating the amount of carbon dioxide that could be liberated from 600 ml. of juice when neutralized by the hydrochloric acid of the gastric juice entering the intestine. Calculation shows this to be approximately 1800 ml., or somewhat more than 1.5 quarts.

The blood's composition and resulting properties make it capable of taking up carbon dioxide liberated from pancreatic juice under normal circumstances and transporting it to the lungs where the carbon dioxide is released and exhaled. On the basis of the observations we have made on experimental animals, and the volume of carbon dioxide available from the pancreatic secretions, the following tentative explanation of flatulence produced by beans is offered. Unusual amounts of mucus produced by the irritant action of saponin may interfere with the diffusion of carbon dioxide to the blood stream. In fact, we have actually seen gas bubbles trapped in the mucus of the intestine. The increased peristalsis further limits the amount of carbon dioxide that can be absorbed by the blood by propelling it to the lower bowel and finally to the rectum.

This tentative explanation accounts for the increased volume of gas, and its carbon dioxide content, passed per rectum. But how about the increased hydrogen, methane, nitrogen, and oxygen in rectal gas? Hydrogen and methane are products of microbial metabolism and occur in the lower bowel where absorption is normally poorer than in the small intestine. These gases may be swept out by the peristaltic waves along with carbon dioxide. The nitrogen and oxygen may be derived from swallowed air, a natural occurrence during eating and drinking. These gases, especially nitrogen for which blood has low affinity, may also be swept along and out of the intestinal canal before normal absorption can take place.

In view of the distension due to mucus secretion we have observed in experimental animals, it may be well to consider the possibility that discomfort associated with the eating of beans may be due in part to this cause of distension, and not entirely to gas.

ROLE OF THE WESTERN DRY BEAN INDUSTRY IN PRODUCTION OF SEED BEANS FOR THE EASTERN DRY BEAN REGION

Axel L. Andersen
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Bacterial blight and anthracnose have long been recognized as two of the most destructive diseases of beans. They occur on beans in areas of high humidity and frequent rainfall such as we frequently have in Michigan and New York during the growing season. The organisms which cause the diseases are transmitted through the seed or they may survive over winter in infested, nondecomposed bean straw. Hence, these two diseases can be controlled by planting disease-free seed on land which has been planted to crops other than beans for 4 or 5 years.

The question arises, where do we obtain disease-free seed? More than 40 years ago, Drs. Muncie and Whetzel recommended that bean seed be produced in areas with little or no precipitation during the growing season. We still concur with this recommendation. This of course restricts production to the irrigated areas of California, Idaho, and possibly Washington. But all seed produced in these areas may not be entirely void of these diseases. For example, bacterial (halo) blight outbreaks have been observed in red kidney beans planted from Western-grown certified seed in New York and in Michigan. Some of the seed had been grown in complete isolation. A similar experience was encountered several years ago with anthracnose in cranberry beans.

For assurance that beans are free from these diseases, the seed should be grown at least two seasons in a rain-free climate. Furthermore, only beans grown with surface irrigation should be used for seed because overhead irrigation favors infection and spread of bacterial and fungus pathogens that may be present.

There are other limiting factors such as "curly top" and for some varieties "common bean mosaic" -- two important virus diseases which further restrict the areas in which Eastern varieties should be grown. A combination of common bean mosaic virus-infected seed and a high aphid population can easily result in serious virus epidemics in the Eastern states.

What other precautions must Western seedsmen take to assure quality seed for planting in the Eastern states? From our experience, we recommend that the right type of combine be used for harvesting to avoid seed injury. Rough handling, whether it be in the combine or in the elevator, results in the development of weak, nonproductive plants, and in many instances the seed injuries result in the development of baldheads. Mixture with other varieties is also a problem. To avoid mixtures a thorough cleaning of the combine is necessary every time there is a change in variety.

Economics is also a limiting factor. If bean growers in the Eastern states are expected to pay premium prices for Western-grown seed, they expect to receive a quality product which meets the standards set by their own seedsmen. We hope that Western bean growers and seedsmen who produce and handle seed for the Eastern states will take all the necessary precautions to assure the delivery of high-quality, disease-free seed.

CURRENT DRY BEAN PRODUCTION RESEARCH

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University of California, Davis, California

Dry bean production research might be defined as research which has the specific aim of increasing the efficiency of dry bean production--by increasing the quantity grown per unit area, by lowering cost per unit of production, by improving quality of the product, or by some combination of these and other aspects of efficiency. However, when we consider the manner in which improvements in methods of bean production have been made in the past, two things become apparent. First, improvement is usually progressive, with no clear starting point and few high points. Second, it has frequently not been the result of work done on beans, but has come from investigations conducted with other crop sciences, or with noneconomic species, or in engineering laboratories, or in statistical centers. Thus, for example, the efficiency with which improved varieties of beans can now be developed is the result of experimentation by numerous geneticists, breeders and statisticians in the 100 years since Gregor Mendel laid down the foundations of modern genetics. And even Mendel's work depended to considerable extent on the findings of experimentalists who preceded him. In other words, dry-bean production research is a much more elastic concept than implied by the narrow definition given above.

As one of many examples that might be cited to illustrate that future progress may come from investigations with no clear relationship to increased production, consider some theoretical investigations now under way at the University of California. There is substantial evidence from population genetics that certain genetically diverse varieties give steadier and higher yields averaged over a number of years than genetically uniform "pure-line" varieties of the type now in favor. But many factors must be taken into account in developing "rational blends" which give optimum performance. Thus for example the number of components that should be blended, the compatibility of each component with every other component, the reproductive system, the amount of heterosis resulting from all possible crosses between components, the effect of natural selection in changing the composition of the population, and so on, must all be taken into account. All of these factors must be considered simultaneously in developing superior varieties, since it is their joint action which determines the potential of a "rational blend." Hence, there are so many combinations that it is impossible to test even the more promising ones in actual field trials.

This problem of large numbers was approached by constructing a mathematical model which takes the more important factors into account and uses a digital computer (IBM 1401) to evaluate the possibilities. The computer can do

100 generations in about 4 minutes, so it has been possible to test many combinations of factors and obtain predictions of the sort of performance that various blends should produce. The results indicate that substantial increases in productivity (10 to 20 percent, or even more) may be possible.

The next step is of course to test some of the more promising combinations in actual field trials. However, field trials are relatively costly and several years will be required to determine whether the advances predicted by the computer can actually be realized.

This particular work may not pay off in increased productivity. But if it does, it will be very difficult to say at what point it became "production research," especially since much of the basis of the computer work comes from theoretical studies that were not directed toward solving practical problems.

In illustrating the idea that improvements in methods of producing beans often come from research that does not have such improvement as a specific aim, I have no doubt been too sketchy to make an air-tight case. I hope, however, that I have convinced you that those of us who devote part of our energies to "way out" studies of this type are not entirely wasting our time. Of one thing I am sure. As a result of this work with theoretical models, I feel more competent to discuss bean improvement than if I had spent all of my time breeding varieties in the conventional way.

FARM MANAGEMENT IN DRY BEAN PRODUCTION

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Although dry beans are produced on only two percent of the cropland in California, they are an important agricultural enterprise in areas where they are grown. Production of all dry beans has averaged about 273,000 acres during the past ten years but has varied from a low of 222,000 to a high of 323,000 acres, a 100,000-acre difference between the high and low years. California produced nearly 30 percent of the U. S. dry beans in 1951 but this proportion has dropped to about 18 percent during the past three years. The 1961 acreage of beans in California was distributed 21 percent in the south, 15 percent in the coast, 42 percent in the San Joaquin Valley, and 21 percent in the Sacramento Valley. Predominant varieties are large Limas in the south, small whites in the coast, Blackeyes in the San Joaquin Valley, and pinks in the Sacramento Valley. Other important varieties include baby Limas which are divided between the Sacramento and San Joaquin Valleys and Red Kidney beans which are grown primarily in the San Joaquin Valley.

Bean production practices vary from the Lima beans grown year after year on the same land in Southern California to pink beans in the Sacramento Valley where they must compete with tomatoes, sugar beets, rice, alfalfa, and other field and vegetable crops for a spot in the rotation. In many areas, beans can be used as a double crop following barley. They can be used in rotations with rice and the number of crops suitable for this purpose is limited. Beans are also useful for interplanting in young orchards because they are comparatively free from diseases that may spread to the trees. Unfortunately, however, beans are often not grown in a planned rotation but yield to other crops under the influence of price relations and other factors.

Costs of production will vary by region, variety, size of farm, and managerial ability of the operator. The following are examples of sample costs which have been prepared by the University of California Farm Advisors. These costs are not presented as averages but are representative of costs in the area indicated with good commercial management practices.

Table 1. Sample costs of bean production

	Large Lima	Small white	Blackeye	Pink
County	Monterey	Monterey	Kern	Solano
Yield - pounds	2,500	2,200	2,000	1,500
Land preparation	$ 16.10	$ 16.10	$ 9.75	$ 16.50
Plant	2.00	2.00	1.90	1.50
Seed	18.00	6.00	2.00	7.00
Fertilizer	14.20	---	---	8.00
Irrigate	19.20	19.20	9.10	10.00
Water	10.00	10.00	15.00	10.00
Cultivate	7.95	7.55	5.60	3.00
Hand weeding	15.40	15.40	---	7.50
Pest control	11.00	4.75	---	5.50
Miscellaneous cultural	9.05	6.50	5.55	4.00
TOTAL CULTURAL	$122.90	$ 87.50	$ 48.90	$ 73.00
Cut	$ 6.45	$ 8.80	$ 6.00	$ 1.50
Rake				
Thresh	16.80	10.95	16.00	8.75
Haul	1.25	2.70	2.75	1.75
Cleaning & warehouse	15.65	11.75	17.00	15.00
TOTAL HARVEST	$ 40.15	$ 34.20	$ 41.75	$ 28.50
Miscellaneous overhead	$ 9.05	$ 11.55	$ 3.50	$ 5.00
Rent	60.00	60.00	81.50	40.00
Management	---	---	---	6.00
TOTAL OTHER	$ 69.05	$ 71.55	$ 85.00	$ 51.00
Total cost per acre	$232.10	$193.25	$175.65	$152.50
Cost per cwt.	9.40	8.80	8.78	10.17
Dealers F.O.B. price 1961	$ 16.93	$ 9.08	$ 10.86	$ 12.59
Dealers F.O.B. price 10 year average	11.91	9.05	8.96	9.10

The future for bean production in California is just as uncertain as it is for any other agricultural commodity. Projections relating to California Agriculture in 1975 which were made by the Giannini Foundation of Agricultural

Economics indicated a possible reduction of 16 percent in bean acreage from 1957 to 1975. The reduction in production was projected at 8 percent, however, because of improved yields resulting from the development of more disease resistant varieties. It is poor policy to make comparisons on annual data but we have had a 23 percent reduction in acreage from 1958 to 1962 and a 16 percent reduction in production over the same period.

VARIETAL IMPROVEMENT OF LIMA BEANS IN CALIFORNIA

C. L. Tucker
University of California at Santa Ana

Four classes of Lima beans are grown in California. Two are processing types, one is a baby dry edible type, the other a dry edible standard type. The breeding work I shall mention covers only the standard dry edible types. There are six well defined areas in California where standard Limas are grown. One is on the west side of northern San Joaquin Valley south of the San Francisco Bay area. The remaining five are along the coast from Southern Monterey County to San Diego. My remarks will cover only work done from northern Santa Barbara County south. The work to be discussed was done mainly at the University of California South Coast Field Station at Santa Ana.

The applied problems to be covered are earliness, nematode resistance, root rot resistance, seed coat color, and of course increased vigor and yielding ability. There are three areas of production where earliness is important, the west side of the San Joaquin Valley and two of the northern coastal growing areas. During the past three years observation and yield trials have been planted at six locations in northern Santa Barbara County mainly for the purpose of earliness evaluation. These plots contained commercial and potentially commercial seed stocks, a segregating population, and a bulk population. None of the commercial or potentially commercial seed stocks appeared to be earlier than the commercial strains now being grown; however, the segregating and bulk populations appeared to contain early genotypes. Selections were made among both populations during 1962. These selections will be carried in a mass selection type program.

Nematode resistance is of prime importance in all areas of Lima bean production in California. The progress of this program has been inhibited because of three factors. First, testing for nematode resistance in the field or greenhouse in California has not been successful; however, a co-operative project with the University of Hawaii is now under way so that testing for reaction to nematodes is done in Hawaii. Second, early observations indicated that nematode resistance was due to a simply inherited gene; however, a recent inheritance test indicates that the inheritance is not simple and it can come from at least two sources. And finally the genotypes which serve as the source of resistance have very small seeds. In spite of these difficulties progress has been made toward a commercial standard dry edible type Lima with nematode resistance.

Two approaches are being made to this problem: (1) backcrosses are being made with two sources of resistance, using the commercial variety Ventura as the recurrent parent, (2) selections are also being made within a bulk population. The status of one backcross is that it has four backcrosses with one or two to follow. The other has only one backcross.

Among the many bulk populations initiated by Dr. Allard at Davis, California, one started 11 years ago contained a nematode-resistant line among its parents. This population was planted over a seven-year period at Davis and Santa Ana. The only artificial selection done on this material was for seed size. After seven years a random sample was removed from the population and sent to Hawaii for a nematode reaction test. None of the resistant lines from this test were of commercial quality; however, some appeared to show promise. Crosses were made between the commercial variety Ventura and several resistant lines. Two cycles of selection mainly for resistance and seed characters have been completed. The remaining selected lines will be planted in commercial growing areas during 1963 for observation and increase. Performance for yield and canning quality will be evaluated on those lines that appear to show promise as potential commercial varieties.

Because of dry summer weather, Lima beans grown in California are not subject to foliar and pod diseases; however, root rots are common to all regions of production. Two main sources of root rot tolerance are being used. One main source is a large seeded calico Lima which is in a pedigree with commercial lines. The promise of superior commercial lines resulting from these pedigrees do not appear to be favorable. The two sources of nematode resistance just mentioned carry root rot tolerance, and selection for root rot tolerance does show some promise in this material.

Lack of uniformity of seed coat color is a common fault of standard Limas; essentially all the standard Limas grown have green seed coats at maturity which bleach to various shades ranging from green to grayish white. An alternative seed coat is one that is snowy white from a very immature stage and, of course, remains white through maturity and drying. Genetic control of this character is through a simply inherited gene, therefore making it possible to transfer the desirable white color into commercial types with a simple backcross. Lines from a backcross with Ventura as the recurrent parent have performed well in canning and yield tests. These lines will be further tested and increased in a commercial field during 1963. A release of this increase can be made at the end of the 1963 season.

This white seed coated program will be brought together with the nematode resistant program as soon as the appropriate crosses and tests can be made. The objective of course is the release of a nematode resistant white seed coated variety. Essentially all breeding programs involve selection within a base population of genetically variable individuals or families, and utilization of the selected material for the creation of new populations to be used either as potential new commercial varieties or as the base for a new cycle of selection.

The approach to selection of superior genotypes at Santa Ana has been through two basic methods, pedigrees and bulk populations. We have four pedigrees which are aimed toward superior yield varieties. Two of these pedigrees are now in the F_6. Several families of these pedigrees were in performance trials last season at Santa Ana. These trials will be repeated next year at Santa Ana and trials will also be run at off-station locations.

As many as 30 bulk populations have been grown at Santa Ana during a single season. One distinct advantage of these populations is that a larger amount of germ plasm can be maintained with far less cost than in pedigrees. Of the many bulk populations started by Dr. Allard and myself one appears to have a good deal of potential as a commercial variety or source of a commercial variety. This population has been grown out over 13 generations. Selections from this bulk and the unselected bulk have been yield tested in 7 locations over a 3-year period; however the area where this material has performed the best, testing has been done in only one season. Needless to say more testing is needed before an estimate can be made of this bulk's potential.

INTRODUCTORY REMARKS ON RESEARCH ON BEAN DISEASES

W. C. Snyder
University of California, Berkeley

Recent estimates place the national loss to bean growers from diseases at 15 to 20 million dollars. To this must be added additional millions in losses induced by smog. Research now under way in the University of California, statewide, is aimed at reducing these losses through the use of chemicals, by plant breeding, and cropping practices such as rotation and cover-cropping. This total program is being undertaken by several different departments of the University, on its several campuses.

At Berkeley, in the Department of Plant Pathology, emphasis is being placed on the below-ground diseases of bean and their control through biological means. Basic studies are being carried forward on the mode of existence of bean-root parasites in different soils, their survival under different cultural practices, and on the infection process itself. It is believed that such knowledge will eventually enable us to use to much greater advantage the little understood benefits of different cropping sequences and other cultural practices.

The Berkeley work being reported upon at this meeting begins with a study by Dr. Shirley M. Nash on the effects of seed-borne fungi in lowering the vitality of Lima-bean seed during storage. This is followed by a discussion on the role of organic matter in soil in relation to seedling injury and root infections by Dr. T. A. Toussoun.

Fungus problems relevant to stored lima bean seed, by Shirley M. Nash. Seed held for planting may lose its vitality, and eventually its germinability, due to growth of fungi inside the seed during the storage period. The kinds of fungi implicated as invaders of seed in storage are species of Aspergillus and Penicillium, which grow at lower relative humidities than most fungi.

Seed with such reduced vitality does not produce a good stand, especially when planted under conditions that are in any way adverse. If the weather turns cool after planting or the irrigation is not proper, or the soil is rather poor, the young plants damp off prior to or following emergence. These seeds may show a high germination percentage, however, and if they are planted under ideal conditions may produce a normal stand.

The fungi causing deterioration of stored seed have been studied extensively by cereal pathologists. Such studies, for example, have been carried on for years at the University of Minnesota. Many of these studies relate the moisture content of the grain put into storage to the development of fungi and the subsequent deterioration of the grain during storage. It was found that the fungi largely responsible for the deterioration develop at moisture contents of 14 to 20 percent (on a wet weight basis). The relative humidity in the environment where the fungi developed would be 70 to 90 percent at 25°C., at these moisture levels.

The fungi which cause the most damage are usually those able to grow at the lower relative humidity levels--the Aspergillus glaucus series. Growth of Aspergillus flavus and Penicillium species was supported primarily by higher moistures at the time when the seed was stored.

The storage fungi which develop on Lima beans are the same group as on the grain. The moisture relations also are similar. It appears however that the seedsman should pay attention not only to the moisture of the seed, but also to the average temperatures in the areas where the seed is to be stored throughout the year and the length of time of storage of each seed lot.

To illustrate the effect that the climate of the storage region can have on the development of Aspergillus glaucus on Lima bean seed we can cite a case where two portions of seed from the same field, harvested at the same time, were stored in two different places. One lot was stored in a Coastal valley area where the average winter temperature is 48°F. and the average summer temperature 67°F. The other lot was stored in an area in the Central valley where the average winter temperature similarly is 46°F. but the average in summer is 80°F. Furthermore, the beans were held about 18 months before planting. When both lots were planted in the same field, the lot that had been stored in the cooler area produced a normal stand. In the lot stored in the warmer area, however, only about half the beans emerged and most of those damped off. Examination of the seed lots by a plating technique revealed that 90 percent of the seed stored at the warmer area were badly infected with A. glaucus, whereas only 10 percent stored in the cooler area were likewise infected. The optimum temperature for growth of A. glaucus is 85 to 90°F.

Limas Showing Fungi in Three Days

Coastal Storage	
Infected beans	11%
A. glaucus (sporulating)	10%
Nonsporulating mycelium	1%
Central Valley Storage	
Infected beans	92%
A. glaucus (sporulating)	90%
Penicillium sp.	1%
Nonsporulating mycelium	1%

The technique that has been used to check infection of seed by these fungi is a simple one. The sample of seeds is surface sterilized with 5 percent Clorox and the seeds are placed one by one - about 1/2 inch apart, on the surface of hardened agar medium in a petri dish. The medium used must be one that has a high enough salt or sugar content so that the humidity in the dish is suitable. One of the most convenient media to use is malt extract agar (Difco) with 7.5 percent NaCl added. The dishes are incubated at about 85°F.

Aspergillus glaucus will be observed sporulating in 2 to 3 days from seeds which are heavily invaded with the mycelium of this fungus, when the seeds are placed in the dishes as described above. The fungus is an easily identifiable Aspergillus, having blue-green conidial heads. In 3 to 4 days yellow cleistothecia of the perfect stage develop.

Often the sporulation first appears at a crack in the seed coat. There is an indication that the fungus mycelium builds up beneath the seed coat. The hilum is also a region where sporulation may occur early. Growth of the fungus mycelium in the seed apparently produces toxins which affect the embryo and subsequently the young seedling. Aspergillus flavus, which has very large bright yellow conidial heads, and Penicillium species grow in seed stored at higher moisture levels.

In conclusion, it has been observed that storage fungi can be important in destroying the vitality of Lima bean seed. However, the problem may be dealt with by checking for the development of storage fungi and by not holding beans for periods when these fungi are present. Temperature and moisture of seed can help to predict if the fungi will develop.

Organic matter decomposition in relation to root diseases, by T. A. Toussoun. Experiments have shown that organic matter incorporated into soil can have important effects on root diseases. It has been found that the addition to soil of mature organic amendments such as barley straw lead to a decrease in the severity of bean root rot, especially that caused by Fusarium. This effect appears to be due to a tying up of the available soil nitrogen by the microorganisms which decompose the straw, thus leading to a nitrogen starvation of the Fusarium. An increase of the disease occurs, however, when organic matter relatively rich in nitrogen, such as green alfalfa hay, is incorporated into soil. These results indicate, therefore, that Fusarium root rot of bean is influenced by the nitrogen content of the organic matter undergoing decomposition.

The direct effect of the nutrition of the pathogen can be masked however, or even completely altered, by the influence of the environment in which organic matter decomposition takes place. For example, it has been shown that substances are produced which are toxic to plant roots when decomposition takes place in cold and wet soils. Such products can be obtained in water extracts of plant residues that have been decomposing in the field for various periods. An effect of the toxic extracts is to inhibit the germination of seed and the growth of seedlings of bean, lettuce, and tobacco. The roots of seedlings are especially sensitive and discoloration and death of root tips take place rapidly. Toxicity is most severe after barley, rye, wheat, sudan grass, vetch, broccoli, and broadbean have been decomposing for 10 to 25 days. Toxicity diminishes with increasing periods of decomposition and is not generally present after 30 days. Toxic extracts are not obtained from the field at all times and the degree and the duration of the toxic period vary with location in a given field and with the kind of crop residue.

In addition to their direct toxic effect on plant roots, these extracts also have been found to increase bean root rot caused by Fusarium, and by Rhizoctonia and Thielaviopsis. The results obtained with Rhizoctonia were particularly interesting, since in this case the fungus actively invaded the plant only after the roots had been exposed to the toxic extract. The major role of extracts in nature may therefore be that of preconditioning roots to invasion by pathogenic fungi.

The results discussed here show that crop residues can depress bean root rot and increase its severity. These differences are due in fact to the effect of the residues on the nutrition of the pathogen, especially nitrogen nutrition, and in part on the environment in which decomposition takes place, for it has been found that toxic products were most often obtained from residues decomposing under cold, wet or anaerobic conditions.

EFFECTS OF AIR POLLUTION ON AGRICULTURAL CROPS

John T. Middleton
Air Pollution Research Center, University of California, Riverside

Man created air pollution with his discovery of fire. The first atmospheric contaminants with nuisance values were smoke and ash. As society became more complex and industrial expansion occurred and developed to meet the needs of society, air pollution increased in extent, severity, and complexity. Today atmospheric contaminants which adversely affect agriculture arise primarily from the products of combustion, the by-products of smelting, and the production of chemical goods.

The 5 air contaminants of importance in the United States and listed in increasing order of significance are ethylene, sulfur dioxide, ozone, oxidant, and fluoride. In California these 5 contaminants are ranked in increasing order of importance as sulfur dioxide, fluoride, ethylene, ozone, and oxidant. All 5 contaminants adversely affect agriculture in damaging leaves or flowers and interfering with normal crop yield.

Sulfur dioxide is released to the atmosphere through burning of fuels containing sulfur and in the smelting of ores and manufacture of chemicals in which sulfur is a component. Sulfur dioxide damages leaves of sensitive crops, such as alfalfa, with as little as 0.3 part per million and an exposure of about 5 hours' duration. Injured leaves typically show yellow to light brown leaf necrosis between the veins and extending inward from the margin of the leaf. The effect of this damage is to reduce the value of the crop in direct proportion to the amount of leaf area affected. Sulfur dioxide can be easily controlled through adequate engineering and use of control equipment, with the collection of sulfur dioxide and the production of either sulfuric acid or elemental sulfur, both of which have economic reclamation value.

Fluoride typically comes from the heating of ores and earth used in the manufacture of metal or the production of glass, tile, and brick. Fluorides also are released in the production of aluminum, the manufacture of phosphate fertilizers, and a variety of other chemical activities. Air-borne fluorides are in the form of both gases and solids and, depending upon the solubility of the solid materials, vegetation receiving it absorbs more or less of it. As little as 0.3 part per billion of gaseous fluoride has an adverse effect upon foliage. Leaves of most plants absorb the fluoride and accumulate it, so that the leaf concentration far exceeds that occurring in the air. Some plant species show leaf tissue collapse when the fluoride content of the tissue is more than 50 parts per million, while other plant species may have as much as 5,000 parts per million with no leaf tissue collapse. Fluoride not only causes leaf tissue collapse but produces fluorosis in livestock if their diet consists of forage with no more than 50 parts per million fluoride content. Were it not for the recent development of control equipment and the recognition of fluoride as an important air contaminant, the industrial expansion taking place in this country would contribute substantially to an increasing level of fluoride and an increasing toll in livestock and damage to agricultural crops.

Ethylene is a contaminant that comes from the burning of natural gas in industrial combustion and domestic space heaters as well as from the exhaust of the motor vehicle. The source of ethylene therefore is both stationary, as with sulfur dioxide and fluoride, and mobile as in the case of the bus, car, and truck. While ethylene has been used commercially at fairly high concentrations to accelerate the ripening of certain fruits, this same material causes severe plant damage, especially to floricultural crops, at very low concentrations. As little as 0.5 part per million causes damage to orchids with an exposure of only 1 hour. Ethylene typically causes collapse of tissue in flowers, the production of abnormal appearing flowers, and especially failure of flower buds to open and the loss of flowers from the flower stalk. There are no known methods for the control of ethylene at this time.

Ozone and oxidant result from the chemical combination of nitrogen oxides and organic vapors in the free atmosphere in the presence of sunlight. These products each have different effects upon plants and their effects on plants are so different that the symptoms produced are useful in detecting the presence of these photochemical smog products. The appearance of injury from ozone and oxidant has been a useful indicator for the presence of smog in urban areas and adjacent rural agricultural regions. Photochemical air pollution or the effects of ozone and oxidant on plants has been recognized in California since 1943, when it was first seen in the vicinity of Los Angeles. By 1950, it had spread throughout most of southern California and was first observed in the San Francisco Bay area. Today the effects of ozone and oxidant are recognized in 26 of California's 58 counties and in 26 states of the nation, as well as the District of Columbia, Canada, and Mexico.

Ozone is responsible for damage to the upper leaf surface either through destruction of the chlorophyll and the development of yellow to tan spots, or the production of red brown to black spots due to leaf tissue collapse. Ozone injury will result from as little as 0.5 part per million to sensitive plants for only 10 minutes' exposure or for several hours' exposure to as little as 0.15 part per million. In addition to causing leaf yellowing and spotting, ozone stimulates the dropping of leaves and prevents the setting of fruits on many plant species. Apart from the visible injuries resulting from ozone this toxicant has adverse effects upon plant metabolism; respiration is increased and photosynthesis decreased, thus interfering with the manufacture of food and its utilization in plant growth, with subsequent reduction in plant size without any visible injury symptoms.

Oxidant, usually due to peroxyacetyl nitrate, results in injury to the lower leaf surface, usually shown as a silvering or bronzing of the leaf blade. Injury to sensitive species results from as little as 0.15 part per million for 4 hours, while higher concentrations cause injury for shorter periods of time. Here, as with ozone, leaf and flower and fruit drop are accelerated, and growth depression is brought about by oxidant interfering with the production of food in photosynthesis and its utilization in respiration. One of the most sensitive plant species to oxidant and ozone is the common bean. While a number of plant species vary in their susceptibility to ozone and oxidant, bean is a particularly useful indicator in detecting the presence of ozone and oxidant and in illustrating the varietal susceptibility of the host to the two toxicants. Table 1 reports the relative severity of response of bean leaves to oxidant from 0.25 part per million of toxicant for a 7-hour exposure. The sensitivity of beans can be readily seen and their susceptibility best realized when one considers that a value of 10 indicates total damage to the entire leaf.

In addition to bean, which is one of the most susceptible crops, there are a number of other herbaceous plants and fruit crops which are equally sensitive. Among these are alfalfa, cereals, cotton, grapes, lettuce, spinach, and coniferous trees such as pine.

The adverse effects of ozone and oxidant are particularly troublesome in areas with poor atmospheric ventilation wherein the air mass is stagnant and concentration of pollutants persists for some time. Damage is most pronounced in well defined areas better defined as airsheds. An airshed may be described as an area bounded by hills and mountains and capped by a layer of air which prevents diffusion of the toxicants upward and out of the described basin. Airsheds have typical air-flow patterns such that the pollutants move from one

Table 1. Susceptibility of some bean varieties to 0.25 ppm. oxidant for a 7-hour exposure

Variety	Injury index
Bountiful	2.8
Fordhook Concentrated	5.4
Kentucky Wonder	4.2
Mexican Red	9.0
Standard Pink	9.4
Pinto	1.6
Pinto (Stripe)	8.8
Red Kidney	2.0
Scotia	8.0
Small White	8.9
Westan	5.2

area to another within the region, which usually involves several political subdivisions, but consists of but a single airshed. There are 5 principal airsheds in California, the south coastal basin (Los Angeles), the central coast basin (San Francisco), the Sacramento, the San Joaquin, and the Salinas. Plant damage from ozone and oxidant is seen throughout the south coastal and the central coastal basins. Injury is commonplace in the lower Sacramento and San Joaquin airsheds while no plant damage occurs in the Salinas or Monterey area. The 5 airsheds are shown as vertically lined areas and plant damage as diagonally lined areas in Figure 1. An inspection of this map will show that the Salinas airshed is free from plant damage and offers a real opportunity for development of satisfactory air-control program to prevent air-pollution injury, while it likewise shows the serious potential of air pollution damage in the Sacramento and especially the San Joaquin valleys.

Control of photochemical air pollution or smog depends upon the reduction of oxides of nitrogen from stationary combustion sources and the reduction of oxides of nitrogen and organic vapors from mobile pollution sources, such as buses, cars, and trucks. Since the responsibility for control of stationary sources rests with counties in the State of California and the control of mobile sources with the state government, it is important that farmers recognize the opportunity for establishing air-pollution-abatement programs in their counties and the need to support the organized State Motor Vehicle Pollution Control Board activity. For although relief from ozone and oxidant damage can be obtained by the planting of resistant varieties or by the application of chemicals, such as antioxidants and reducing agents (for example vitamin C), the ultimate and cheapest solution rests in abatement of the basic constituents--the oxides of nitrogen from combustion and organic vapors released from combustion sources. Immediate relief requires that stationary sources be abated. Recognizing the future growth of California requires that other programs be activated which will provide maximum opportunity for pollutants to be diffused in the atmosphere through local and regional planning, proper location of freeways, the development of mass rapid transportation systems, and especially the development of efficient means of transportation which will not release oxides of nitrogen and hydrocarbons, and power plants which will not contribute significantly to the production of organic vapors and nitrogen oxides. Speedy local control of stationary sources, state control of mobile sources, and plans to develop more hydroelectric power and motor vehicles that are not powered by organic fuels will provide relief from smog damage to agriculture in the future.

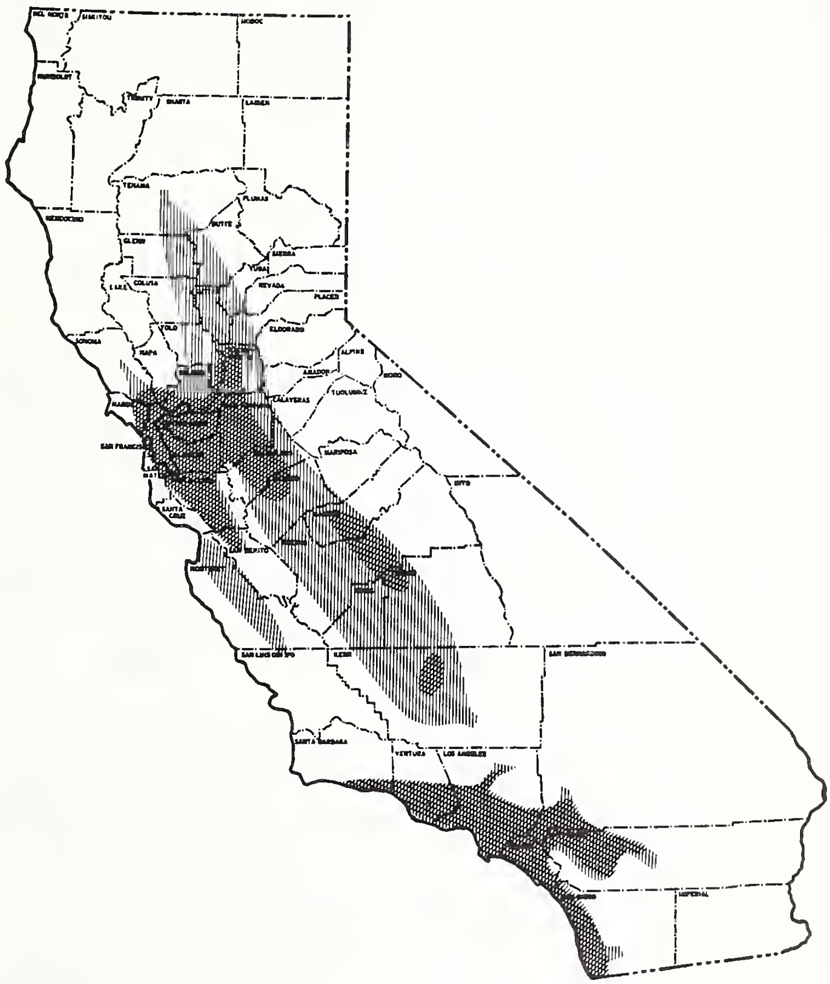

Figure 1. Airsheds (vertical ruling) and plant damage areas (cross-hatched) in California.

BREEDING RED KIDNEY BEANS FOR RESISTANCE TO HALO BLIGHT, ROOT ROT, MOSAIC, AND FOR HIGHER YIELDS

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The variety Red Kidney, which constitutes the greater part of the dry bean acreage of New York State, is very susceptible to halo blight. The disease is not a problem as long as certified seed grown in the arid regions of the West is used to plant the commercial crop. For a number of years we have had a program under way to develop a halo-blight-resistant variety, with the thought that such resistance might enable us to produce at least a portion of our own Red Kidney seed. Certified seed of varieties that are less susceptible to halo blight is currently satisfactorily produced in our own area. Resistance was derived from the variety, Great Northern -1, and has been incorporated by backcrossing.

About four years ago it was determined that among derivatives of the third cross to Red Kidney there were lines exhibiting the following combinations of characters: (1) essentially immune to halo blight, susceptible to mosaic, slightly lighter in seed coat color than Red Kidney, somewhat tolerant to common blight, and free of hard seed coats, (2) moderately resistant to halo blight, resistant to mosaic, slightly darker in color than Red Kidney, no evidence of tolerance to common blight, a high proportion of hard seed coats, and generally higher yields than Red Kidney. In short, the lines available possessed many desirable characters but there were serious limitations for each of the lines available.

In order to obtain lines with desirable expressions for all of the characteristics listed above, the lines then available were intercrossed. Because the ultimate release of a halo-blight-resistant variety had been anticipated by our growers for what to them appears as many years, we moved this material along as rapidly as possible. Selection for resistance was accomplished at Ithaca in the summer, some further selection was done in the greenhouse in the winter, and the most promising selections were increased over winter in Mexico, under the direction of the Rockefeller Foundation. Yield evaluations were begun at the F_6 and F_7 generations. Just this fall, we have selected seven lines which are essentially immune to halo blight, resistant to mosaic (we are currently testing to see if this resistance is against both the Race 1 and New York 15 races of common mosaic), free of the hard seed coats which have plagued us, have acceptable red kidney seed type and color, and have been among the top performers in yield trials. Our expectation is to conduct further yield trials on these lines during the coming season as well as to grow some larger observational plots. In the fall of 1963 we hope to select one of the seven lines for release as a halo-blight, mosaic-resistant variety. Probably the chief fault of these lines is that their time required to reach maturity is slightly longer than that of the variety Red Kidney. The breeders at Michigan State have developed anthracnose-resistant, light-red kidney lines which are slightly earlier than Red Kidney. Our lines are being crossed with these Michigan lines with the view of combining both anthracnose resistance and the earlier maturity with the halo blight and mosaic resistance already possessed by our lines. We have yet to ascertain whether we have retained any of the tolerance to common blight that seemed to be present in some of our earlier breeding lines.

We also have a breeding program under way which is aimed at the development of root-rot-resistant beans. In particular, we are again anxious to incorporate resistance into a red kidney type variety. The variety Scarlet Runner of the species Phaseolus coccineus and the black-seeded, viney selection from Mexico, N203 (P.I. 203958), have served as sources of resistance. Resistance does not approach immunity as is the case for halo-blight and mosaic resistance, but consists of a degree of tolerance. The so-called resistant parents will develop some root rot and the amount of damage on all lines is very much influenced by environmental conditions. The genetic control of resistance is not simple and because of this and the large influence of environment, we have recently begun to use progeny tests and evaluation procedures generally applied to quantitative characters. We continue to use a field that has been grown to beans for the past 40 years or more and which is very much infested with the causal organism, Fusarium solani f. phaseoli. Field evaluation is currently conducted by breaking the field into blocks of 45-foot plots or rows. Positioning of breeding entries is completely randomized so as to minimize the number of closely related lines that may fall into the same block or otherwise be positioned adjacent to each other. Four of the 40 rows of each block are used for check rows, one plot of each of the varieties Yellow Eye, Red Kidney, Scarlet Runner and N203 being planted in each block. Up to four replications of each entry are planted when seed is available. Each family is represented by as many progenies as space and other circumstances permit. About 20 seeds are planted in each 5-foot plot. Planting is done during June and sometime during the month of August the plants are scored for root-rot damage. All but three or four plants of each plot are individually scored.

Within each block the mean scores for each of the checks is used to obtain a calculated rating for each breeding line. These ratings are designed to tell that within this particular block the entry under consideration displayed--as compared with the check varieties--an amount of root rot that was: (a) greater than that of the least-damaged susceptible check, (b) intermediate between the least damaged susceptible check and the most damaged resistant check, (c) intermediate between the two resistant checks, and (d) less than that of the least damaged check. Group (b) has been further subdivided into three classes and group (c) into two classes so that there are a total of seven classes. Utilization of these classes permits direct comparison of observations obtained from different blocks. IBM procedures are used to obtain the calculated ratings and to reshuffle the data so that it can be printed out in such a way as to facilitate meaningful genetic comparisons.

Greenhouse tests are conducted utilizing the procedure outlined in the 1962 report of the Bean Improvement Co-operative. Comparisons between different greenhouse tests and between greenhouse tests and field tests are facilitated by using the calculated ratings or classes as described above. The procedures outlined have permitted good progress in the last year, so that we have been able to select several breeding lines with good levels of resistance. Some of these are from a last cross to Red Kidney and exhibit red kidney seed-coat color, although the seed is small. From an intercross between lines deriving resistance from Scarlet Runner and N203, at least one selection is available which may have better resistance than either of the resistant parents. All of these lines will be used in further crosses to Red Kidney.

Empirical evidence has been obtained to indicate that certain varieties of dry bean have higher net assimilation rates than others. It has also been ascertained that in similar varieties with different average yields, the higher yielding variety frequently exhibits the greater leaf area and that the varieties differ with respect to the proportion of photosynthate that is directed toward development of seed, the commercially important organ. Further studies are planned on these physiological bases for yield differences and crosses for obtaining favorable recombinations of factors are being made.

THE EFFECT OF CHEMICAL DEFOLIATION ON YIELD OF RED KIDNEY BEANS

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Sodium chlorate (a defoliant) and potassium cyanate (a desiccant) were applied to Red Kidney beans at various stages of plant maturity to determine their effect on seed yield.

Yields were not significantly affected by either chemical when 80 to 90 percent of all seed was at a full pink color in 1960. The yields and sizes of beans were significantly decreased with both chemicals when spray application began at the time 40 to 50 percent of the beans were a full pink color in 1961 and 1962. There was a linear increase in yield and size of beans as the chemical applications were delayed for one and two week intervals. There were no significant yield differences from the check when chemical applications were delayed until 80 to 90 percent of the beans were a full pink color.

Yield reductions were greater with potassium cyanate than with sodium chlorate when applied to immature beans in 1961 but no significant differences occurred in the other two years. Seed color was a more reliable indicator of the time to apply the chemicals than was foliage color.

INVESTIGATIONS ON BEAN ROOT ROT AND LEGUME VIRUSES IN MICHIGAN

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The development and introduction of several bean varieties in Michigan the past few years has provided growers with improved varieties having excellent plant types, high-quality seed, and good disease resistance. This has helped assure the Michigan bean industry of a continued supply of high-quality beans year after year. It has also given those of us who were so busily engaged in varietal improvement an opportunity to pay some attention to other major problems confronting the bean industry. In our case, this involves research on other important diseases of beans.

Michigan bean producers still have to contend with several major diseases. These can be grouped into three categories. The first and most important includes the bacterial blights. This group of diseases is also the most easily controlled because all that is required is to plant disease-free seed on land, 4 to 5 years removed from beans. For many years it was impossible for growers to obtain blight-free Navy bean seed because all their seed was produced in the areas where beans were commonly grown. Now the Michigan Foundation Seed Association and the Michigan Crop Improvement Association are planting western-grown bacterial-blight-free seed in isolation in noncommercial bean-growing areas. Hence, the industry is continually supplying certified seed growers with relatively clean seed. This appears to be an economical way to improve seed quality and control bacterial blight for Michigan farmers.

The second group of diseases is those that attack the below-ground portions of the stem and the roots of beans. In Michigan the losses resulting from bean root rot amount to several million dollars annually. Many disease outbreaks early in the season have been so severe that farmers have had to replant or replace with another crop. We have much to learn regarding root diseases. For instance, we have observed fields of replanted beans with little or no Fusarium, whereas the first planting resulted in the death of 90 percent of the beans. Root rot is normally controlled by hybridization, chemical or biological (rotation) methods. We are presently breeding for disease resistance using material obtained from New York in which N203 and the Scarlet Runner bean (Phaseolus coccineus) were used as a source of resistance. Of the two, P. coccineus appears to have a higher degree of resistance than N203. Neither is immune to attack by Fusarium.

If these varieties are not truly resistant but only highly tolerant, then we certainly must be prepared to control the root diseases in some other manner. Chemical control is generally limited to higher-return-per-acre crops. This eliminates dry beans from the group. Finally, we have biological control. That is control by the manipulation of the soil ecological systems in such a manner that the populations of the disease-producing organisms are reduced in numbers or held in check. This should be possible by the addition of amendments, by rotation, or by some other means. Dr. Burke has been doing considerable work along this line in Washington. Dr. Snyder and his group have also studied soil amendments.

Although a barley-bean rotation has been reported effective in reducing root rot severity, under our conditions, this rotation has resulted in an increase in severity of root rot. In fact, root rot was more severe after barley than after 4 other crops and the yields were correspondingly lower following barley. Furthermore, the increase or decrease in root rot under any specific crop sequence was directly correlated with the prevalence of a bacterium parasitic to Fusarium. So as not to duplicate work being conducted at the University of California entirely, we have set our goals on a comprehensive study of the factors that affect the invasion of bean roots by soil-borne pathogens. This encompasses a study of the ecology of the soil microflora. We hope to determine which organisms in the soil are commonly found growing together and which are antagonistic. How do various cropping sequences affect the ecology of the microflora? What is the significance of microbial parasitism on other micro-organisms in the soil? What are the mechanisms that make it possible for one micro-organism to live at the expense of another? What are the morphological and biochemical responses of resistant and susceptible plants to invasion by root and stem-invading organisms? What role does nutrition play in the invasion of the plant by the pathogen? Dr. Snyder and his group have certainly shown that nutrition is important.

The final group of diseases is the legume viruses. This group is exemplified by the yellow bean mosaic, alfalfa mosaic, tobacco ringspot, tobacco streak or red node, pod mottle, and common bean mosaic viruses. Severe outbreaks of many of these virus diseases have occurred in Michigan, resulting in high reduction in yield.

Our first and major effort has been directed toward the identification of the viruses present in Michigan. It was soon discovered that there was no easy solution to this problem, and so we have centered our attention on the development of a key for identification of the legume viruses that go to beans, using plant infection as a basis for classification. We are now in the process of testing this key. In addition, we hope to produce antisera for all the principal groups. Presently we have antisera for three strains of tobacco ringspot, common bean mosaic, and the pod-mottle virus. We are also purifying the viruses for electron microscopy.

CONTRIBUTIONS OF SCIENCE TO AGRICULTURE

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We might say that when the first cliff dweller set aside his best-looking ears of corn for next year's seed, science made a contribution to agriculture. When the explorers following Columbus gathered up some knobby little tubers and introduced western Europe to the potato, science's contribution to agriculture helped set off a sixteenth-century population explosion.

Today agriculture is of course an increasingly complex science itself. We might then recite endlessly from the scientific advances that have made this country the best-fed nation on earth. But I might make a better point by expressing some thoughts on where the sciences of agriculture are going.

In this country we have demonstrated what soil and water, grasses and trees, twentieth century know-how, and the sun's energy can create as food and fiber for man's use. We are reminded by almost daily news stories of yields we can barely keep in bounds. By our own abundance we are most certainly given cause to wonder if this planet needs to have as many hungry people as it has. We may even look ahead and ask if it is truly necessary, as far in the future as we can project world population, that anyone on this earth at any time should go hungry or ill clothed.

When the pioneer plant explorers of the 1500's brought the potato to Europe, people were fairly scarce on that continent by today's standards. A new source of food, possibly more than any other factor, gave impetus to the population growth that followed. Now we are in the middle of another population explosion, an almost worldwide one. This one is most often credited to the science of medicine, with its reduction in infant mortality and extension of life expectancy, even in primitive areas.

Some statisticians who study the rate our species is multiplying calculate that this planet - toward the end of the year 2026 - will contain 50 billion people. (Right now it has about three billion.) These same statisticians also calculate that no small portion of those 50 billion people--only 63 years from now--will almost certainly starve, unless world production of food is stepped up <u>immeasurably</u>. Agricultural science, then, which has surely shown that it can set off a "food explosion" in this country, has the job of setting off a worldwide one to match the population explosion.

Even in our country there are occasions when we feel that agriculture has been running pretty hard just to stay where it is. Our opulence has had some profound effects. The way we live has changed the <u>ways</u> we plant and harvest, and also <u>what</u> we plant and harvest. It has, more than anything, changed the ways we market what we grow.

Our general economic status in this country has leveled off at such a high mark that we can't afford to do a lot of things in agriculture--such as hand gathering of prunes and walnuts--the way we did a few years ago. Human hands are becoming more costly every year as harvest devices. So science, calling on the full role of its disciplines, has gone out to find the farmer economic substitutes.

Our agricultural engineers are in a race to build machines that will do what harvest hands and backs used to do. But there is a catch in the rules of this contest. We are accustomed in this country to high quality, as well as unlimited quantity and variety. We expect to keep on getting our foods at the world's lowest prices too--lowest prices, certainly, in ratio to our less bountiful food markets in the foreseeable future.

As one of our engineers expressed it only a few days ago, we are "over the hump" on beets, cotton, and the prune harvest. We are into peach mechanization. The techniques are ready. There is no reason to think now that we can't mechanize the harvest of delicate fruits. But he added that mechanization has moved so rapidly that fresh fruits and vegetables are well on the way to becoming luxury items.

And so, here is where the plant scientist joins the engineer. Plant science must design fruits and vegetables that can take harvesting by machine and keep their quality, too. And our food scientists are in the race. They must find means of keeping food quality up to our demands after the machines have harvested the crop.

This past year machines developed by University of California agricultural engineers handled around a fourth of the prune harvest in this state. This harvest normally costs about 5 million dollars. The saving in cost for one year was estimated between 400 and 600 thousand dollars. When costs of operation keep rising, this is how science and machine efficiency keep farms in business, and keep their products on our tables.

Sometimes science comes dramatically to the rescue of agriculture. In 1955 the spotted alfalfa aphid hit the California hay crop and losses ran to 13 million dollars a year. But plant breeders in the University and the USDA had the weapons--their arsenal of research-based knowledge--to fire back at the insects. Today half of our alfalfa acreage is planted to aphid-resistant varieties. Each year, through the precision plant breeding made possible by genetics today, the yields of resistant varieties are approaching those of our top-producing alfalfas before the aphid struck.

The chief beneficiaries have been the dairy industry and its customers. The spotted alfalfa aphid threatened to close out California's hay supply. First came prompt chemical controls, then the aphid-resistant varieties. Insect-control know-how and knowledge of genetic principles together saved one of the most vital food supplies. And saved Californians from paying an appalling cost for milk.

As long as there has been agriculture, risk has been its inseparable mate. Farming is still the most competitive of all businesses in the most uncontrollable of all environments. It must always be braced for a blow from either the weather or the market place.

But agricultural science--including economics and engineering--is steadily adding to the areas in which we do have some control. Economics is becoming constantly more precise in its scientific measurement, and we are learning a lot more about the market place.

Today we are especially mindful of marketing because one of the best markets for California's high-value crops has been the countries of western Europe that now make up the prospering Common Market--the European Economic Community. We are not waiting to see what the growing self-sufficiency of the Common Market does to some of our crops. Our researchers have been deeply involved for a long time in studies of the market. They have learned how it is growing, determined what its impact can be on our agriculture, and helped California growers and marketers plan adjustments to stay strong at home and abroad.

The processes of marketing foods in today's specialized world, and even more in the markets of tomorrow, call on a whole spectrum of the sciences. Today's marketers have already found out what our food shoppers want. They want foods that are appealing, and invitingly packaged. And foods that never vary. They want a constant arrival of new products. And more of what we are already calling "built-in maid service." They want shelf lives of months to years with no drop in quality. The sciences of quality control have a job to do.

Some of the sciences standing behind the uniform quality in our food markets today might seem far removed from agriculture in the old sense of plowing and planting and harvesting. Our land preparation today and the real precision planting we are aiming for are, at face value, purely mechanical creations. But real precision cropping can be accomplished only in a soil that is prepared with precision. And that can come only from a deep understanding of soil physics and chemistry. The need of agriculture for far more knowledge of soil structure and soil manipulation will most surely be a crying need if we continue, as we are doing now, to put cities on our most fertile and most uniform soils and paving over our valley fields for subdivisions, shopping centers, factories, freeways, and airports.

The year-end observance of California's new distinction suggests some further calls upon the sciences. In this most populous state we have competition for space and the economics of scale both working in the same direction, toward concentration of people and animals and plants and the problems that crowding brings. Today's tens of thousands of cattle in one feedlot, poultry ranches housing a quarter million birds, and cotton fields that stretch over the horizon are pretty dramatic exhibits of our agricultural future. They are most certainly going to be challenges to the veterinary scientist and the plant pathologist. The more crowded and more specialized the operations of agriculture become, the clearer it is that a touch of disease is a potential disaster. Farm enterprise will become still more a challenge to the geneticist, because the market demands the best in color and flavor, and shape and texture, along with quantity and total uniformity. For the same reasons farming is sure to become still more a challenge to the designers of planting and cultivating and harvesting machinery, to the irrigation scientists and the economists, who scientifically guide modern farm decisions.

We are going to need a lot of new knowledge of how organisms--good and bad--survive in a changing environment. We must know more about what is happening to the bacteria and viruses that affect the lives of our plants and animals--and us.

Resistance to diseases and to parasites and predators calls for vast research enterprise. We have seen bacteria that were once almost totally susceptible to an antibiotic become almost totally resistant. Strains may even be selected that can't live without the drug. Selection can go on to a point where bacteria once susceptible to an antibiotic will resist and survive on even related drugs. Resistance is truly almost a science in itself.

We might say we have seen genetics evolve from mathematics to chemistry, and now amazingly close to the key to full understanding of life. If new developments from the electron microscope come to fruition, genetics may develop a subsidiary technology measuring the very makeup of the DNA molecules. It may not be too "far out" to see ahead precision tools and methods in genetics--means of changing genetic structure to design the uniform steer, or tomato, or bean that the market of the future wants.

We have seen a recent burst of public attention to agricultural science that has not all been favorable. Scientists dealing in chemical control of diseases have been drawn with a marked resemblance to the wicked sorcerer.

Agricultural science in the University of California, I know, has been deeply concerned for many years with the analysis of pest control chemicals to protect people and animal life. Our people at Riverside and on other campuses of the University have been out in front in the search for the most minute traces of pesticides, herbicides, or other chemicals wherever they might end up--on or in plants or animals, or in the soil. This search--involving universities, federal agencies, and industry--is the reason our foods are now probably the safest man has ever eaten.

The chemical defense against plant and animal pests has another side, too. This world's arable land has already shrunk to 1.2 acres per person. When the three billion people in the world today have multiplied into six billion, as they will in about 35 years, the land that can grow our food will have shrunk to little more than a half acre, no bigger than your suburban lot.

It will take new chemicals--which must be safe chemicals--new plant varieties and strains, new fertilizers and vast quantities of them, and radically new methods of growing plants and animals to feed even our own people. This need in an exceedingly near future calls upon all of the agricultural sciences and on those who can transplant our science and know-how to other areas of the world. Agricultural techniques are unevenly distributed, and the need in places is already desperate.

I am sure I don't need to suggest to you where a few hungry billions of people around this world can look for one good source of nutrition. For ourselves, living in the opulence of this country in the 1960's, we tend to think in terms of animal proteins--and of converting our surpluses of vegetable resources into them. But about 80 percent of this world's people today go through life rarely, if ever, tasting meat, or any other food that does not come directly from a soil-grown plant.

In the United States we are eating 89 pounds of beef per capita, 43 percent more beef than we ate 10 years ago. But wherever population has already reached near-disaster proportions, the primary foods--the food grains and legumes--are almost the only foods. There isn't the quantity or time for conversion into the animal proteins we favor.

Even in this meat-eating country some primary food items are holding a pretty high popularity. Up in New England, we certainly are served our traditional baked beans without apology. And the pintos and reds and pinks are surely staples in this beef eating and beef growing Southwest. So, whether we are thinking of regional tastes or international needs, we can be sure we need more knowledge of the bean as a growing plant, as a storable, staple crop to market, and as a nutritional item on the table.

A glance over your program tells me this meeting offers a fruitful mingling of the sciences and exchange of information. Nutrition, plant pathology, genetics, economics, engineering are readily apparent in the topics of discussion. I would hope that it is as readily apparent that behind each of these topics lie fundamental studies in the laboratory and the field.

Remarks on the "Nutritional Value of Dried Beans" could come only from knowledge of the biochemistry of beans; and that knowledge could come only from many hours in the laboratory, from extractions with the intricate and costly tools of modern biochemical research, from measurement of animal feeding values, and from reading--incessant reading--of the findings of other scientists in the literature of nutritional research.

I am well aware, too, that a talk on the "Effects of Smog on Agricultural Crops" stems from a lot more than John Middleton's wandering through the lettuce and celery and bean fields. His information comes from the breakdown of smog into its smallest components and the creating of smog through monstrous and ingenious--and expensive--devices. His information comes from elaborately controlled chambers where plants can be grown with <u>no</u> smog--something of a feat now any place where automobiles and industry concentrate.

Basic studies in many disciplines and much applied science and engineering must be the sources of such roundups of knowledge. Your speakers have drawn from the bank of fundamental knowledge that is science's great and continuing contribution to agriculture.

We might take a cue from the commercial world. A few weeks ago our idea was expressed for us by the president of du Pont. His company, he announced, will most certainly continue its program of basic research. And then he added: if the choice were between doing basic research and paying dividends, <u>he</u> would choose research. Because du Pont had chosen the road of fundamental research in past years, he said, du Pont is paying dividends today.

The fundamental research going on today in our Division of Agricultural Sciences at Davis, Berkeley, Los Angeles, and Riverside will help agriculture pay future dividends to the people of California and the world.

CONTRIBUTIONS OF UTILIZATION RESEARCH TO NEW FOOD PROCESSES

Sam R. Hoover
Agricultural Research Service, USDA, Washington, D. C.

I am happy to have your invitation to talk to you, for this is an excellent opportunity to sketch, in a general way, some of the things our laboratories are doing in some areas of food research. As the rest of the conference is devoted solely to the dry bean, I will give you five examples of process developments, which have been worked out in our laboratories on other foods, to illustrate the type of process development work which we have been doing so successfully. At another time, perhaps, someone will tell you of the more basic studies on the constituents of foods and the enzymic and technological changes which they undergo, which constitutes a major portion of our research program; but I will not do so today.

Some of you in the dry bean industry may not realize that the Western Utilization Research and Development Division in Albany, and its satellite at Pasadena, are just a part of a program that is worked on in the North, East and South; Peoria, Illinois; Wyndmoor near Philadelphia; New Orleans, and the fruit and vegetable regions of the Rio Grande Valley and Florida. If any of you wishes more detailed information about the processes I am going to describe, I urge you to get in touch with the director of the respective division for the most recent information they have available:

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- Dr. C. H. Fisher, Southern Utilization Research & Development Division, 1100 Robert E. Lee Blvd., New Orleans 19, La.
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Dehydrofreezing. A process was discovered in the early 1940's in our Western Laboratory, which has, in more recent years, developed into a large scale method of preserving fruits and vegetables. After the necessary steps of washing, peeling, blanching, etc., which are common to all food processing, the food is partially dried to remove about 50 percent of the water. It is then frozen, packaged, and treated in commerce as frozen food is handled. The decreases of 50 percent in weight and volume, in freezing costs, in packaging and subsequently in storage costs are significant, essentially offsetting the additional costs that arise from using two distinct processing steps. The products rehydrate quite well to give a cooked fruit or vegetable that is equivalent to the best frozen products. The initial success of this process was in products for remanufacture--most notably with pimento for processed cheese spreads; and more recently peas and Lima beans, apples for pies, and in developing increased domestic and export markets. Dehydrofrozen potatoes appeared on the consumer market in the past year, and I can attest to the excellent quality.

Sweetpotato flakes. I will not review the major contribution to the dehydrated potato products made several years ago by our Eastern Laboratory in the development of potato flakes and our Western Laboratory in the development of potato granules. These products, and more recently, dehydrated sliced products, have made major contributions to stemming the decrease in potato consumption, and we are confident of increased use in both institutions and homes.

Our Southern Laboratory at New Orleans has recently developed a processing technology for sweetpotatoes which is quite similar to the white potato process, but has many differences in process steps, resulting from the differences of the raw material. The cured sweetpotatoes are washed, preheated, lye peeled, trimmed, sliced, and steam blanched (cooked), pureed, and drum dried. The resulting flakes are ground and packaged.

The sweetpotato is unusual in that it is not distinctly a tuber, but is a root tissue that keeps on growing as long as the plant grows, and quite large sweetpotatoes can be produced which are satisfactory for processing this way. Sweetpotatoes are also very susceptible to rots and large losses occur in marketing and in the home. The sweetpotato flake can be made from large or misshapen roots and are a stable product, quite high in vitamin A, readily incorporated into many dishes. One plant operated successfully last year, and within the next month another is scheduled to go into operation. As yet, the product is sold strictly on the institutional market.

Foam-mat drying. The Western Laboratory has pioneered the development of a process in which liquid food products are whipped to a stable foam and air dried. The greater bulk of the foam allows more rapid drying and a wide variety of products have been shown in the laboratory to be suitable for this type of dehydration. In co-operation with our Southern Laboratory and the Florida Citrus Commission, which contributed both funds and personnel to the project, a major effort to produce a foam dried orange juice is under way at our Fruit and Vegetable Products Laboratory at Winter Haven, Florida. The dryer employs a continuous belt and the foam of orange concentrate is fed through nozzles which lay down strips of foam. The resulting product looks like yellow, brittle spaghetti. It is ground and packaged. Problems of maintaining a fresh orange flavor in the dehydration step and flavor maintenance in storage are still under investigation. An alternative method of preparing the foam for drying includes deposition of a sheet of foam on a perforated tray and "cratering" this sheet by blowing a jet of air through the perforations. Dryers for this method have been developed, are available from machinery manufacturers, and are now in commercial use.

"Instant" fruit and vegetable pieces. Quickly rehydrated fruits and vegetables are produced by an explosive puffing process now being developed by our Eastern Laboratory. One of the major drawbacks of dehydrated fruits and vegetables is the long time necessary for rehydration. Potatoes, beets and carrots, for example, take 25 to 30 minutes of simmering--a time comparable to that needed to cook the fresh vegetable. In this new process, the food is again washed, peeled and blanched in the conventional manner, but is then cut into pieces. To date, most of the studies have been done with 3/8-inch dice, which is dried by hot air to an optimum moisture content of 35 to 40 percent. It is then charged into a puffing gun, similar to those used in the puffing cereal industry, heated to a definite pressure of steam inside and blown from the gun as an expanded, porous piece which maintains this more open structure when it is dried to the low moisture content necessary for stability. The total drying time is greatly diminished because of this change in texture; the total time necessary for rehydration and cooking is about five minutes. Most satisfactory results achieved to date have been with carrots, beets, potatoes and apples; sweetpotatoes and many other vegetables and fruits are also under study. It is anticipated that major use of such products will be in dehydrated soups, stews, etc.

Oriental soybean foods. For our fifth example, let us go way out to Miso, Tofu, and Tempeh. These are not islands, but are traditional soybean foods of Japan and Indonesia, and they are really good. After World War II, the Japanese were importing soybeans from the U. S. rather than their former source in Manchuria. They reported that our beans did not ferment satisfactorily in the process of making their food products, and an important market was threatened. So the American Soybean Association brought over two Japanese scientists to work at our Northern Laboratory. Here our know-how on both soybeans and fermentation processes is centered. The work was quite successful; rapid fermentation methods were developed that produced superior products from a number of varieties of U. S. beans.

What are Tofu and Miso? Tofu is the soy curd, somewhat similar to cottage cheese, which is eaten in many parts of the Far East. Miso is, next to soy sauce, the most important soybean food of Japan. The annual consumption is over 900,000 metric tons, over 1 ounce per capita per day. It is a major constituent of the hot breakfast soup which the Japanese eat, and is a flavoring constituent in vegetable and meat dishes. It is rather highly fermented and probably would only be eaten by Americans as a flavor constituent.

Miso is produced by an interesting combined fermentation in which rice is molded by *Aspergillus oryzae* and the soybeans by *Saccharomyces rouxii*. In the laboratory studies, it was found that soy grits, a necessary commercial form of soybeans, can be converted rapidly and easily to Miso.

In carrying out this work, an interesting collaboration between the Soybean Council, the Foreign Agricultural Service of the Department, and our Northern Laboratory was developed. The Soybean Council brought Japanese scientists to Peoria, and through collaboration with specialists in the Fermentation Laboratory, the problem of adapting modern technology to these unusual foods was rather quickly solved. The Japanese scientists, now back in their own country, are working on this development of a modern food technology to an ancient food.

Tempeh is a favorite Indonesian food, produced by a 24-hour fermentation period of soybeans by *Rhizopus oryzae*. The inoculated beans are fermented in a wrapping of banana leaves; it was found that a perforated cellophane bag could be used and a pan fermentation was also developed. The raw product is deep fried and is very, very good. I believe there are real possibilities of a specialty and snack market for Tempeh in our country.

These five examples illustrate some of the types of processes that are being applied to other foods than beans in our laboratories. As I stated in my discussions, these are only examples of a portion of our work on food products in the laboratories. I have omitted deliberately our programs on poultry, meat and animal products--the areas I, myself, have been mostly engaged in for many years; and I have not even mentioned our major studies in cotton and wool, and in the industrial uses of cereals, oilseeds and other crops. I hope I have stimulated you to come to our laboratories and learn about our research in each of these diverse areas.

MODERN MERCHANDISING AND PRODUCT DEVELOPMENT

D. M. Anderson
Assistant General Manager, Sunkist Growers

Modern merchandising and product development are obviously two entirely different activities, but just as obviously, very closely related. Product development is just as important in agriculture as it is in the field of electronics and as yields per acre become larger, product development will become increasingly important. While there may be arguments regarding the merits of frozen foods, the development of this line of agricultural products has without question helped to move what might otherwise have been surplus crops and, of equal importance, has elevated the nutritional standards of the American diet. Improvement in meat processing has certainly broadened markets and made it possible for meat producers to minimize waste.

Product development, to say the least, is expensive and time-consuming. Some of the leading people in food research have stated that one-tenth of the products researched develop into real sales potentials. Because of its expense, product development demands close direction and strict budget control, coupled with imagination and patience. These four points are somewhat paradoxical, but certainly outstanding product development has used all of them.

Product development does not always mean new products. It is extremely valuable in gaining new recognition for old products and thus keeping consumer interest in those products at a profitable level. I would cite an example in our own organization where new-product research actually helped in the marketing of our old-line standard product more than it did the new product itself. I speak of bio-flavonoids. In studying bio-flavonoids, a material now common to most cold inhibitants and a good many other pharmaceutical products, our Research Department originally was intending to develop a by-product of citrus fruit. It was rather soon determined, however, that if the product was available in the fresh fruit, it could be demonstrated that it was just as useful in fresh-fruit form as it was in the product form and the bio-flavonoid story was picked up quickly and used in our educational and advertising work to promote the sale of fresh oranges. Fortunately, this development occurred at a time, when fresh fruit needed a sales stimulus because there was a strongly increasing interest in the use of frozen concentrated orange juice as a substitute for fresh oranges. The bio-flavonoid research was very instrumental in turning consumer attention to fresh oranges--and to fresh oranges from California, in particular--and certainly was invaluable in maintaining the fresh-orange market for the California citrus grower.

New product development must have, as one of its handmaidens, market research. Scientists can develop many new products, but if it is true that only one-tenth of the projects researched develop real sales potential, then it is equally true that 90 percent have little sales value. Market research can help us to determine in advance whether or not new products have a chance to succeed.

Merchandising, in my definition, is a word which verbalizes a noun that really means getting the merchandise and the consumer together. Merchandising is tremendously important in the sale of new products but is equally important in the sale of existing products. It is impossible to introduce new products or maintain old products without strong merchandising support. To understand this we need only take a brief glance at the retail grocery distribution picture of today.

The latest statistics on this subject indicate that in round numbers there are 260,000 retail grocery stores in the United States. Twenty-one percent or 55,000 of these stores do 81 percent of the business. Of these stores 79 percent or 205,000 do 19 percent of the business. It is obvious that the 81 percent must be large stores with expensive installations and expensive maintenance costs. This leads us to the inevitable conclusion that these stores must do a high-volume business at a reasonable margin of profit.

As a result, those of us who merchandise and sell to the retail grocery trade have come face to face with what is sometimes termed IBM buying, or selling to the electronic idiot. Buyers in the modern grocery field depend upon extremely accurate and precise inventory and sales records to determine their buying habits. Practically all of the large stores in one way or another use computers to determine their day-to-day position in all of the 8 to 10 thousand products that they stock in a single supermarket. This has led to the square-foot theory of grocery store income. The square-foot theory is common practice and it's good business, but in the introduction of a new product, it makes quick success a necessity and in the maintenance of an old product it makes absolutely essential the maintenance of a high level of volume. Both of these factors emphasize need for strong merchandising.

The average supermarket today demands approximately $3.50 gross income per square foot per week. This will vary by departments, of course. The produce department, for example, the one with which I am the most familiar, should average $2.27 per week per square foot. I don't know the mathematics of this as regards beans, but let's take oranges, which I do know. One carton of oranges requires two square feet of display space. This means that these two square feet must earn $4.54 per week if the product is to be successful as far as the store is concerned. In 1962, oranges were priced at retail on the average to reflect about $3.26 per square foot, or $6.52 for two square feet. Bear in mind, however, that a two-foot display of oranges is a small display. But as long as the $3.26 per square foot earning is prevalent and as long as the cost that must be developed from the space is only $2.27, oranges are in a good position in the retail store.

Looking to the future, however, in orange production for California, stores doing 81 percent of the business in the United States must sell 412 cartons of oranges per store per year, compared to about 275 cartons per year last year. Increases in population will help, but continued merchandising is also necessary to do the job.

What are the objectives of merchandising? I would list them in about this order:

1. To keep products in the main stream of consumer traffic. By this I mean placement to attract consumer attention. There are various ways of doing this--location of displays, shelf talkers, price cards, any type of device which will get the product into the public eye and set it somewhat apart from the general run of products in the store and thus gain additional consumer attention for that product.
2. To keep the product priced properly for volume sale with mutual profit for all levels of distribution. A product which is used as a loss leader may be attractive to consumers, but will not continue to be attractive to retailers unless it develops such a terrific store traffic that they can afford to carry it as a loss leader. A product priced too high will diminish volume and the store will find that its earnings, while high on a single unit, do not average high enough to keep the product in the store.
3. To help co-ordinate sales and advertising at point of purchase. Merchandising itself never sold anything. It has to be in support of advertising and sales if it is to accomplish the job. Merchandising can help develop sales programs and develop advertising programs, because the people engaged in merchandising are the closest to the consumer of any of the people working in the field of distribution, with the exception of the retail clerks themselves.

The fundamentals of merchandising are very important. First of all, I believe sincerely that merchandising must be planned and controlled by the seller of the merchandise. Money is wasted and effects are nil if the buyer determines merchandising programs. Merchandising is sometimes confused with price discounting. Some sellers, unfortunately, regard discounts from the face of the invoice as merchandising. In my estimation, this type of activity is nothing but bribery to encourage the store to stock the product and loyalty to the product lasts only as long as that is the lowest price at which the product can be purchased. The minute another seller comes along with a similar product at a lower price, the buyer will move to the lower price schedule. Merchandising must be sold as a service of the seller which will enhance the value of the product to the buyer.

Merchandising must have a basic continuing program. It must have a goal. The appearance of merchandising may change from year to year as packages change from year to year, or from season to season, but the underlying motive must be to increase the sale of the product, keeping in mind the inherent value of the product itself.

Merchandising certainly demands experienced personnel. Competition is extremely acute in the field of merchandising, just as the competition for space in the modern grocery store is extremely acute. Only those people with experience who can demand respect for their knowledge should engage in either merchandising or new product development.

PANEL DISCUSSION: What's new in the bean industry?

Moderator: F. Regis Dailey. Members: Ella Lehr Nisja, Robert G. Dodge, J. C. Hawley, Gordon W. Monfort.

Question. Eastern beans are usually handled at 16 to 17 percent moisture content and western at 8 to 10 percent. What effect does moisture content have on handling?
Answers. Mr. Dodge: In eastern areas splitting and checking occur in beans containing less than 16 percent moisture. This damage occurs on farms, in elevators, and in processing plants. In cold weather such beans when suddenly warmed tend to pop open and must be tempered slowly. Mr. Monfort: Moisture and temperature have a definite effect on cooking time (see report by Herman Morris).

Q. Does cooking time affect sales?
A. Mr. Monfort: A Lima Bean Advisory Board survey several years ago showed that sales are reduced by slow cooking. Some younger women however have become interested in cooking beans because they can be flavored to please individual tastes. Some young housewives have expressed interest in recipes that require a long time--because cooking provides an activity to fill the hours when children are in school.

Q. How does flatulence affect sales of beans?
A. Monfort: The editor of Volume Feeding Management has estimated that institutional sales of beans could be doubled by solution of the flatulence problem. Nisja: Because of flatulence hospitals do not use dry beans. A food editor of one national magazine rarely prints bean recipes because mothers object to beans in children's diets.

Q. How do canned beans affect market for dry beans?
A. Monfort: Cost and flavoring keep dry beans on grocery shelves. Nisja: New canned bean products are attractive and are receiving promotion, whereas little effort is devoted to dry beans.

Q. Do instant bean powders have sales possibilities?
A. Nisja: The popularity of "convenient" foods suggests that powders would be popular and as a result of my work (see report of speech by Mrs. Nisja) I am most enthusiastic. (There was some comment to the effect that canned products meet the need for convenience.)

Q. How will the European Common Market affect dry beans?
A. Hawley: The effect will probably not be too great because, so far as we know, tariff barriers are not being erected against dry beans. In fact because of last year's shortage in France, tariffs have been reduced. USA now seems to have become an exporter of Limas to England, as a result of reduction in production of Madagascar Limas.

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