ON-GOING RESEARCH PROJECT STATEMENT
(PROPOSED EXTENSION - ADDITIONAL TIME AND FUNDING

January 10, 1971

A. PROJECT SUMMARY

1. Statistical

Project Title: Improvement of the Nutritional Quality of Wheat Through Increased Protein Content and Improved Amino Acid Balance

Extension: Proposed Extension Period - Three Years

Contractor and Address: Wheat Laboratory, Department of Agronomy, University of Nebraska, Lincoln, Nebraska 68503

Principal Investigators: Drs. P.J. Mattern (Analytical Laboratory)
V.A. Johnson and J. W. Schmidt (Plant Breeders) Lincoln

Duration: Current Authorized Period: July 1, 1966 to March 31, 1971
Proposed Extension Period: April 1, 1971 to March 31, 1974
(Subject to review at the end of the second year to determine whether additional time will be required to satisfy project objectives.)

Total Estimated Cost July 1, 1966 - March 31, 1974	$1,533,827
Total Estimated Cost July 1, 1966 - March 31, 1971	783,827

FY 1971	-	240,000
FY 1972	-	250,000
FY 1973	-	260,000
		750,000

Project Manager: Samuel C. Litzenberger, TA/AGF

2. Narrative

AID has supported this contract research activity at the University of Nebraska since 1966 to improve the nutritional quality of wheat. Ordinary wheat provides ample calories but it is relatively low in protein and certain essential amino acids. Increasing the protein content and quality of wheat offers an economical, practical and acceptable way to improve nutritive quality of diets where wheat is adapted, particularly when the genetic process is incorporated with the development of higher yielding varieties underway.

Uniform International Winterwheat Performance Nurseries which were established in 1969 and expanded to include 39 locations in 25 countries in 1970 will require further expansion to improve the network of winter and spring wheat breeding programs in the LDCs.

Evaluation of the USDA world wheat collection of bread wheat (13,000 samples) has been completed. Screening of the durum varieties (about 3,500 samples) for protein and lysine is nearly completed. Lysine differences from 2.25% to 4.29%

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(lysine percent of protein) have been found among the world collection. The nature of these differences (genetic and non-genetic) is being determined in special plantings.

Hybrids of different high protein and suspected high lysine wheat varieties have been made.

Comprehensive analyses from these progenies are under study. Some hybrid population with superior nutritional qualities were distributed in South Korea and India for evaluation and selection.

Additional research is required to achieve the following: (1) develop "Mexican" type varieties with a broad-base germ plasm and improved protein content and quality, (2) develop technical competence of local breeders so that they can successfully incorporate new improved varieties into their programs, (3) develop methods on enzymatic hydralysis for determination of value of wheat protein.

This project is closely linked with CIMMYT, North African Regional Accelerated Wheat Production Project, the FAO and individual USAID Missions.

B. EXPANDED NARRATIVE STATEMENT

1. Project Description Background and Accomplishments

Wheat -- a major food worldwide -- is a predominant element of the human diet in the LDCs. Like the other major cereals, it provides ample calories but ordinary varieties are usually low in protein content and in certain amino acids, notably lysine. The purpose of this project, approved by the RAC in May 1966, is to improve the nutritional value of wheat varieties produced in the LDCs by increasing protein content and improving the amino acid balance of breeding stocks and by incorporating these lines into the varieties used by farmers. Now in its fifth year, the project is about midway in the 10-year time span originally projected and usually required for such plant improvement programs. However, considering the progress already made, a three year extension is now proposed with further review at the end of the second year to determine the additional time needed to achieve the project's long-range objective.

Prior to initiation of this project, little was generally known about the existing genetic variation of protein content and quality among the wheat varieties produced in various parts of the world. The logical initial effort, therefore, was a systematic screening of USDA's World Wheat Collection for protein and amino acid (lysine) differences to identify strains with superior protein characteristics. Evaluation of the bread wheat collection (about 13,000 samples), now half finished, will be completed by the end of this calendar year.

Among the varieties already analyzed, protein content ranged from 7 to 22% and lysine from about 2.3 to 4.3% of the protein content. Numerous hybrids of different high protein and suspected high lysine varieties have been developed and many have been tested in the field. In 1969, thirty of the most outstanding winter wheat varieties were uniformly grown as an international yield nursery and evaluated at 23 sites in 16 countries on five continents; in 1970, the performance trial was expanded to include 39 locations in 26 countries. One of the 1969 entries -- Bezostaia -- proved to be a superior genotype throughout the winter wheat producing areas of the world. However, varieties possessing Atlas 66 genes for high protein -- developed at Nebraska and field tested at the same time -- consistently maintained their protein superiority over other varieties. Judged by results to date, the Nebraska project has demonstrated that genetic control is not only an effective tool to incorporate more and better protein but is highly essential to achieving the desired goals of improving the nutritive quality of wheat.

Analyzing protein and lysine content of segregating populations

Hybrid populations utilizing primarily three genetic sources of higher protein (Atlas 66 or Frondosa, Aniversario, and P.I. 176217 or Nep Hal) are being analyzed for improved protein content. Of this list, P.I. 176217 and five additional selections of higher than normal lysine content have been used similarly in hybridization and their progeny are being checked for improved amino acid balance.

Twenty-six breeding lines, whose grain averages 2 to 3 percent higher in protein than that of commercial varieties under Nebraskan conditions, have been released from Lincoln to interested wheat breeders. These breeding lines will serve as genetic sources of increased protein in the development of commercial varieties with agronomic and quality characteristics desired by growers, the milling and baking industry, and consumers. Atlas 66 is one of the parents of all 26 breeding lines.

Lysine analyses of segregating populations have shown P.I. 176217 to be one of the most encouraging parents for improving lysine content genetically. Five other varieties containing above-normal lysine are also being used in the hybridization effort and as resulting selections become sufficiently advanced they are evaluated for lysine. To date this phase of the project has not been extremely fruitful since a number of the higher lysine strains have not 'bred true', i.e., the recorded value did not continue high under subsequent tests. Apparently in some instances environment was the causal factor and not genetic. While some such experiences have occurred, it can be stated that it appears possible to increase lysine through genetic manipulation. However, it is more complicated than changing the protein content.

Analyze protein and lysine determinations from IWWPN trials

All determinations from the second International Winter Wheat Performance Nursery (IWWPN) test will be completed by the end of this year. The results are expected to be published before March 31, 1971. All analyses have been made on each replication from trials conducted at 39 locations in 25 countries. The varietal entries have been the same both years.

Assemble and distribute seed of Third IWWPN test

For the 1970-1971 nursery there are 38 sites and 13 new entries. Thirty-three varieties will be increased and preliminarily evaluated for possible inclusion in the 1972 nursery. Special disease evaluations of varieties included in the IWWPN are undertaken by Drs. Fuchs (Germany), Boskovic (Yugoslavia) and Weilenmann (Switzerland) and for winter hardiness by Dr. Grant in Canada. Most recent requests for the IWWPN nursery have come from East Germany, Bulgaria, Czechoslavia and Russia. Since the U.S. does not have diplomatic relations with East Germany it will not be possible to cooperate with them. Of those cooperating in growing the first two IWWPN trials only France did not wish to be included in the 3rd year's work.

Provide material and technical assistance to all cooperators as required

Travels have been effected to cooperating locations in support of this wheat activity by Dr. Schmidt to Italy and Turkey and Drs. Johnson to Iran, Austria, Yugoslavia, Turkey, Afghanistan, Switzerland, Rumania and England. Through these efforts, addressing the wheat breeders at the Turkey Conference in April 1970, by seed exchanges, providing reports, correspondence, etc. close contact has been had with cooperators. This has kept cooperators in close touch on progress of the research and on project status. One Korean research worker is currently at Lincoln to gain practical experience in wheat research and production. More foreign students are expected, although most training could be satisfied through the regular training programs offered in wheat research and production at CIMMYT in Mexico.

2. Relativity to AID Objectives

Protein malnutrition is second only to total food supply in the worldwide problems of LDCs and is consequently a matter of paramount concern to AID. The malnutrition results from shortages of high-protein foods and deficiencies of protein quality in the foods most widely consumed, among them wheat. These deficiencies can be corrected by several methods. One of the most practical and efficient means is to improve human diets by increasing the quantity and improving the quality of the protein content of this major cereal food. The applicable key problem area is "Higher Protein Crop Production" and its priority rating is one of the highest.

3. Anticipated Objectives

The proposed three year extension of the Nebraska project is expected to achieve the following: (a) a more rapid buildup of indigenous research

capability in cooperating countries by providing field and laboratory experience for more trainees, and increased on-site assistance to local breeders in incorporating new improved materials into their local wheat improvement programs; as well as (b) a broader and more dependable base for determining the best method of analyzing the nutritional value of wheat protein and for selecting the improved protein sources best adapted to the environment of individual LDCs.

4. Other Related Research (within/without AID)

There are three A.I.D. centrally-funded research projects involving cereal grains that support the same objective as the Nebraska wheat project; that is, improving their nutritional quality through increased protein content and improved amino acid balance. Purdue University is the intermediary for the research on the other two -- sorghum and maize. In addition to the cereal protein effort, A.I.D. through USDA is responsible for research on pulses (beans, peas, lentils, etc.) now under way in Iran and Puerto Rico and until recently in India as well. As a result of these ongoing research programs, collaborative linkages are being established with other U.S. universities, the international research centers, the Foundations, and local institutions and agencies in the developing nations. These linkages will allow the scientific and research capabilities of each of the cooperating institutions to be utilized efficiently and effectively, at lower aggregate costs.

5. Project Program

Scope and Methodology

Encouraging progress has been made on all facets of the work required of the contractor when this project was started; namely: (a) to systematically evaluate the world wheat collection for significant differences in lysine and protein content; (b) to establish complete amino acid profiles on high lysine wheat varieties; (c) to test high lysine and other nutritionally promising lines at different locations to determine the effect of environment on the stability of high lysine and high protein traits; (d) to introduce genes for high protein and high lysine into wheat breeding programs of developing countries; (e) to combine new genetic sources of high protein with existing high protein lines to further raise the protein threshold in wheat; and (f) to make available promising materials, when identified, to other countries and research agencies.

An International Winter Wheat Performance Nursery (IWWPN) was established in 1968 with numerous cooperators in the LDCs to aid in identifying agronomically superior varieties and to serve as a necessary vehicle for exchange and evaluation of nutritionally superior new wheat selections. Seed of the first IWWPN was distributed to cooperators in June 1969 and the results have already

been analyzed. Seed of the second IWWPN was assembled and distributed in June 1970, and at least three more such annual nursery trials will be needed to reach valid conclusions regarding the performance of different strains and varieties of wheat in different environments.

Work Plans

The main thrust of the project during the next few years is expected to shift increasingly from screening and identification to the rapid utilization of newly acquired research information and nutritionally superior genetic stocks in an expanding program for developing countries. The nature of the project activities, however, will remain as before partly in the laboratory and partly in the field.

Quality Laboratory

Continuing analyses will be required for protein content and quality and amino acid balance to evaluate selected lines from environmental nurseries in the U.S. and the annual nursery trials overseas; to determine which of the genotypes used for higher protein are the most satisfactory in the protein improvement program; to identify new genetic sources of protein to achieve higher levels of protein in commercial types, etc. The number of samples analyzed will be in the realm of 100,000 annually.

Initiate research on enzymatic hydrolysis for determination of value of wheat protein

Using the chicken egg as a base, enzymatic hydrolysis studies are currently underway to establish biologically the value of high protein and high lysine wheat lines. Chemical acid hydrolysis values are relatively unsatisfactory as they do not correlate with actual feeding trials. Enzymatic determinations will facilitate research by indicating which components are truly digestible and those that are not. This would also apply to the endosperm segment.

Before any high protein variety is released it must be verified that it also has a relatively high lysine content, as high protein does not necessarily mean high lysine. In fact it may be the contrary according to the studies made to date. Therefore, it is essential that both the protein content and lysine be checked before releasing to farmers for production.

Field and Nursery

New hybrid combinations will be made between wheat varieties with the best nutritional and agronomic potential. Distribution of germ plasm and research information to AID Missions and wheat researchers in developing countries will be continued. Evaluation and selection of high-protein and

high-quality crosses will be made to achieve new levels of higher protein in wheat. On-site inspection of IWWPN trials and consultation with AID Missions and cooperating personnel will be continued as required.

The combined analytical and field activities will require more time than previously for data collection, evaluation, report preparation and training support: on-the-job, counterpart and workshops. A minimum of three years of additional research and technical assistance will be required to achieve meaningful results.

Continue protein and lysine analyses of winter and spring wheat lines

The Yuma, Arizona and Davis, California locations are regularly used to facilitate evaluating segregating lines from winter and spring crosses and nurseries grown under non-winter severe environments. The California location is common to CIMMYT where the less-hardy Mexican Wheat varieties are able to survive without killing. With such an arrangement both improved spring and winter types can be selected for distribution to the cooperating LDCs. About 5,000 samples are expected to be evaluated per year from these tests.

Develop special high protein populations

As is now being developed by the sorghum breeders, wheat breeders will use the newly discovered male-sterility character in producing a special plant population of high protein lines. Into this population will be incorporated all high-protein and high-lysine cultivars or lines as they become known or are isolated. This live bank of germ plasm will be maintained by the Nebraska Station as both winter and spring wheat populations. As a breeding tool this is a new technique. It will be made available to all cooperating in this common effort of improved wheat nutrition.

Determine location of increased lysine and protein in wheat seed

Additional work is planned to determine where the increased nutritional factors are located and what affect milling will have on its use for bread, animal feed, etc. While nutritional differences are not expected to be great, if any, with the newly developed materials when compared with currently grown varieties, should unexpected differences become evident this should be made known as in many countries not all of the wheat kernel is used in the same way in all parts of the world. Where it is eaten or utilized in its entirety there are no problems, but where the bran and germ are removed and only the endosperm are utilized for bread it must be known how much digestible protein and lysine are also contained in this component.

6. Evaluation of Contractor Competence

Based on performance to date, the University of Nebraska is uniquely qualified for this project activity. It has general and specialized laboratory facilities for conducting basic and applied research in various phases of wheat chemistry. Its Experiment Station has ample land for the field propagation of varietal selections and breeding lines. The project leaders have had long years of experience in the required fields of expertise and two of them -- Drs. Virgil Johnson and John Schmidt recently received national citations for their accomplishments at the University in developing improved varieties of winter wheat.

7. Utilization/Dissemination of Project Results (within/without AID)

Reports submitted to AID for distribution internally and to Missions, etc. have routinely listed high-protein and high-lysine wheat varieties identified by screening of the USDA World Collection, and these values have been made a part of the permanent record maintained by the Department's Agricultural Research Service.

Wheat germ plasm identified as having superior nutritionally quality (higher protein and/or suspected higher lysine) will be distributed as soon as possible to all cooperating breeders in developing countries. The extensive breeding, selection and laboratory evaluations will fully support maximum effort along these lines. Similarly, results from enzymatic tests for protein digestibility which determine the best known genetic sources, will be made known to and utilized in the cooperative breeding program.

All research findings will be widely distributed in scientific journals and at national and international meetings, as has been done in the past. The availability of superior germ plasm and new analytical techniques will be made known to other scientists in these publications and meetings.

All data relating to protein and amino acid composition of wheat varieties analyzed by the contractor are put on punch cards and printout sheets and are made available to all cooperators in other countries, the International Maize and Wheat Improvement Center (CIMMYT) in Mexico, USDA, the Rockefeller Foundation and other interested agencies and organizations.

8. Technical Evaluations (within/without AID)

There is a high level of interest, worldwide, in the cooperative wheat protein research effort at the University of Nebraska. Cooperators are enthusiastic about the usefulness of the information provided by the International Winter Wheat Nursery, now in its second year. All are familiar with the project reports and publications, and some are sending their own

nationals to the U.S. for study with the wheat group at Nebraska.

The proposed project extension will be reviewed shortly with regional bureau representatives on the Technical Agricultural Subcommittee.

9. Participating U.S. Missions, Foreign Institutions, etc.

USAIDs in cooperating countries where winter wheat is an important crop are participating directly in Nebraska's project activities overseas. Among these are: Tunisia, Morocco (North Africa), Turkey, Pakistan, Afghanistan (Middle East), South Korea (East Asia) and Argentina, Brazil and Chile (Latin America).

The USDA, FAO, and CIMMYT are expected to continue assistance in collecting genetically interesting wheat varieties for inclusion in the world germ plasm bank, to assist in disseminating nursery and breeding stocks to interested agencies and cooperators, and to help train technical personnel through the holding of work shops and seminars for researchers, breeders, cereal seed technologists and production agronomists. Closer ties are to be promoted in the future as more selected lines and breeder seeds and information will be exchanged among cooperators.

PROJECT BUDGET REQUIREMENTS

ITEM	COST
Salaries and Wages	
Professionals (1.7 man years)*	$26,000
Research Associate (Post Doctorate)	11,000
Technical (13 employees) **	64,500
Research Assistants (5 grads and 3 undergrad equivalent)	25,000
Indirect costs of above (38.0%)	43,890
Payroll Costs	7,000
Sub-total	177,390
Maintenance and Servicing of Electrical Equipment	11,655
Integrater and 2 head threshers	10,000
Expendable supplies, chemicals	8,000
Publications, printing	6,000
Computer Costs	2,000
Shipping	2,000
Travel	6,000
Conducting work shops and regional seminars	16,955
Total	$240,000

*Includes one full-time research instructor simultaneously working on advanced degree

** Actual man-years is equivalent to 9.

Summary Conclusions

The University of Nebraska's performance on the wheat improvement research project has been commendable in all respects. Substantial progress has been made since its inception in 1966 and the results are encouraging. The need for some extension beyond June 30, 1971 was anticipated when it was initially approved by the RAC. It is estimated that at least three years of additional research will be required to achieve its established objective of improving the nutritional value of winter wheat varieties now produced in the LDCs.

PROJECT STATEMENT

Date: September 17, 1973

A. PROJECT SUMMARY

1. Statistical

Project Title: Improvement of the Nutritional Quality of Wheat Through Increased Protein Content and Improved Amino Acid Balance

931-17-130-471

New or Extension: Extension - Three years

Contractor: University of Nebraska
Lincoln, Nebraska 68503

Principal Investigators: Professor Paul J. Mattern
Biochemist, Department of Agronomy

Dr. Virgil C. Johnson
Research Agronomist
Department of Agronomy

Duration: Started June 29, 1966
Termination Date: June 28, 1974
Proposed extension - June 29, 74 to June 28, 1977

Total Estimated Cost: $2,503,614

Obligated through FY 1973	:	$1,543,614
Funds requested for FY 1974	:	320,000
Estimated fund requirement FY 1975	:	320,000
Estimated fund requirement FY 1976	:	320,000

Project Manager: Dr. Russell Desrosiers

2. Narrative

Wheat is a major food throughout the world. When used as a sole source of food it provides ample calories but an inadequate amount of protein, together with an imbalance of certain essential amino acids, especially lysine. Genetically increasing the content and quality of protein of the wheat grain offers a cheap, practical and acceptable way to improve the human diet. This effort is especially valuable if the improvement in nutritional quality is accompanied by increased grain yield and resistance to diseases and insects.

Research has shown that the protein levels and amino acid composition of crops are genetically transmissible characteristics. The University of Nebraska has identified several important varieties: Atlas 66 from USA, Frondoso from Brazil and Aniversario from Argentina (high protein); Nap Hal from India (high protein and high lysine); and Pearl from Sweden (high lysine); as well as a number of others, as useful or potentially useful sources of genes for improved nutrition. It continues to evaluate the world wheat genetic reservoir for additional factors that would further increase the quality and quantity of protein in wheat. Crosses have been made among selected high protein and high lysine lines and varieties having other desired agronomic characteristics in order to produce superior varieties with improved nutritional quality.

The work at Nebraska is directly tied in with CIMMYT, FAO, and, by means of the International Winter Wheat Performance Nurseries (IWWPN), with Ministries of Agriculture and National Research Organizations in many cooperating countries. Also, because of the favorable climatic environment for the simultaneous growth of both spring and winter wheat, under Oregon conditions, CIMMYT, with Rockefeller assistance, is financing a special program at Oregon State University to incorporate into their spring wheats the protein quality improvements now developed by the Nebraska winter wheat improvement project.

B. EXPANDED NARRATIVE STATEMENT

1. Project Description Background and Accomplishments

Protein and lysine data have been obtained from 12,600 common wheats and 4,300 durum wheats of the world collection and new accessions are constantly being analyzed. This information is the best and most comprehensive of its kind available today, and is of value to breeders everywhere in their efforts to improve protein and lysine content of wheat. Twenty-six promising new lines, based on the high protein variety Atlas 66, have already been developed and distributed for testing and some of these are already being used in breeding programs in LDCs. Evidence of transgressive segregation for high protein and lysine between Atlas 66 and the high lysine variety Nap Hal has been obtained indicating that it will be possible to increase protein and lysine to levels above those of the original Atlas and Nap Hal varieties, contrary to earlier beliefs. Seed of these promising populations has been distributed to wheat breeders in the U.S.A. and several foreign countries.

The International Winter Wheat Performance Nurseries (IWWPN) have provided an extremely useful means of rapidly testing the adaptability of new varieties under a vast array of climatic conditions. These nurseries are now operating at 52 sites in 33 countries. They have played an important role in promoting cooperation and the exchange of plant material and information among the cooperating countries. They have served to detect varieties of wide climatic and soil adaptability as, for instance,

the high yielding Russian variety Bezostaya which has become widely established in Turkey and neighboring countries as a result of its superior performance in the IWWPN. The current use of this variety at Nebraska and other worldwide locations in crosses with lines superior in protein and lysine also traces back to the continued superior performance of this variety at Nebraska over a period of several years. The Nebraska variety Bolal has also become well established in Turkey for the same reason. Wheat varieties have been identified which produce significantly more protein and lysine than other varieties over many environments. High protein genes from Atlas 66 effectively promote higher grain protein in a wide international array of environments. Atlas-derived varieties produce grain with higher protein content than ordinary varieties under low as well as high soil fertility. Their protein advantage is normally in the range of 2 to 3 percentage points or about 25 to 30 percent. Production of high protein grain (14-17%) can be achieved from these genetically high protein varieties grown under high fertility situations, laboratory analysis indicating that they would provide more of the limiting amino acids than would Opaque-2 maize containing 10% protein. Data from normal feeding tests indicate that high protein varieties generally produce better weight gains and feed efficiency ratios than varieties with lower protein levels. This increased efficiency is expected to be the same for humans.

A rapid in vitro screening test is being developed for the early identification of high protein cultivars. A highly important side benefit of this research has been the detection of perhaps the major mechanism by which herbicides kill plants and the usefulness of the same in vitro technique for the rapid screening of herbicides, a method which has been public patented. This research may also be extremely important in elucidating the mechanism by which fungi and other parasites kill plants. An additional dividend of this research has been the discovery that surfactants tend to be plant specific. In addition to its usefulness in the wheat breeding programs, it is evident that this line of investigation may very well have important and far reaching beneficial effects on agricultural development in general, and especially in the fields of pest and disease control.

Nearly 50 publications have resulted from these investigations and have been distributed in the LDCs. In addition, the staff has participated in numerous lectures and workshops.

2. Relevance to AID Objectives

Because of the encouraging results already achieved from the breeding efforts to date and, considering the importance of wheat to the nutrition of the world, there is every reason to expect that this project will continue to make important contributions to the improvement of nutrition,

both quantitatively and qualitatively, on a worldwide scale. Excellent relationships have been established with national research, educational, and extension organizations in cooperating countries through the IWWPN program. Through these linkages, established with the network of national and international research and development organizations such as CIMMYT and FAO, delivery of new improved varieties and related production information to the farmers is greatly enhanced (see attached network chart for details).

3. Objectives

The objectives of this extension of the contract are to accomplish the following:

a. Develop additional genetically superior lines (nutritionally and agronomically) from the already identified source materials.

b. Identify additional genetically superior sources (high protein and high lysine) through a continuing assessment of new collections of wheat varieties and related species.

c. Utilize the IWWPN program, both as a means of detecting and evaluating varieties of broad adaptability to which genes for high protein and high lysine might be transferred and as a means of testing the adaptation and performance of new high protein and high lysine varieties.

d. Determine the value of new developed wheat varieties in human nutrition through chemical and biological evaluations of selected improved varieties.

e. Through research on the nitrogen metabolism of wheat, develop new and/or improved fast in vitro techniques for the detection of high protein capability in seedling populations which may have different enxyme systems.

f. Determine the relationship of soil fertility to protein content and yield capability through parallel soil fertility studies at the IWWPN sites.

g. Through the provision of experienced staff strengthen network capability for work on quality improvement and better dissemination of information regarding nutritionally superior wheat and its culture. This will be accomplished through support to the development of regional quality improvement activities for wheat in Turkey, Korea, southern Brazil and other LDCs as services are requested.

h. Increase competence of research assistants from LDCs through on-the-job training and annual workshops held in cooperating countries.

4. Other Related Research

CIMMYT regularly carries out an extensive international program of research with non-winter-hardy wheat; i.e., with varieties that are grown as spring or fall sown, the latter where the winters are relatively mild and with little or no freezing weather. This program is primarily production-oriented, however, and has not been especially concerned, except as influenced by the Nebraska winter wheat program, with the improvement of protein and lysine content in the grain.

There are three AID centrally-funded research projects (including Nebraska) involving cereal grains that support the same general objective as the Nebraska wheat project; that is, the genetic improvement of their nutritional quality through increased protein content and improved amino acid balance. Purdue University is the institution responsible for research on the other two -- sorghum and maize. In addition to the cereal protein effort, AID is responsible for research on food legumes, now underway in Puerto Rico and, until recently, in India and Iran as well; and the soybean for food project at the University of Illinois and Puerto Rico. As a result of these research programs, collaborative linkages are being established with other U.S. local institutions and agencies in the developing nations. These linkages will allow the capabilities of each of the cooperating institutions to be utilized efficiently and effectively.

5. Project Program

Encouraging progress has been made on all facets of the work undertaken by the contractor since this project was started; namely, a) to evaluate systematically the world wheat collection for significant differences in lysine and protein content; b) to establish complete amino acid profiles on high lysine wheat varieties; c) to test high lysine and other nutritionally promising lines at different locations to determine the effect of environment on the stability of high lysine and high protein traits; d) to introduce genes for high protein and high lysine into wheat breeding programs of developing countries; e) to combine new genetic sources of high protein with existing high protein lines to further raise the protein threshold in wheat, and f) to make available promising materials, when identified, to other countries and research agencies.

The work plan for the contract extension is shown in Attachment A.

6. Evaluation of Contractor Competence

The contractor's performance has been outstanding. The contractor's personnel have demonstrated initiative and originality to a high degree in devising solutions to the problems encountered in the course of the

research. Two of them have received special awards for their efforts involving winter wheat improvement in Nebraska. Too, recommendations have been made that their work be similarly recognized on a national basis and accordingly rewarded.

7. Utilization of Project Results

The IWWPN have been a very useful vehicle for the dissemination and utilization of information and genetically superior materials in the countries where located and in the stimulation of interest in the program on the part of local research and extension personnel. The variety Bezostaya has achieved prompt importance in Turkey and neighboring countries because of its outstanding performance in the IWWPN. Superior varieties into which genes for high protein and high lysine have been introduced are being tested and released for further trial by cooperating research institutions.

Results of the research are available to all and reports are widely distributed. In addition, numerous articles have been published in technical journals.

A Basic Ordering Agreement is being considered as a possible additional contract mechanism to enable the contractor to give more direct assistance to interested countries in the area of extension and information to facilitate the transfer of results obtained by the project.

8. Participation by U.S. Missions and Foreign Institutions

USAIDs in cooperating countries where winter wheat is an important crop are participating directly in this project. Among these are Turkey, Pakistan, Afghanistan, South Korea, Morocco, Argentina, Brazil, and Chile.

The USDA, FAO, CIMMYT and European winter wheat growing countries are expected to continue their interest in and close cooperation with the project.

9. Budget Analysis

The budget presented by the contractor is reasonable in the light of the plan of work. Salaries make up the greater portion of the cost. Overhead, which is established by university regulation, is within the acceptable range. The request on a yearly basis is the same as the level of operation for Fiscal Year 1973.

10. Internal and External Review

This project has been reviewed frequently by TA/AGR officers over the past several years. The most recent utilization review was held May 7, 1973. In each instance, the resulting reports were highly complimentary and most encouraging for its continuation.

A Summary Report of research findings covering the period July 1, 1966 - December 31, 1972 has been distributed and provides details of progress made as well as the importance of the different research activities.

This project statement is being presented to the Inter Bureau Technical Committee prior to formal review by the Research and Institutional Grants covered September 27, 1973.

11. Proposing Office General Evaluation and Recommendation

The project continues to hold the highest priority among the projects supervised by the Office of Agriculture and is an integral part of the program of the Division of Crop Production. It addresses directly, by improvment of the grain itself, the all important problems of hunger and malnutrition as well as making a contribution towards the improvement of the lot of the average farmer.

A three year extension will allow for the realization of important research in progress and solution of problems directly affecting food production and nutrition in the LDCs.

Omer J. Kelley, Director
Office of Agriculture

R. Desrosiers

Russell Desrosiers, Project Manager

Samuel C. Litzenberger, Chief
Crops Production Division

IMPROVEMENT ON THE NUTRITIONAL QUALITY OF WHEAT THROUGH INCREASED PROTEIN CONTENT AND IMPROVED AMINO ACID BALANCE

Contract No. AID/csd-1208

Work Plan for 6th Contract Extension

1 April 1974 to 31 March 1975

1. Continue the International Winter Wheat Performance Nursery and Preliminary Nursery to identify varieties with superior performance and adaptation characteristics. Obtain analytical data for protein and lysine on all samples and subject selected samples to a nutritional evaluation. Data related to fertilizer response, soil type, climate, agronomic factors and plant characteristics as affecting yield will also be included in the evaluation.

2. Continue protein and lysine analyses of promising hybrid populations to identify lines with superior protein and amino acid properties.

3. Study the influence of soil fertility environment and wheat production practices on the nutritional value of wheat.

4. Identify differences in kernel components and protein fractions of varieties differing in protein and amino acid composition.

5. Make new hybrid combinations to achieve improved levels and/or combinations of protein and lysine.

6. Continue the study of selection criteria for the identification of wheat varieties with the highest nutritional value and potential for breeding purposes.

7. Continue the use of mouse feeding to identify samples which exhibit differences in protein value.

8. Organize feeding studies on wheat to determine the usefulness and relationship of such test animals as the mouse, rat, chick, and humans for measuring the nutritional value of wheat.

9. Make available to developing countries wheat varieties and lines with improved productivity and nutritional value.

10. Exchange genetic stocks, experimental lines, and research information with other organizations engaged in international agricultural activities, such as CIMMYT, FAO, IAEA, Oregon State University, and Purdue University to insure most rapid progress in the nutritional improvement of wheat.

11. Continue the enforced hybridization program in wheat involving the use of chemical male gametocides to accelerate the development of genetic recombinants with superior protein levels and composition.

12. Compare the influence of nitrogen nutrition on high and low grain protein wheats.

13. Determine lysine availability and protein digestibility using new available procedures or selected new materials from the breeding program.

14. Screen the dryland wheats in the world collection for protein and lysine content.

15. Screen and select wheat seedlings segregating for key enzymes of protein synthesis.

16. Evaluate levels of *in vivo* and *in vitro* nitrate reduction of selected wheats.

17. Make on site inspections of IWWPN nurseries and consult with AID Mission, FAO, and CIMMYT personnel in developing countries.

18. Study the interaction of surfactants and growth regulations in the protein metabolism of wheat.

19. Publish research results.

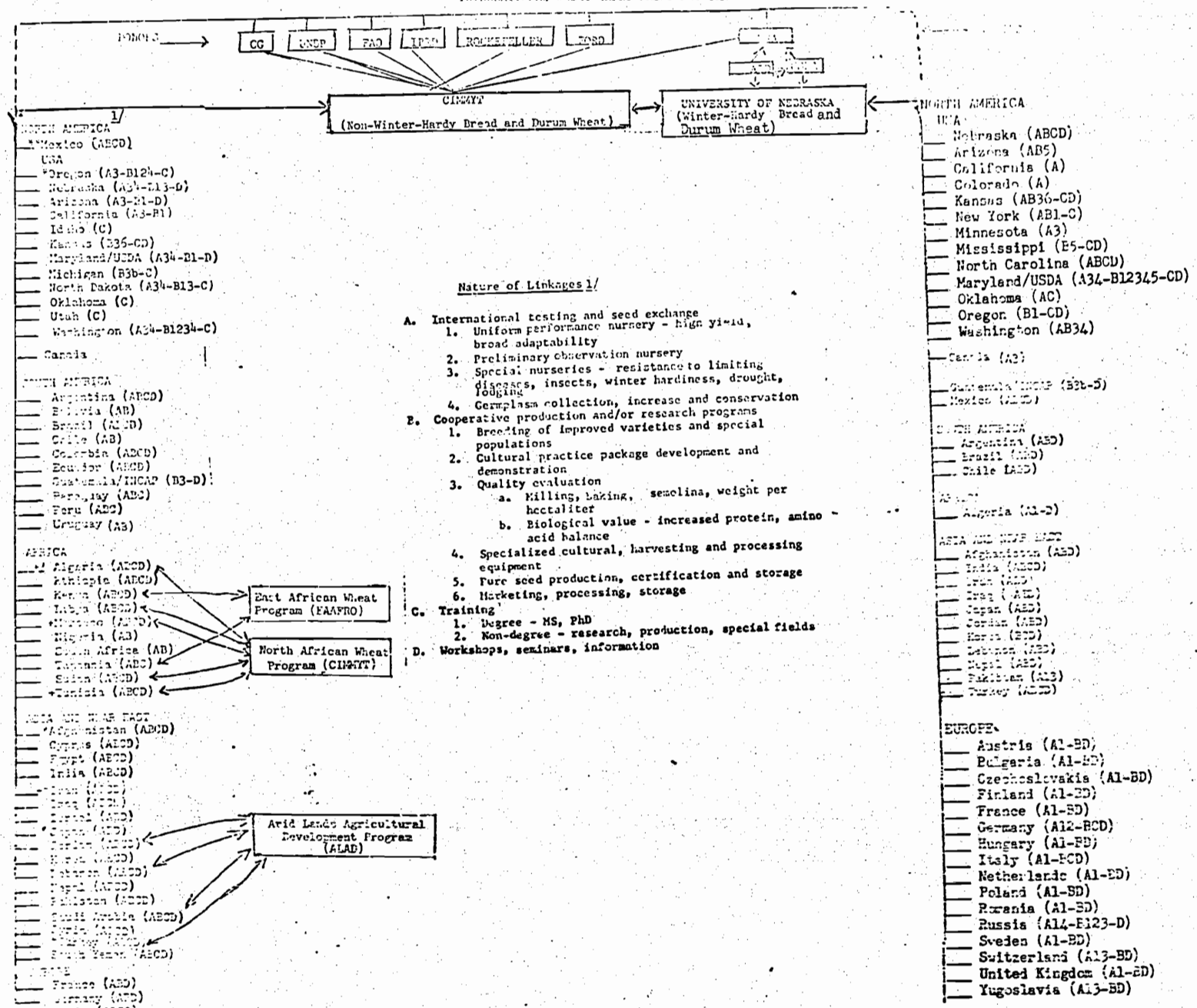
BUDGET ESTIMATE
1 APRIL 1974 TO 31 MARCH 1975

Salaries:

Professional (4.7 man years)	$63,100
Technical (11 man years)	88,000
Research Assistants (2 graduate students)	8,800
Undergraduate Equivalents (3 man years)	15,000
Subtotal	$174,900

Indirect Costs (43.22%)	75,592
Payroll Costs	14,000
Laboratory Supplies and Maintenance of Equipment	6,508
Analytical Laboratory Service Charge	7,500
Biological Laboratory Service Charge (Mouse and Rat)	20,000
Computer Charges	2,500
Publications	4,000
Yuma Nursery Costs	6,000
Nursery Shipping Costs	5,000
Travel	4,000
	$320,000

INTERNATIONAL WHEAT IMPROVEMENT NETWORK



Nature of Linkages 1/

A. International testing and seed exchange
   1. Uniform performance nursery - high yield, broad adaptability
   2. Preliminary observation nursery
   3. Special nurseries - resistance to limiting diseases, insects, winter hardiness, drought, lodging
   4. Germplasm collection, increase and conservation

B. Cooperative production and/or research programs
   1. Breeding of improved varieties and special populations
   2. Cultural practice package development and demonstration
   3. Quality evaluation
      a. Milling, baking, semolina, weight per hectaliter
      b. Biological value - increased protein, amino acid balance
   4. Specialized cultural, harvesting and processing equipment
   5. Pure seed production, certification and storage
   6. Marketing, processing, storage

C. Training
   1. Degree - MS, PhD
   2. Non-degree - research, production, special fields

D. Workshops, seminars, information

1/ Letters in parentheses refer to the nature of the primary and secondary linkages as shown in this chart.

* Special cooperation with program at Oregon where special effort made to cross winter with spring wheat for high-elevation regions.

\+ Special cooperation with durum wheat.

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ATTACHMENT C

PROJECT STATEMENT

A. PROJECT SUMMARY

1. Statistical

Project Title: Genetic Improvement of Productivity and Nutritional Quality of Wheat

New or Extension: New

Contractor: University of Nebraska
Lincoln, Nebraska 68503

Principal Investigators: Professor P. J. Mattern
Biochemist
Department of Agronomy

Dr. V. A. Johnson
Research Agronomist (ARS)
Department of Agronomy

Duration: Current Authorized Period: December 1976

Proposed Extension Period: 1 Apr 75 - 31 Mar 78

Total Estimated Cost:

Funds Obligated Through FY 75:	$2,235,000
Funds Requested for FY 76:	535,322
Funds Required for FY 77:	550,322
Estimated Fund Requirement for FY 78:	566,222
	3,886,866

Project Manager: Dr. Russell Desrosiers

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2. Narrative

Wheat is a major food throughout the world. It ranks in importance with rice as an efficient provider of both calories and protein. Genetically increasing the content and quality of protein of the wheat grain offers an inexpensive, practical and acceptable way to improve the human diet. For maximum value the improvement in nutritional quality must be accompanied by high grain yield and resistance to production hazards like diseases and insects. Full utilization of available genetic variability for protein and lysine in the world's wheats could provide the protein needs of an additional 400 million people. Coupled with anticipated advances in wheat productivity the number of people accommodated could be substantially higher than 400 million.

Research has shown that amount of protein and its amino acid modification are genetic traits that are amenable to modification by breeding in food and feed crops. The University of Nebraska in cooperation with the Agricultural Research Service, USDA, and with major financial support since 1966 from the Agency for International Development, U. S. Department of State, has identified a number of wheat varieties with high potential value as genetic sources of high protein and elevated level of lysine. High protein varieties include Atlas 66 and Atlas 50, U. S. varieties derived from Frondoso (Brazil), Aniversario (Argentina), Nap Hal (India), and Nebraska Male Fertility Restorer. The most promising genetic sources of elevated lysine are Nap Hal (India) and C. I. 13449 (USA). Crosses among these and other varieties have produced experimental lines with levels of protein and lysine significantly higher than the parental varieties and much higher than ordinary varieties of wheat. More than 100 lines under irrigated test conditions at Yuma, Arizona since 1973 have averaged 17% protein and 3.5% lysine. This represents an approximate 40% increase in protein and 20% increase in lysine. Such lines can be expected to possess superior nutritional value.

Prior AID-supported research on the nutritional improvement of wheat at the University of Nebraska has been coordinated with wheat research activities in ARS, FAO, CIMMYT, and Oregon State University. Through establishment of an International Winter Wheat Performance Nursery (IWWPN) network, effective cooperative relationships have been established with Ministries of Agriculture and National Research Organizations in approximately 40 cooperating countries. The proposed research is an outgrowth of this prior research supported by AID since 1966. Cooperative relationships with LDC's and international organizations will be fostered and enlarged to provide for orderly movement to and local evaluation of nutritionally promising segregating populations and experimental lines in LDC's. There will be emphasis on exploitation of already-identified genes for high protein and lysine in the development and use of productive, agronomically acceptable varieties in LDC's. The direction of research will be shifted and its scope broadened to include investigation of basic physiological processes that contribute to improved nutritional value and productivity of wheat including nitrogen metabolism, photosynthetic efficiency and associative symbotic nitrogen fixation.

B. EXPANDED NARRATIVE STATEMENT

1. Project Description Background and Accomplishments

Success of research efforts to genetically improve the nutritional quality of wheat depends on existence of genetic variation for protein and lysine. Protein

and lysine data were obtained on 13,000 common wheats, 3,400 durums, and 673 spelt wheats in the World Wheat Collection maintained by the USDA, Agricultural Research Service and new accessions to the Collection continue to be analyzed. The information is the best and most comprehensive of its kind available in the world today. Seed of nutritionally promising varieties in the Collection has been made available to most countries in which wheat is an important crop and is of much value to breeders in these countries for genetic improvement of wheat.

Twenty-six high protein lines selected from crosses of Atlas 66 with hard red winter varieties were publically released as elite germplasm. Seed has been distributed for testing and is being used in breeding programs in LDC's. A new high protein variety NE 701132 also derived from Atlas 66, is undergoing seed multiplication for distribution in 1975. NE 701132 combines high protein content with high yield, disease resistance, and excellent agronomic traits. Its production on all of Nebraska's wheat acres could contribute as much as 900 railroad boxcars of additional protein in a single year. In those LDC's where it is adapted NE 701132 could provide significant additional protein for human consumption.

Transgressive segregation for very high protein and high lysine was demonstrated in crosses involving Atlas 66, Nap Hal and CI 13449. This provides evidence of different genes for high protein in the parent varieties that function additively to produce new high levels of protein and lysine. Two hundred eighty high protein-high lysine lines from these crosses were distributed to breeders at 26 different sites in LDC's and other countries in 1974 for local agronomic evaluation and use in breeding programs. Known genetic variability for protein in wheat suggests that grain protein content can be increased by as much as five percentage points. Accumulated performance data from Nebraska and the IWWPN indicate that it should be possible to accomplish this without sacrificing yield.

Seed fractionation studies of Atlas 66, Nap Hal, and CI 13449 have shown the high protein effect to reside entirely in the endosperm of Atlas 66 and largely in the endosperm of Nap Hal. The high protein effect, therefore, is transmissable to white flour milled from these varieties and is not lost in the milling process. The high lysine effect was found in the endosperm of CI 13449 but in the aleurone of Nap Hal. Research at Nebraska has shown that high quality protein can be extracted from the aleurone and its addition to the white milled flour to achieve much elevated nutritional quality may have commercial feasibility. Although much wheat is consumed as whole wheat flour in LDC's, there is a strong trend toward the use of commercially milled white flour by the urban populations of these countries. High protein-high lysine effects that reside in the endosperm provide much more flexibility of utilization than would similar effects in the less digestible bran fraction.

Small animal bioassays conducted at the University of Nebraska have confirmed that increased protein content in wheat grain improves its nutritional value. High protein varieties fed at 56% grain in the diets consistently produced significant higher weight gains and FER values in weanling mice than lower protein varieties. At higher levels of grain in the diets, all varieties produced acceptable weight gains and similar FERs. Somewhat reduced PER values of the protein from the high protein varieties was more than offset by their additional protein when equal quantities of grain were fed. This increased efficiency is expected to be the same for humans. This is being tested for selected parental varieties in cooperative small animal and human bioassays conducted at the University of Nebraska and the British-American Hospital in Lima, Peru in 1974 but not yet analyzed and summarized.

The International Winter Wheat Performance Nurseries (IWWPN) organized by the University of Nebraska and the ARS in 1969 provide an extremely useful vehicle for rapid and efficient testing of new varieties on a worldwide basis. They have been equally as effective in promoting cooperation, improved communication, and exchange of useful new germplasm among wheat breeders throughout the world. They are now grown at 57 sites in 35 countries and have served to identify varieties with outstanding adaptation to widely differing conditions of climate and soil. The high yielding Russian variety Bezostaya 1 has become widely established and is contributing to increased wheat production in Turkey and neighboring countries as a result of its superior performance early in the IWWPN. The high yielding variety Bolal, developed in Nebraska, also has become established in Turkey and is contributing to its wheat production.

Bezostaya 1 and other varieties whose performance superiority has been demonstrated in the IWWPN are being widely used in LDC and other breeding programs. They are being utilized prominently by Nebraska in crosses with high protein-high lysine wheats to combine high productivity and broad adaptation with superior nutritional value. Testing of high protein Nebraska varieties in the IWWPN has established the stability and usefulness of high protein genes in a wide array of international wheat production environments.

Atlas 66 derived varieties produce comparable yields of grain with higher protein content than ordinary varieties under low as well as high soil fertility. Their protein advantage in Nebraska and international tests is in the range of 1.5 to 3.0 percentange points or about 20-30 percent more protein than comparably yielding varieties in the same tests. Production of high protein grain (14-17%) can be achieved from these already available Atlas-derived wheats grown under high soil fertility. Laboratory analyses indicate that, with 17% protein, they will provide more of all of the essential amino acids, including lysine, than an equal amount of Opaque-2 maize with 10% protein.

A rapid in vivo laboratory screening test involving nitrate reductase assay is being perfected in the Nebraska laboratory for efficient early identification of cultivars with genetic potential for high grain protein. A highly important spin-off from this research was the discovery of the major mechanism by which most, if not all, herbicides kill plants and the associated development of a rapid efficient laboratory technique for identification of chemicals with herbicidal properties. The method has been public patented. The research may also contribute to elucidation of mechanisms by which fungi and other pathogens damage or kill plants. An added dividend from this research was the discovery that many surfactants used in conjunction with herbicides are plant specific and a key to successful destruction of weeds without damage to the crop specie involved. It is evident that this line of investigation may have important and far reaching beneficial effects on future agricultural development especially in the fields of pest and disease control.

More than 50 publications have resulted from these investigations and have been distributed in the LDC's. High protein-high lysine wheat germplasm has been distributed to geneticists, breeders, and agronomists throughout the world. The staff has organized two international wheat conferences and has participated in numerous other workshops. The Nebraska laboratory has provided important analytical service for many LDC's.

g. Strengthen wheat research in LDC's through distribution of germplasm, hybrid populations, advanced lines, and research information to the LDC's and international organizations; organize and participate in regional, national, and international wheat workshops and conferences; make on-site inspections of cooperative nurseries and special plantings; encourage and accept qualified students and young scientists from developing countries and the USA for graduate study and special training in wheat genetics, breeding, and production at the University of Nebraska.

4. Plan of Work — Estimated Portion of Total Effort

a. Genetics and Breeding — 30%

This must be a continuing research activity to assure achievement of the objectives of the project on Nutritional Improvement of Wheat. The following lines of research will be pursued:

New hybrid combinations involving the most recently identified genetic sources of improved nutrition will be made. The best spring and winter wheats from foreign countries and the USA will serve as recipient genotypes.

Appropriate selection criteria and field and laboratory evaluation techniques will be utilized to identify populations and lines with best agronomic and nutritional potential.

Screening and selection will be made at production sites in Nebraska and Arizona under favorable and unfavorable conditions of soil moisture, soil fertility, temperature, and other production factors.

Large scale enforced genetic recombinations will be induced in composite populations using chemical male gametocides.

Yield tests of promising nutritionally improved lines will be conducted and selected lines will be advanced to the International Winter Wheat Performance Nursery for international evaluation of their productivity and adaptation.

b. Chemical and Physical Characterization of Nutritionally Improved Wheats — 20%

Wheats have been identified that possess improved protein and lysine levels on a whole kernel basis. Location in the kernel of the improved protein-lysine levels is an important consideration since it will determine the degree to which the effects are transmissable to milled flour. High levels of protein and/or lysine in the bran fraction would require that they be biologically available during digestion of whole grain or through a commercially feasible extraction process. Best usage would be made of high protein grain that possesses traditional food processing properties. These include endosperm hardness and the amount and types of protein and starch in the grain.

2. Relevance to AID Objectives

Wheat is the most efficient producer of both calories and protein among the food cereals. Wheat, consumed as whole wheat flour, can produce enough protein from an acre of land in one year to satisfy the protein needs of one person for 877 days. This compares with 654 days for rice, only 130 days for beef or hogs, and 185 days for poultry. Development and full use of genetically high protein productive wheats with improved amino acid balance would significantly increase its nutritional value and could provide protein for as many as 400 million additional people. Combined with anticipated advances in yield, the number of additional people accommodated could be substantially more than 400 million.

Because of the encouraging results already achieved from the breeding efforts to date, there is every reason to expect that this project will continue to make highly important contributions to nutritional improvement on a worldwide basis by increasing yield and improving wheat protein both quantitatively and qualitatively. The excellent relationships already established by the Nebraska-ARS group with national research, educational, and extension organizations in a large number of cooperating countries through the IWWPN network provides the necessary vehicle for rapid evaluation and use of improved wheats from the project. This together with effective linkage with international research and development organizations such as CIMMYT, FAO, and IAEA will enable early delivery to and utilization of new improved varieties and related production information by farmers in LDC's (see attached network chart for details).

3. Objectives

a. Develop by established genetic and breeding procedures hybrid populations and experimental varieties with genetic potential for high productivity and improved nutritional value for evaluation and selection in national breeding programs and in international performance trials.

b. Characterize the quality properties of nutritionally improved wheats through chemical and physical studies to provide a more reliable basis for prediction of biological value.

c. Identify agronomically and nutritionally superior broadly adapted winter wheat varieties and study the influence of soil and environmental factors on yield and quality of the varieties in the International Winter Wheat Performance Nursery.

d. Study the roles of nitrogen metabolism and photosynthetic efficiency in increased productivity and improved nutritional value of wheat to enable improved efficiency of selection for these complex traits.

e. Determine the potential and limitations of nitrogen-fixing microorganisms for increased nitrogen utilization by wheat and enhancement of its productivity and nutritional value by means of studies of associative symbiotic nitrogen fixation.

f. Verify the biological value of a limited number of promising high protein-high lysine advanced wheat lines by means of rat bioassays.

Screening techniques to measure processing acceptability of nutritionally improved wheats in LDC's are needed. Wheat from LDC's that exhibit extremes in processing acceptability would be useful standards for development of screening tests.

Laboratory research will be undertaken to:

Identify differences in kernel components and protein fractions of varieties with improved nutritional value.

Utilize available procedures to measure chemically available lysine in high protein-high lysine varieties and subject those with high and low values to small animal feeding trials for correlation of chemical data with bioassay data.

Obtain wheats from LDC's that represent extremes in processing acceptability for food use, analyze for hardness, and determine protein and starch properties associated with acceptable processing quality in these countries.

c. International Evaluation 15%

Ongoing Research

Evaluation in the International Winter Wheat Performance Nursery and in special plantings of the best new experimental lines and varieties developed in Nebraska and elsewhere will continue. To assure maximum utility of the IWWPN, the Nebraska group will closely coordinate this important activity with the International Spring Wheat Yield Nursery and with other international and regional nurseries. It will encourage enlarged dialogue with CIMMYT, FAO, and other international organizations in an effort to find the most efficient and effective future management of these nurseries and to avoid duplication of effort and unnecessary competition. Only through such dialogue can the legitimate interests of all groups be understood and assured and the goal of more productive and nutritious wheat for hungry people most rapidly achieved.

Additional nursery sites in LDC's as well as in the People's Republic of China and the Republic of South Africa will be arranged to provide more thorough worldwide performance evaluation of new varieties. New lines and varieties submitted by these countries for IWWPN evaluation will provide an important new source of wheat germplasm for continued improvement of wheat.

New Research

Comprehensive study of the influence of soil and environmental factors on the yield and quality of varieties in the IWWPN will be undertaken at selected nursery sites. Soil chemical and physical factors that may influence yield and quality of wheat will be measured and correlated with performance, quality, and plant analysis data to uncover useful relationships and interactions between varieties and production factors that would provide a sound basis for continued improvements in yield and quality.

Nebraska personnel will arrange for initiation of necessary sampling procedures and experimental details with cooperating agronomists at selected test sites to assure proper collection of data and reliable soil samples.

AID Mission and CIMMYT personnel and facilities will be utilized, wherever appropriate, to assure liaison and proper shipment of soil and plant samples to the Nebraska laboratory. Seed samples from each nursery site will be analyzed for protein and lysine content and selected samples will be subjected to nutritional evaluation.

d. Physiological Studies of High Yield and High Protein Nitrogen Metabolism 15%

Continued progress in increasing the "genetic potential" for higher protein content and improved protein quality in wheat demands improved understanding of the enzymatic processes associated with uptake, reduction, and translocation of nitrogen. This area of research will be expanded.

Laboratory and field studies will be continued to:

Identify wheats that are most efficient in taking up and reducing nitrate under optimal and suboptimal nitrate environments and elucidate the processes involved using established techniques for measuring nitrate content and nitrate reductase activity in leaf and stem tissue.

Identify wheats capable of synthesizing large amounts of vegetative protein.

Identify wheats with greatest capacity for translocating large amounts of vegetative protein to the grain for final protein synthesis using newly developed instrumentation for measurement of true protein in vegetative tissue and in the grain.

Plant Loss of Nitrogen

Maximum utilization of available soil nitrogen by the wheat plant is essential. Measurements of plant nitrogen frequently suggest unexplained losses of nitrogen from the plant system.

Research will be initiated to determine how, when, and where nitrogen escapes from the wheat plant and what factors influence the magnitude of this loss. Special transparent, gas-tight chambers will be constructed to maintain environmental control and monitor nitrogen.

Photosynthetic Efficiency

Increases in productivity and protein content of wheat are inextricably tied to improved photosynthetic efficiency of the wheat plant. Light interception, plant size, leaf type, leaf arrangement, and plant physiological responses to day and night temperatures in relation to existing or new management practices are involved.

Significant continued yield advances in wheat should be possible because wheat is phenotypically a C_3 type species. As such, leaves will be light saturated at high intensities and any mechanism that results in light distribution within canopy should be beneficial.

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Wheat matures in an environment in which day and night temperatures are increasing. The effect of these increasing temperatures on photo efficiency as reflected in quantity and quality of grain produced needs to be established.

Research will be initiated in the laboratory and field to:

Characterize photosynthetically active radiation (visible light) interception efficiency and distribution patterns by wheat canopies that vary phenotypically and utilize this information for more efficient genetic selection of productive new wheats and development improved management systems.

Evaluate photosynthetic efficiency as influenced by different combinations of day-night temperature effects on night respiration and the balance between photosynthesis and photorespiration during the day.

Investigate wheat plant senescence in relation to phytohormone changes to establish the opportunity for extending the period of active photosynthesis in the wheat plant to make it more productive.

e. Associative Symbiotic Nitrogen Fixation 10%

Associative symbiotic nitrogen-fixing relationships between specific microorganisms and cereal grasses have been demonstrated by Dr. Dobereiner in Brazil. They have the potential for being extremely important in the nitrogen utilization of wheat and enhancement of its productivity and nutritional value.

Drs. Klepper and Klucas of the University of Nebraska have visited Dr. Dobereiner's laboratory and have established excellent communications with her which can lead to meaningful future cooperative research in nitrogen fixation. Such research is promising because (a) large numbers of samples can be surveyed using acetylene reduction assay for nitrogen fixation, (b) Dobereiner has demonstrated the existence of nitrogen-fixing relationships in certain grass ecosystems, and (c) the area of microbial genetics of nitrogen-fixing systems has not advanced sufficiently to permit transfer of nitrogenase genes from one microorganism to another and develop partially constitutive nitrogen-fixing microorganisms.

The following research activities will be undertaken:

Samples consisting of roots of the various wheat species and forms plus the surrounding soil will be collected throughout Nebraska and surrounding states initially and from wheat production sites in developing countries, as opportunity permits in the 1975 crop season. Samples will be assayed for acetylene reduction (nitrogenase activity).

Wherever feasible, the assays will be done in situ because of the sensitivity of nitrogenase activity to environmental changes. Greenhouse experiments will be included to extend the research.

When and if positive samples are found, location (intra or extra cellular), identity, and efficiency (N_2 fixed/carbon source consumed) of the nitrogen-fixing microorganism(s) will be determined.

If positive results are obtained, microbial strain selection for maximum nitrogen fixation will be initiated and the best strains utilized to develop constitutive mutants that will form nitrogenase in the presence of fixed nitrogen. Required technology for this activity already exists.

If negative results occur, specific microorganisms that associate with wheat forms will be sought. An attempt will be made to transfer the genetic information for nitrogenase into the microorganisms.

Close communication in the form of sharing of information and biological material, will be established and maintained with Dr. Dobereiner and coworkers. Dr. Dobereiner will be invited to the University of Nebraska for a 2-week period at an appropriate time in 1975 for consultation and information exchange.

f. Nutritional Evaluation 5%

Data from an international cooperative study in which grain of wheat varieties differing in protein and lysine content was the protein source in bioassays involving adult, adolescent, and child human subjects, weanling mice, rats, and chicks will be analyzed, correlated, and published in 1975.

Consistent with recommendations of the nutritional experts who met in Mexico in 1974, short term bioassays involving the rat as the test animal will be substituted for the weanling mice heretofore used for evaluation of new high protein wheat strains.

Selected advance lines with high protein and/or high lysine capabilities will be evaluated and the bioassay results correlated with chemical laboratory data to identify the most promising nutritionally superior lines.

g. Information, Germplasm Exchange, Technical Assistance, and Training 5%

Make available to developing countries, genetic stocks, populations, wheat varieties, and lines with improved productivity and nutritional value.

Exchange genetic stocks, experimental lines, and research information with other organizations engaged in international activities, such as CIMMYT, FAO, IAEA, Oregon State University, and Purdue University to insure most rapid progress in the nutritional improvement of wheat.

Make on-site inspections of International Winter Wheat Performance Nurseries and consult with AID Mission, FAO, and CIMMYT personnel in developing countries.

Publish research results in appropriate reports, bulletins, and scientific journals.

Organize and participate in national and international workshops and conferences on wheat as an effective means of communication and information exchange. An International Winter Wheat Conference has been organized for Zagreb, Yugoslavia in June, 1975.

Provide technical assistance in wheat breeding, production, laboratory development, nutrition and training on request from developing countries in which there are AID Missions via a Basic Ordering Agreement approved in 1974.

Encourage and accept qualified students and young scientists from developing countries for graduate study and special training in wheat breeding and quality improvement at the University of Nebraska wherever necessary financial arrangements can be made.

Provide assistantships to qualified students from the USA for graduate training in wheat improvement to assure technical expertise for future assistance to developing countries.

5. Other Related Research

CIMMYT regularly carries out an extensive international program of research with nonwinterhardy wheat; i.e., with varieties that are grown as spring wheat or fall sown; the latter where the winters are relatively mild and with little or no freezing weather. This program is primarily production-oriented, however, and has not been especially concerned, except as influenced by the Nebraska winter wheat program, with the improvement of protein and lysine content in the grain.

There are three other AID centrally-funded research projects involving cereal grains that support the same general objective as the proposed Nebraska wheat project; that is, the genetic improvement of their nutritional quality through increased protein content and improved amino acid balance. Purdue University is the institution responsible for research on sorghum and maize and Montana State University for that on barley. In addition to the cereal protein effort, AID is responsible for research on food legumes, now underway at the University of Puerto Rico and, until recently, in India and Iran as well; and the soybean for food project at the Universities of Illinois and Puerto Rico.

6. Project Program

This proposal is an outgrowth of research conducted in a predecessor project initiated in 1966. Encouraging progress was made on all facets of work undertaken by the contractor; namely, (a) to evaluate systematically the World Wheat Collection for significant differences in protein and lysine content; (b) to establish complete amino acid profiles on high protein and high lysine varieties; (c) to test high nutritionally promising lines at different locations to determine the effect of environment on the stability of high protein and high lysine traits; (d) to introduce genes for high protein and high lysine into wheat breeding programs of developing countries; (e) to combine new genetic sources of high protein with existing high protein lines to further raise the protein threshold in wheat; and (f) to make available promising materials, when identified, to other countries and research agencies.

7. Utilization and Dissemination of Research Results

The IWWPN has been a highly useful vehicle for the dissemination and utilization of information and genetically superior materials in the countries where located and in the stimulation of interest in the program on the part of local research and extension personnel. The Russian variety Bezostaya achieved prompt importance in Turkey and neighboring countries because of its outstanding performance in the

IWWPN. Superior varieties into which genes for high protein and high lysine have been introduced are being tested by cooperating research institutions. A new high protein productive variety is being released to Nebraska farmers in 1975.

Results of the research are available to all and reports are widely distributed. In addition, numerous articles have been published in technical journals.

Two highly successful International Wheat Conferences have been held and a third conference has been organized for 1975. An International Winter Wheat Conference was held in Ankara, Turkey, in 1972. An International Wheat Conference, aimed principally at the Latin American countries, was held in Porto Alegre, Brazil, in 1974. A Winter Wheat Conference will be held in Zabreb, Yugoslavia, in June, 1975. These conferences have done much to stimulate interest and promote new research among the scientists of the developing countries and to assure the early delivery of research results.

Graduate degree and nondegree programs at the University of Nebraska are available for the training of scientists and technicians from developing countries.

A Basic Ordering Agreement has been developed as an additional mechanism to enable the contractor to give more direct assistance to interested developing countries in wheat research and development.

8. Participation by U.S. Missions and Foreign Institutions

USAIDs in cooperating countries where winter wheat is an important crop are participating directly in this project. Among these are Turkey, Pakistan, Afghanistan, South Korea, Morocco, Argentina, Brazil, and Chile.

The USDA, FAO, CIMMYT, other international and national research institutions, and European winter wheat growing countries are expected to continue their interest in and close cooperation with the project.

9. Development of Linkages

This project has well developed linkages with the USDA; other U.S. universities; International and Regional Research Institutes, including CIMMYT, FAO, IAEA, ALAD, and the East African and North African Wheat Programs; and numerous national research institutions. (See Attachment B.)

10. Budget Analysis

The budget presented by the contractor is reasonable in the light of the plan of work. Salaries make up the greater portion of the cost. A copy of the budget is included as Attachment A.

11. Ecological and Environmental Consideration

No adverse environmental impact is foreseen as a result of this project.

12. Section 113 Considerations

The Agency has no evidence that the University of Nebraska discriminates against women in the selection of staff. Women occupy both professional and subprofessional positions at the University in or closely related to this project.

13. Internal and External Review

The proposal for extension has been reviewed by both the Interbureau Technical Committee and the Research and Development Committee. Approval for extension was unanimous in both instances.

14. Proposing Office General Evaluation and Recommendation

The project continues to hold the highest priority among the projects supervised by the Office of Agriculture and is an integral part of the program of the Division of Crop Production. It addresses directly, by improvement of the grain itself, the all important problems of hunger and malnutrition.

The proposed changes in the work plan of the project are sound and can be expected to make extremely important contributions to the technology of wheat production and, thus, to the alleviation of hunger in the world, as well as to the improvement of the lot of the small farmer.

Approval of the project is recommended.

Russell Desrosiers, Project Manager
Crop Production Division, TA/AGR

Willard H. Garman, Chief
Crop Production Division, TA/AGR

Leon F. Hesser, Acting Director
Office of Agriculture
Bureau for Technical Assistance

DETAILED COST ANALYSIS
First Year
(Excluding Administrative Costs)

Genetic Improvement

a. Genetics and Breeding
b. Laboratory Activities

Professionals	FTE	April 1, 1975 to March 31, 1976	
J. Stroike	.33	$ 6,268	
K. Wilhelmi	.33	4,342	
P. Mattern	.50	11,216	
J. Schmidt	--	N.C.	
V. Johnson	--	N.C.	
Graduate Assistants	5	25,000	
Technicians	9.0	82,612	
Hourly	2.25	14,459	
Total Salary			$143,897
Payroll Costs		$14,684	14,684
Maintenance, lab supplies		$ 6,500	
Analytical Service Charge		10,000	
Computer		1,000	
Publications		1,000	
Yuma Nursery Costs		4,000	
Shipping Costs		1,000	
Travel		2,000	
			$ 25,500
			$184,081

Genetic Improvement (Cont.)

c. International Evaluation
Ongoing Research

Professional	FTE		
J. Stroike	.66	$12,536	
K. Wilhelmi	.66	8,684	
Hourly	2	12,150	
Total Salary			$33,370
Payroll Costs		$ 3,225	3,225
Yuma IWWPN Nursery Costs		$ 1,000	
Shipping		4,000	
Computer		1,500	
Analytical Service Charge		2,500	
Publications		3,000	
Travel		6,000	
			$18,000
			$54,595

Proposed Research (R. Olson)

Materials and Equipment for Field Operations	$ 2,000	
Maintenance, Laboratory Analyses, and Supplies	5,000	
Travel	8,000	
		$15,000

d. Nutritional Evaluation

Small Animal Fees	$15,000

Physiology

a. Nitrogen Metabolism (L. Klepper)

Technician	$10,000	
Student Labor	5,000	
		$15,000
Payroll Costs	$ 1,477	1,477
Equipment, Drying Oven	$ 500	
Foliage Grinder	500	
Protein Analyzer	13,000	
Colorimeter (probe type)	2,700	
Growth Chamber	6,000	
Supplies, Maintenance, and Publications	4,500	
Travel	1,000	
		$28,200
		$44,677

b. Nitrogen Loss (G. Peterson and D. Sander)

Research Associate		$14,000
Payroll Costs		819
Proposed Gas Collecting Chambers	$25,000	
Supplies	1,000	
Travel	1,000	$27,000
		$41,819

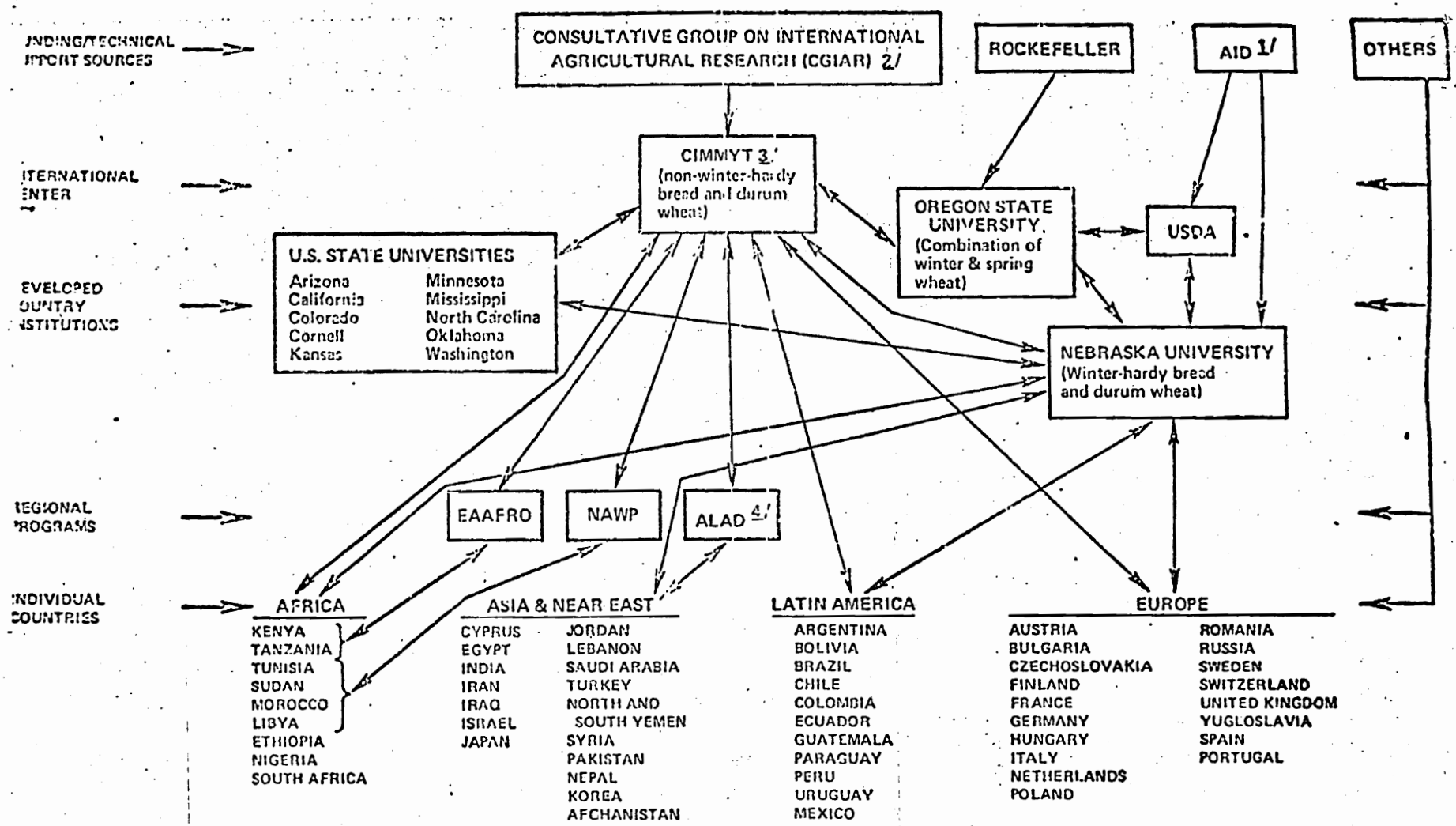
c. Photosynthetic Efficiency (M. Clegg)

Technician	$10,000	
Graduate Assistants	9,000	
Student Labor	3,000	
		$22,000
Payroll Costs		1,287
Growth Chambers	$22,500	
Maintenance, Supplies, and Publications	1,500	
Travel	1,000	
		$25,000

38

Symbiotic Nitrogen Fixation (R. Klucas and A. Vidaver)

Research Associate	$12,750	
Technician	10,080	
		$22,830
Payroll Costs		1,233
Maintenance, Supplies	$ 4,000	
Shipping Samples	1,000	
Publications	300	
Travel	2,500	
		$ 7,800
		$31,863



1/ AID IS SHOWN APART IN ORDER TO INDICATE FUNDING LINKAGES TO U.S. RESEARCH INSTITUTIONS. AID ALSO CONTRIBUTES THROUGH BILATERAL ARRANGEMENTS TO INDIVIDUAL COUNTRY PROGRAMS. OTHER DONOR MEMBERS OF CGIAR HAVE CORRESPONDING ADDITIONAL FUNDING LINKAGES.

2/ THE DONOR MEMBERS SUPPORTING CIMMYT ARE CGIAR, FORD FOUNDATION, ROCKEFELLER FOUNDATION, GERMANY, UNDP AND IBRD. OTHER CGIAR DONORS INCLUDE BELGIUM, DENMARK, FRANCE, JAPAN, KELLOGG FOUNDATION, NETHERLANDS, NORWAY, SWEDEN, SWITZERLAND, UNITED KINGDOM. ALL CGIAR MEMBERS ARE POTENTIAL FINANCERS OF OPERATING LINKAGES WITHIN THE NETWORK.

3/ THE LINKS BETWEEN CIMMYT AND THE INDIVIDUAL COUNTRIES TAKE THE FORM OF INFORMATION AND MATERIALS EXCHANGE, THE CONDUCT OF SEMINARS AND WORKSHOPS, COOPERATIVE RESEARCH PROJECTS, ADVISORY SERVICES AND TRAINING.

4/ ALAD ALSO SERVES SEVERAL AFRICAN COUNTRIES.

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ATTACHMENT 3

Informal Minutes of Research and Development Committee Meeting
Held on March 18, 1975

Project: Genetic Improvement of Productivity and Nutritional Quality of Wheat (extension), 3 years, $1,651,866

Contractor: University of Nebraska

Project Manager: Dr. Russell Desrosiers, TA/AGR

Discussion Highlights:

Dr. Erven Long commented on the background of AID-supported research on the nutritional improvement of wheat at the University of Nebraska. The proposed research is an outgrowth of this prior work with focus on: (1) basic physiological processes that contribute to improved nutritional value and productivity of wheat, and (2) coordination with the research activities and the outreach of CIMMYT.

Dick Birnberg, NESA, asked about the selection of Nebraska rather than CIMMYT for this work. Dr. Long commented that with the focus on protein and lysine analytic work, the laboratory resources of the University are essential as is their extensive experience with research in winter wheat. Sam Litzenberger, TA/AGR, added the information that CIMMYT tends to be oriented towards production aspects.

Project approved without objection.

TA/RIG:WSchaefer

PROJECT SUMMARY

Major Type of Activity: Key Problem Area - Higher-Protein Crop Production

Project Title: Improvement of the Nutritional Quality of Wheat Through Increased Protein Content and Improved Amino Acid Balance

Contractor: University of Nebraska

Contract Number: AID/csd-1208

Contractor Liaison Officer: Dr. Paul J. Mattern
Title: Associate Professor, Department of Agronomy

Project Number: 931-17-130-471
Present: 73-3102718

Project Duration: Started 6/29/66 Termination Date 6/28/71

Comments: Extension for another 3 to 5 years is anticipated.

Budget:		
a) Funds obligated through FY 69	:	$ 494,077
b) Funded for FY 70	:	193,500
c) Funds requested for FY 71	:	250,000
d) Estimated fund requirement FY 72	:	275,000

TA/AGF Project Monitor: Dr. Samuel Litzenberger

Purpose: Wheat is a major food worldwide. It provides ample calories but is low in protein and certain essential amino acids. Increasing the protein content and quality of wheat offers a cheap, practical and acceptable way to improve the nutritive quality of diets in wheat growing areas, particularly when the genetic process is incorporated with the higher yielding genetic work under way.

Description of Activity: Research has shown that protein levels and the amino acid composition of crops are genetically transmittable characteristics. The University of Nebraska identified Atlas 66, a winter wheat, as a source of high-protein germ plasm. It also is evaluating the world wheat collection for other high-protein source materials. These are crossed with high-yielding varieties to produce high food value materials of greater yield and with higher total protein. The work at Nebraska is tied in with CIMMYT in Mexico and with a cross-section of wheat trials and demonstrations worldwide.

Accomplishments: Rapid progress is being made in combining protein genes with other desirable traits, to produce new strains for worldwide testing. In 1969 improved winter wheat varieties were grown and evaluated at 23 sites in 16 countries; in 1970, new improved strains will be evaluated at 39 sites in 25 countries. From 3 to 5 years additional research is projected to achieve delivery of improved winter wheats for commercial growth in many nations. This project is expected to have a major impact on world protein needs.

Future Plans: Superior varieties with high protein and high lysine developed and tested under this project will be made available to wheat breeders in the LDCs. University of Nebraska technical personnel will also help the local breeders incorporate these improved materials into local breeding programs. The University estimates that breeding programs can increase the protein content of wheats by 15-25% without depressing yields.

TA/AGF: MGalli:7/15/70; revised 8/5/70

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RESEARCH

Project Title Improvement of the Nutritional Quality of Wheat

Project Number 931-17-130-471

Starting Date 6/29/66 Termination Date 6/28/71 1/

Cumulative Obligations (in thousand $)

June 30, 1968	370
FY 1969 Actual	124
FY 1970 Estimate	175
FY 1971 Proposed	250

Name of Contractor(s) University of Nebraska

Contract Number(s) CSD-1208

Cooperating Sponsor(s) CIMMYT, FAO and 16 countries are cooperating on winter wheat nurseries.

Project Summary (RAC)

Date of [illegible] 4/66 Date Approved (RAC) 5/66 Evaluation Date ([illegible]) [illegible]

Purpose: Wheat is a major food worldwide. Wheat provides ample calories but is low in protein and certain essential amino acids. Increasing the protein content and quality of wheat offers a cheap, practical and acceptable way to improve the nutritive quality of diets in the wheat growing areas, particularly when the genetic process is incorporated with the higher yielding genetic work underway.

Description of Activity: Research has shown that protein levels and amino acid composition of crops are genetically transmittable characteristics. The University of Nebraska identified Atlas 66, a winter wheat, as a source of high protein germ plasm. The University of Nebraska is also evaluating the world wheat collection for other high protein source materials. These are crossed with high-yielding varieties to produce high food value materials of greater yield and with higher total protein.

The work at Nebraska is tied in with CIMMYT in Mexico and with a cross section of wheat trials and demonstrations worldwide. It is ARDS' contention that the ultimate solution to the world's protein problem lies in the route being followed.

Accomplishments: High protein and high lysine materials have been identified and proven to be heritable characteristics. Crosses with high-yielding varieties have been made and are under test. International Winter Wheat Nurseries have been established under this project for testing selected winter wheat materials in 23 locations in 16 countries. CIMMYT is testing crosses with spring type wheats developed under this project.

Future Targets: Superior varieties with high protein and high lysine developed and tested under this program will be made available to wheat breeders in the LDCs. Furthermore, the University of Nebraska will assist the local breeders to incorporate these improved materials into local breeding programs. The University of Nebraska estimates that breeding programs can increase the protein content of wheats by 15-25% without depressing yields.

1/ It is anticipated that the contract will be extended for another 3 to 5 years and that there will be an increased work load in getting the approved materials into LDC breeding programs.

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PROJECT SUMMARY

Major Type of Activity: Key Problem Area - Higher-Protein Crop Production

Project Title: Improvement of the Nutritional Quality of Wheat through Increased Protein Content and Improved Amino Acid Balance

Contractor: University of Nebraska

Contract Number: AID/csd-1208

Contract Coordinator: Prof. Paul J. Mattern
Title: Biochemist, Department of Agronomy

Project Number: 130-471

Project Duration: Started 6/29/66 Termination Date 6/28/74

Comments: A three year extension was approved by RIGC (Oct. 22, '70) and RAC (Jan. 28, '71)

Budget:
a) Funds obligated through FY 70: $ 687,577
b) Funded for FY 71 : 243,057
c) Funds requested for FY 72 : 275,000
d) Estimated fund requirement FY 73: 280,000

TA/AGF Project Manager: Dr. C. A. Breitenbach

TA/AGF Project Specialist: Dr. S. C. Litzenberger

Purpose: Wheat is a major food worldwide. It provides ample calories but is low in protein and certain essential amino acids. Increasing the protein content and quality of wheat offers a cheap, practical and acceptable way to improve the nutritive quality of diets in wheat growing areas, particularly when the genetic process is combined with the selection of cultivars with higher grain yield.

Description of Activity: Research has shown that protein levels and the amino acid composition of crops are genetically transmissible characteristics. The University of Nebraska identified Atlas 66 as well as several other genetic sources of high-protein germ plasm. It is also evaluating the world wheat collection for other high-protein source materials. These are crossed with high-yielding varieties to produce superior varieties with higher total protein. The work at Nebraska is directly tied in with CIMMYT in Mexico and with a cross-section of uniform wheat trials, seminars, and demonstrations worldwide.

Accomplishments and Utilization: Protein increases in wheat as large as 25% have already been achieved by breeding. Atlas 66 has been the main genetic source. At least two genes condition protein level in this variety, one of which is linked with a gene for leaf rust resistance. Rapid progress is being made in combining these and other known sources for improved protein with other desirable traits for worldwide testing. In 1970 improved winter wheat varieties to produce new strains were grown and evaluated at 38 sites in 24 countries; in 1971 the Fourth International nursery will be evaluated at 44 sites in 27 countries. To date more than 16,000 entries of the USDA world wheat collection have been analyzed for protein and lysine. From 3 to 5 years additional research is

projected to achieve acceptance of improved winter wheat varieties for commercial production in developing nations. This project is expected to have major impact on world protein needs.

Future Plans: Superior varieties with high protein and high lysine developed and tested under this project will be made available to wheat breeders in the LDCs. University of Nebraska technical personnel will also help local breeders incorporate these improved materials into local breeding programs. The project has recently initiated a program of mouse breeding tests to better measure the biological value of the high protein varieties as *in vitro* laboratory and chemical tests appear inadequate.

TA/AGF:CABreitenbach:SCLitzenberger:revised 6/17/71

October 30, 1978

ACTION MEMORANDUM FOR THE DEPUTY ASSISTANT ADMINISTRATOR FOR FOOD AND NUTRITION, DEVELOPMENT SUPPORT BUREAU

FROM : DS/AGR, Dean F. Peterson Dean F Peterson

SUBJECT: Extention of the Project 931-0471,11, Improved Nutritional Quality of Wheat - University of Nebraska (AID/ta-C-1093) at a Cost of $90,000 for One Year

Problem: Your approval is needed for a one year extension requiring FY 1979 funds of $90,000 for the subject project.

Discussion: An international winter wheat evaluation network was initiated by USDA/SEA/FR (formerly USDA/ARS) and the University of Nebraska in 1969 as a component of Contract AID/csd-1208 (Improvement of the Nutritional Quality of Wheat). The evaluation network was continued after 1974 under Contract AID/ta-C-1903 (Genetic Improvement of the Productivity and Nutritional Quality of Wheat).

The evaluation network is comprised of two nurseries:

A. A replicated International Winter Wheat Performance Nursery (IWWPN).

B. A High Protein-High Lysine Observation Nursery (HP-HL Observation Nursery).

New improved winter varieties and experimental lines from winter wheat-producing countries are evaluated at the IWWPN. Selections and advanced lines, with new and unusual combinations of genes for high protein and high lysine from the USDA-Nebraska wheat protein project are distributed in the Observation Nursery for local evaluation and use by wheat breeders in developing countries.

The evaluation network has the enthusiastic support and active participation of wheat breeders and agronomists from every major winter wheat-producing country except the People's Republic of China. Through the network, firm linkages have been established for dissemination and delivery of useful new wheat germplasm and research information to developing countries. These lines are used either for crossing with local lines or following a performance evaluation released as varieties for commercial production.

This project received a nine month no-new fund extension through December 31, 1978 to provide sufficient time for the USDA and the University of Nebraska to obtain non-AID funds to continue the research elements of this project after December 1978. Following further discussions with USDA and the University of Nebraska that they would provide FY 1980 funds to continue the evaluation nurseries, AID was requested to provide $90,000 to fund the evaluation nursery element of the project through December 31, 1979, at which time USDA and the University of Nebraska will assume management and funding responsibility. Funds from this project will assure retention of skilled technicians at the University of Nebraska and the Quarantine Center at Yuma, Arizona whose services are necessary for successful management of the network. Such funding will avoid disruptive temporary discontinuation of the network while new funds are sought.

Work to be performed under this one year funded extension will include assembling and distributing experimental wheats from the Nebraska program which possess new unusual combinations of genes for productivity, high protein and high lysine in an International High Protein - High Lysine Observation Nursery. Wheat samples will be disseminated by the contractor who will also supervise the evaluation of new improved wheats from cooperating countries in the International Winter Wheat Performance Nursery. See Attachment A, Work Plan and Attachment B, Budget Summary for more specific details.

Recommendation: That you sign the attached PAF for a one year extension costing $90,000 for the subject project.

Attachments:
A/S

Clearance:
DS/PO, RSimpson Date:_____

ATTACHMENT A

WORK PLAN

A. New improved winter wheat varieties will be solicited from countries cooperating in the IWWPN network. Seed of candidate varieties will be propagated under quarantine at Yuma, Arizona to provide the seed quantity necessary for their inclusion in the IWWPN and establish eligibility for issuance of U.S. Phytosanitary Certificates to accompany IWWPN seed shipments.

B. Seed of IWWPN entries will be processed, packaged, and distributed to nursery cooperators together with field books and data reporting forms. Performance data and seed samples from cooperators at each IWWPN site will be processed, subjected to quality laboratory computer analyses, interpreted and assembled into appropriate preliminary reports and published full reports by the project personnel at Lincoln, Nebraska for international distribution to wheat scientists.

C. Existing experimental lines of wheat in various stages of development from the USDA-Nebraska wheat protein improvement project will be advanced as appropriate in field selection nurseries at Lincoln, Nebraska and Yuma, Arizona. Laboratory protein and lysine analyses will be performed to identify those lines that possess the most effective combinations of genes for productivity, agronomic traits, protein, and lysine. These lines will be entered in the International High Protein-High Lysine Observation Nursery for distribution, local evaluation, and use by breeders and agronomists in developing countries. Seed samples from harvested rows at each test site will be analyzed for protein and lysine in the Nebraska Wheat Quality Laboratory and the results of the analyses will be distributed to cooperators in appropriate reports and publications.

D. Project supervisory personnel will make on-site visits to testing locations as their work schedules permit for consultation with cooperators and evaluation of nursery materials.

E. Large numbers of requests for high protein-lysine wheat germplasm and research information are received by the USDA-Nebraska wheat group. These will be processed promptly as received to enable the requesting scientists to utilize the materials and information without unnecessary delay.

ATTACHMENT B

BUDGET SUMMARY
January 1, 1979 - December 31, 1979

Salaries :

Professional (1 scientist) - - - - - - - - - - -	$21,000
Technical (1 laboratory technician) - - - - - - -	13,500
Hourly labor (field and laboratory) - - - - - - - -	15,000
Salary subtotal	49,500

Operational Costs:

Nursery increase plantings (Yuma, Arizona)- - - - -	10,000
Supplies (field and laboratory) - - - - - - - - -	5,000
Computer charges and publication costs - - - - - -	5,000
Travel (domestic and foreign nursery sites) - - - -	7,500
Operational subtotal	27,500
Total salary and operational costs	77,000
Administrative charges	13,000
Total	90,000

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT AUTHORIZATION AND REQUEST FOR ALLOTMENT OF FUNDS PART I

1. TRANSACTION CODE: A (A = ADD, C = CHANGE, D = DELETE)

PAF

2. DOCUMENT CODE: 5

3. COUNTRY/ENTITY: DS/AGR RDA-2 Type A Research

4. DOCUMENT REVISION NUMBER: 2

5. PROJECT NUMBER (7 digits): 931-0471.11

6. BUREAU/OFFICE: A. SYMBOL: DSB; B. CODE: 10

7. PROJECT TITLE (Maximum 40 characters): Improved Nutritional Quality of Wheat

8. PROJECT APPROVAL DECISION — ACTION TAKEN: A = APPROVED, D = DISAPPROVED, DE = DEAUTHORIZED

9. EST. PERIOD OF IMPLEMENTATION (For 1 year extension): YRS. 01 QTRS. 0

10. APPROVED BUDGET AID APPROPRIATED FUNDS ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	PRIMARY TECH. CODE C. GRANT	D. LOAN	E. THRU 9/30/78 F. GRANT	G. LOAN	H. 1ST FY 79 I. GRANT	J. LOAN	K. 2ND FY 80 L. GRANT	M. LOAN
(1) FN	111-I	973	–	3887	–	90	–	0	–
(2)									
(3)									
(4)									
TOTALS				3887	–	90	–	0	–

A. APPROPRIATION	N. ~~3rd~~ 3rd FY 81 O. GRANT	P. LOAN	Q. ~~5th~~ 4th FY 82 R. GRANT	S. LOAN	FY 79 LIFE OF PROJECT T. GRANT	U. LOAN
(1) FN	0	–	0	–	3977	–
(2)						
(3)						
(4)						
TOTALS	0	–	0	–	3977	–

11. PROJECT FUNDING AUTHORIZED (ENTER APPROPRIATE CODE(S)) 1 = LIFE OF PROJECT, 2 = INCREMENTAL, LIFE OF PROJECT: A. GRANT 2; B. LOAN

C. PROJECT FUNDING AUTHORIZED THRU FY 79

12. INITIAL PROJECT FUNDING ALLOTMENT REQUESTED ($000)

A. APPROPRIATION	B. ALLOTMENT REQUEST NO. C. GRANT	D. LOAN
(1)		
(2)		
(3)		
(4)		
TOTALS		

13. FUNDS RESERVED FOR ALLOTMENT

TYPED NAME (Chief, SER/FM/FSD)

SIGNATURE

DATE

14. SOURCE/ORIGIN OF GOODS AND SERVICES: ☐ 000 ☐ 941 ☐ LOCAL ☐ OTHER

15. FOR AMENDMENTS, NATURE OF CHANGE PROPOSED

This amendment increases the funding level of the subject project by $90,000 (an increase from $3,887,000 to 3,977,000 and extends the life of the project by one-year (an extension from January 1, 1978 to December 31, 1979). This funding will only provide for the continuation of the winter wheat evaluation nurseries as specified in the previous project documentation. This will provide the time required for the University of Nebraska and USDA to negotiate outside (non-AID) funding for this activitity on a continuing basis.

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FOR PPC/PIAS | 16. AUTHORIZING OFFICE SYMBOL | 17. ACTION DATE MM DD YY | 18. ACTION REFERENCE (Optional) | ACTION REFERENCE DATE MM DD YY

DRAFT

PROJECT AUTHORIZATION AND REQUEST FOR ALLOTMENT OF FUNDS

PART II

Entity : DS/Bureau

Project : Improved Nutritional Quality of Wheat, University of Nebraska

Project Number : 931-0471.11

I hereby authorize FY 1979 grant funding of $90,000 for a one-year extension (through December 31, 1979) of the subject project for the purpose only of continuing the winter wheat evaluation nurseries. This will provide the time required for the USDA and University of Nebraska to negotiate outside (non-AID) funding for this activity on a continuing basis.

The A.I.D. funded research portions as currently approved for this project will have been completed by December 31, 1978.

Tony Babb
Deputy Assistant Administrator
for Food and Nutrition
Development Support Bureau

~~Date:~~ 11/8

Clearances:
DS/AGR/FCP: RJackson RJ 11/2/78
DS/AGR/FCP: KMByergo 11/2/78
DS/AGR: MMozynski
DS/AGR: DPeterson 11/6/78
DS/PO: MRechcigl
DS/PO: RSimpson

Reference:
Action Memo - Peterson to DAA/FN/DS dated