PD-AAN-078
ISN 24316

PROJECT EVALUATION SUMMARY
(Submit to AID/W after each project evaluation)

1. Mission or AID/W Office Name	2. Project Number
DS/AGR/CP	-0524

Project Title

Inheritance and Improvement of Protein Quality and Content in Maize

3. Key project dates (Fiscal years)			5. Total U.S. funding life of project
a. Project Agreement signed 6/30/75	b. Final Obligation FY 76	c. Final input delivered 3/31/78	$1.8 million

4. Evaluation number as cted in Eval. Schedule	7. Period covered by this evaluation		8. Date of this Evaluation Review
	FROM: 10/1/75 Month/year	TO: March 1978 Month/year	April 18,19, 1978 month/day/year

Action Decisions Reached at Evaluation Review, including items needing further study (Note--This list does not constitute an action request to AID/W. Use telegrams, airgram, SPARS, etc., for action)	10. Officer or Unit responsible for follow-up	11. Date action to be completed
A. Make available more information on commercial use in LDC and DC of high lysine corn varieties	Purdue and A.I.D	9/78
B. Information on the use of high lysine varieties for site specific situations should be made available to missions, international centers, and other interested institutions and donors.	Purdue and A.I.D	9/78
C. Close liaison with continuing research on high lysine maize should be maintained. As any breakthroughs occur this information should be extensively disseminated.	Purdue and A.I.D.	Continuing

Signatures:

Project Officer		Mission or AID/W Office Director	
Signature	[signature]	Signature	[signature]
Typed name	Keith M. Byerge, DS/AGR/FCP	Typed name	Leon F. Hesser, DS/AGR
Date		Date	January 26, 1978

13. SUMMARY - Summarize in about 200 words the current project situation, mentioning progress in relation to design, prospects of achieving purpose, major problems encountered, etc. Purdue University Contract AID/ta/c/1211 entitled "Inheritance and Improvement of Protein Quality and Content in Maize" terminated March 31, 1978. The starting date for this contract was June 30, 1975, but the overall financial support by A.I.D. for the research at Purdue covered approximately an eight-year period.

Although the chief aim of the cooperative undertaking, i.e., increasing the quantity and nutritional value of food crops in developing countries, was not attained, the expenditure of A.I.D. funds can nevertheless be considered as worthwhile. Much knowledge has been added to the field of the breeding genetics, and biochemistry of endosperm of maize; deposition of starch; quality and quantity of protein; associated characters such as oil content and quality, starch composition, and insect and disease resistance; effects of associated genes both singly and in combinations with Opaque-2; and the nutritional values of maize with various qualities of protein.

There have been a total of 109 publications and abstracts of research reports by the Purdue project staff during the period the project was supported by A.I.D. (See Appendix F). This extensive store of knowledge will be of value not only for the continuing research at Purdue but also at other institutions over the world doing research on cereal grains.

Germplasm containing Opaque-2 and a number of other endosperm-conditioning genes, along with various modifying genes, in various genetic backgrounds have been distributed to a large number of LDCs, European countries, and corn breeders in the U. S. and Canada. The Purdue scientists have worked with maize scientists in 13 different LDCs as well as with a number in the Eastern European block. They have trained 21 graduate students, 9 postdoctorates, and 10 trainees representing 7 different countries.

Scientific breakthroughs are unpredictable. They can occur at any time. A.I.D. should maintain liaison with the research which will be continued (although on a reduced basis) at Purdue, and be in position to exploit future findings that could be utilized in the LDCs.

4. EVALUATION METHODOLOGY - Describe the methods used for this evaluation, i.e., was it a regular or special evaluation? Was it in accordance with the Evaluation Plan in the PP with respect to timing, study, design, scope, methodology, and issues? What kinds of data were used and how were they collected and analyzed? Identify agencies and key individuals participating and contributing.

The terminal evaluation of Purdue University Contract AID/ta/c/1211 was held at the Department of Agronomy, Purdue University, West Lafayette, Indiana on April 18 and 19, 1978. There was no provision in the Project Statement (1) for such a review. The evaluation was made in accordance with customary procedure with respect to A.I.D. research contracts.

Mr. Keith M. Byergo, Project Manager, provided the members of the Review Team with a number of relevant documents (1 to 9) in a mailing made on March 26, 1978. Dr. David V. Glover, Principal Contract Investigator, complying with a request made by Mr. Byergo sent to each team member, under date of April 7, a copy of a "brief overview of the project developments" (10).

14. Cont'd

April 17 was devoted to a review of the project procedures, findings, and other accomplishments by the Purdue staff. During the forenoon of April 18, the members of the Evaluation Team prepared the initial rough (tentative) draft of the evaluation report. The afternoon of April 18 was devoted to a discussion of the draft report with the Purdue staff.

A list of the documents made available to the Team are listed in "References". A list of the team members and of the Purdue participants, and the agenda for the first day's meeting are presented in Appendices A, B, and C, respectively.

15. Documents to be revised to reflect decisions noted page 1 (other side)

___ Project Paper (PP) ___Logical Framework ___CPI Network ____Financial Plan
___ PIO/T ___PIO/C ___PIO/P ___Project Agreement ___Other
___ This evaluation brought out ideas for a new project - - a Project Identification Document (PID) will follow.

The Evaluation Team concurs in the decision made previously that A.I.D. should not provide further financial support for work in this area. However, it is noted that Purdue University has submitted a proposal to the USDA/SEA Competitive Grants Office for support for a research program on "Genetic regulation of yield parameters inherent in maize endosperm". The research would address itself to the principal constraint in utilization of the high lysine character, i.e., the concomitant reduction in yield. It would be of a basic nature, an approach that appears logical in view of the difficulties encountered in attempting to produce a high lysine corn through traditional breeding methods. The Evaluation Team is favorable to the continuation of the research under way, modified somewhat to be more basic in nature and supported by an agency (cies) other than A.I.D. which can appropriately support this type of activity.

16. Evaluation findings about EXTERNAL FACTORS - Identify and discuss major changes in project setting which have an impact on the project. Examine continuing validity of assumptions.

Since the beginning of support of this project by A.I.D., there has been some shift in thinking on the part of plant scientists, nutritionists, and others on the relative importance in the human diet of protein vis-a-vis calories. The emphasis has shifted in part from protein to calories. This general development is evidenced in numerous technical reports, conferences, and other similar sources. In a conference in Boulder, Colorado held in 1976 (11), it was concluded that all improvements in the quality or quantity of cereal grains, whether by genetic manipulation or by fortification, should be directed toward the use by intended populations or specific target groups. Recommendations to the effect that no decreases in yield be accepted must be considered on a cost benefit basis.

16. Cont'd.

The validity of assumptions which follows is based on the assumption listed in the 10/30/75 log frame, which are as follows:

(1) Assumption: LDCs will actively attempt to expand food crop production. Valid? Yes. Such efforts are being made in varying degrees in all of the LDCs.

(2) Assumption: Nutritional quality can be improved without major constraints on yield. Valid? Not with respect to increasing lysine with the Opaque-2, or similar genes. Purdue has not been able to come up with a high lysine corn equal in yield to "normal" commercial hybrids.

(3) Assumption: Solutions can be found to major constraints. Valid? No. See response to Assumption 2 above.

(4) Assumption: Agriculture extension services are able and willing to promote proven practices. Valid? Yes, given acceptable practices, there should be little question relative to extension cooperation. It is possible that in areas where maize yields are low and there is a lack of high quality proteins in human diets, A.I.D. might undertake adaptive trials with present Opaque-2 varieties. It should not be difficult to equal yields of maize varieties now being grown in some of these areas. The Purdue staff indicated a willingness to provide assistance on a consultant basis, for any such undertakings.

(5) Assumption: LDC research institutions develop adequate capabilities. Valid? Maize research capabilities in the LDCs vary a great deal. However, there are a reasonable number of places where the capabilities for the work intended are adequate. Lack of scientific capability in the LDCs has not constituted a limiting factor in the program.

(6) Assumption: LDCs and USAIDs will request technical assistance; research finiings will be available. Valid? Fully acceptable. There has been a good outreach to scientists in the LDCs through conferences, correspondence, distribution of published materials and distribution of germplasm.

(7) Assumption: Interest and resources exist in LDCs. Valid? Interest and resources adequate, if the yield problem could have been solved.

(8) Assumption: Collaboration of international institutions. Valid? Good cooperation with appropriate international institutions, especially with CIMMYT, CIAT, and the Inter-Asian Maize Workers program.

16. Cont'd.

(9) Assumption: AID/W funding will be available on schedule and in quantity agreed upon. Valid? The contractor stated that this assumption was valid.

(10) Assumption: Contractor will have necessary qualified personnel; university facilities will be available to project. Valid? The qualifications of the Purdue staff working on the project are excellent. The staff conducted the research with a high degree of interest and motivation. Facilities are very good and were made fully available.

(11) Assumption: International organizations, USAIDs, and LDCs will have personnel and resources to support this activity. Valid? This assumption was never fully tested because the technical progress was such that not too much cooperation abroad was indicated. The USAIDs and LDCs probably participated to the extent that was justified. The breeding efforts in some LDCs are continuing.

17 Evaluation findings about GOAL/SUBGOAL - For the reader's convenience, quote the approved sector or other goal (and subgoal, where relevant) to which the project contributes. Then describe status by citing evidence available to date from specified indicators and by mentioning progress of other projects (whether or not U. S.) which contribute to same goal. Discuss causes - can progress toward goal be attributed to project, why shortfalls?

The sector goal given in the 10/30/75 log frame is as follows: "To increase quantity and nutritional value of food crops in developing countries".

For the most part, the goal has not been attained. Information on the hectarages and yields of commercially produced Opaque-2 maize were not available to the Evaluation Team. However, it was the judgment of the Purdue participants that such production is very limited. It was pointed out that Opaque-2 maize is being grown on a commercial scale in a number of the Eastern Block countries, but perhaps not to any great extent elsewhere.

The reason for the short-fall is the failure to obtain hybrids and synthetics with the Opaque-2 gene equal in yield to "normals". It is now well established that the presence of the Opaque-2 gene in an otherwise "normal" genetic background results in lowered yields. Furthermore, there is serious doubt whether yield of Opaque-2 materials can be brought to the level of "normal" through any type of genetic manipulation. Adding the sugary-2 gene solves the floury starch problem (i.e., starch is made much more vitreous) but yields, if anything, are further depressed. Modifier genes also solved the soft starch problem but not yield. It is thought by the Purdue participants that problems of greater disease and insect susceptibility of the high lysine maize hybrids and synthetics can be solved.

17. Cont'd.

The methodology employed by the contractor appears to have been appropriate, adequate, and well conceived.

18. Evaluation findings about PURPOSE - Quote the approved project purpose. Cite progress toward each End-of-Project Status (EOPS) condition. When can achievement be expected? Discuss causes of progress or short-falls.

The purpose given in the 10/30/75 log frame is as follows: "To develop high lysine maize populations and lines having good agronomic characteristics and market quality and make these available for use in the LDCs".

Good progress has been made in getting maize with high lysine and high triptophane content. However, the populations with the Opaque-2 gene are more susceptible to ear rots, to insect damage, and they dry out more slowly than "normals" under field conditions. The soft (floury) starch problem associated with Opaque-2 can be solved either through incorporation of the Sugary-2 gene or through modifiers. It is the judgment of the Purdue research staff that all of the agronomic characteristics can be brought up to an an acceptable level through genetic manipulation, except possibly yield. Opaque-2 results in arrested endosperm development. So far this shortcoming has not proven amenable to a research solution, and will possibly remain so. There may have to be a trade off of some yield for quality, i.e., high-lysine corn with a somewhat lower yield may have to be grown only as a specialty crop.

Admittedly, the problem of obtaining Opaque-2 (or genes with similar effects on quality of protein) with yields equal to "normal" has proven much more difficult, perhaps impossible, than originally envisioned. Probably no authority in the field foresaw the magnitude of the problems involved at the time A.I.D. started supporting this project - at least not anyone whose negative judgment at the time has come to the attention of the Evaluation Team.

19. Evaluation findings about OUTPUTS and INPUTS - Note any particular success or difficulties. Comment on significant management experiences of host contractor, and donor organizations. Describe any necessary changes in schedule or in type and quantity of resources or outputs needed to achieve purpose.

The Outputs listed in the 10/30/75 log frame and progress made on same are as follows:

Output (1): Isolation and evaluation of new genes for high lysine, high protein, and other characters.

Progress: Dr. Bauman picked up 7 different genetic events of Opaque-2. Subsequent testing resulted in finding no difference from Opaque-2 in the expression of these alleles. Dr. Crane reported that all "new" Opaque-type mutants picked up in material gathered in Colombia proved to be Opaque-2, probably coming from pollen of materials grown from seed sent to Colombia by Purdue. Dr. Glover reported obtaining a fair number of opaque phenotypes with chemical mutagen treatment of both seed and pollen. Some of these have proven to be allelic to Opaque-2. Further testing is in progress to determine the

loci and effects of the remainder.

Output (2): Study of double mutant combinations with a view to produce on Opaque-2 combination of superior nutritional quality, good agronomic character and high yield.

Progress: Placing Opaque-2 in double mutants with Opaque-7, floury, shrunken, and brittle enhances the effects of Opaque-2 alone. All such combinations are deficient in starch and still lower in yield. The effects are less pronounced in double mutants with ae, du, su, and wx. There are some shifts in zein content and non-zein protein.

Output (3): Chemical and bioassay of promising new material.

Progress: Purdue has a well-equipped biochemical laboratory which was fully available to and utilized by the project. Adequate testing for quality was done as needed. Nutritional studies were made with rats as the laboratory animal.

Output (4): Distribution of superior germplasm to LDC maize breeders.

Progress: There has been a good distribution of germplasm to LDCs and also to other countries. The list of recipients is shown in Appendix D. The germplasm distributed consisted of 13 synthetics, plus a number of inbreds and other populations carrying one or more endosperm mutant genes.

Output (5): Training of LDC research personnel.

Progress: Training, under way or completed, included 11 foreign graduate students, 10 U. S. graduate students, 9 postdoctorates, and 10 trainees representing 7 different countries.

Output (6): Establishment of international linkages.

Progress: The Purdue investigators worked with maize scientists in 13 different LDCs (list shown in Appendix E). They also worked with many eastern European countries.

The Inputs listed in the 10/30/75 log frames and progress made to date are as follows:

Input (1): AID/W provides financial support and project guidance.

Progress: A.I.D. provided approximately $1.8 million during the eight years of contracts with Purdue University. This amount appears to have been adequate to cover the contract provisions. It was noted by the Purdue staff that there has been some shift in emphasis on various aspects of the program as the years went along, but it was agreed that shifts are to be expected. The shifts have included a narrowing of focus, but this has not been a controversial point. There was some misunderstanding early

of when annual reports were due but this problem was resolved. Purdue felt somewhat torn between research and outreach aspects of the program and pointed out that in more recent years A.I.D. expected more outreach than earlier. It was also noted that early expectations may have been somewhat too high; it was agreed that neither Purdue or A.I.D. is to blame for this.

On the whole, the Purdue reaction to A.I.D. management of the contract was favorable.

Input (2): Contractor provides qualified personnel and backstopping facilities.

Progress: No problem here. In an undertaking of this type, there is a limited amount of assistance (other than financial) that A.I.D. can provide.

Input (3): Participating personnel and cooperation provided by (a) LDCs, (b) USAIDs, and (c) international organizations.

Progress: The LDCs have given good cooperation with respect to utilizing germplasm (see Appendix D), sending graduate students and trainees to Purdue, and working with the Purdue scientists through seminars, conferences, correspondence, and personal visits (see Appendix E for list of countries worked with).

The USAIDs have not been very much involved for the reason that there was no material available for promotion in the LDCs. If the trade off concept (sacrifice some yield for an enhancement in quality) is accepted, the USAIDs could become more involved in promoting high lysine corn as a specialty crop.

Active and good cooperation has been received from CIMMYT, CIAT, and the Inter-Asian Maize Workers Program. CIMMYT has been and is continuing to carry on a high-lysine -in-maize research program primarily for the tropics, whereas Purdue has had the corresponding responsibility for the temperate zones. However, research findings and germplasm developed at Purdue are also of much value in the tropics.

20. Evaluation findings about UNPLANNED EFFECTS - Has project had any unexpected results or impact, such as changes in social structure, environment, technical or economic situation? Are these effects advantageous or not? Do they require any change in plans?

No unplanned effects were observed.

21. CHANGES in DESIGN or EXECUTION - Explain the rationale for any proposed modification in project design or execution which now appear advisable as a result of the preceding findings (items 16 to 20 above) and which were reflected in one or more of the action decisions listed on page 1 or noted in Item 15 on page 3.

This section not applicable since contract has expired and there will be no further A.I.D. financial support.

22. LESSONS LEARNED - What advice can you give a colleague about development strategy - e.g., how to tackle a similar development problem or to manage a similar project in another country? What can be suggested for follow-on in this country? Similarly, do you have any suggestions about evaluation methodology?

The experience gained in this project underscores the fact that in advance the pay-off in any research undertaking is an unknown, and that indeed it may be zero with respect to the main objective. The maize protein quality research was (and should have been so recognized at the outset)a high risk undertaking with the potential of an extremely high pay-off. Authorities in the field when A.I.D. commenced financial support were very optimistic about the possible outcome. Given the knowledge and scientific counsel at the start of the project, A.I.D. was fully justified in providing support. The decision on the last three-year contract was made about 4 years ago, i.e. about 4 years after starting the work. It would have been short-sighted to terminate a genetic/breeding/nutrition project after so short a time of support, i.e., the last three-year contract was fully justified. It is the judgment of the Evaluation Team that A.I.D. acted properly and wisely in coming to the support of the work initially, in continuing the support for a reasonable length of time, and in terminating its support with a three-year advance notice, after it became rather apparent that the chief goal, i.e., obtaining a high lysine corn with yields comparable to "normal", was not obtainable, at least not likely so in the very near future. A.I.D. recognized the value of the "store of knowledge" that was being developed, which will be of value not only in a continuation of this type of research but also in related research in maize and other cereals. However A.I.D. feels, and properly so, that basic research which can well be continued, should be supported by other agencies.

There is no suggestion for evaluation methodology.

23. SPECIAL COMMENTS or REMARKS (For AID/W projects, assess likelihood that results of project will be utilized in LDCs).

It would be helpful if information were available on commercial utilization of the high lysine character in both the United States and in the LDCs. Dr. Glover stated that he has written to the LDCs for such information, so it should be forthcoming. It was also suggested that A.I.D. might secure information on utilization of the high lysine character in the U. S. from the American Seed Trade Association.

A.I.D. should maintain liaison with the continuing research program at Purdue. If the yield and other agronomic problems are solved, consideration should be given to reactivating a program which would extend the information and make the germplasm available to LDCs where protein is limiting in human diets.

24. RECOMMENDATIONS.

Research on inheritance and improvement of protein quality and content in maize should be continued. The problem of maintaining yields equal to normal with high lysine maize is a difficult one, and may in fact prove to be insolvable. However, the research should be continued since the pay-off from th use of such maize genetic material would be very high. The research in the future obviously needs to be of a basic nature, since traditional plant breeding approaches have not proven successful.

Support for such research needs to come from other agencies, since it does not fall within the primary objectives of A.I.D.

A.I.D. needs to maintain liaison with research carried on in this field. If the yield and other agronomic limitations are solved, consideration should be given by A.I.D. to extending the information and helping to make the germplasm available to appropriate countries (I.E. those where at least in some areas quality protein is limiting in the diets). Also, the possibility of growing high lysine maize (in spite of reduced yields) as a specialty crop should be kept in mind for a possible program in LDCs by A.I.D.

REFERENCES

1. Project Statement for "Inheritance and Improvement of Protein Quality and Content in Maize", Proposed extension period 4/1/75 - 3/31/78. Contractor: Purdue University.

2. Informal minutes of research and development committee held on January 14, 1975. Project: Inheritance and Improvement of Protein Quality and Content in Maize - extension for 3 years. Contractor: Purdue University.

3. Research on inheritance and improvement in protein quality and content in maize. October 1975. Work plan and budget under Contract AID/ta-c-1211. Prepared by Purdue University and submitted to A.I.D.

4. PAR for period 10/1/74 to 9/30/75. Inheritance and improvement of protein quality and content in maize. Earl R. Leng, Project Manager.

5. Report on progress of the maize protein research project, based on a review of the project at Purdue, December 13-14, 1976, "as well as on the most recent annual reports". Prepared to meet the requirement specified by RAC at the March 20-21, 1975 meeting.

6. Copy of letter sent by Russell Desrosiers, TAB, to D. Wood Thomas, Purdue University under date of March 25, 1975 suggesting emphasis on four principal lines of investigation.

7. Contract between A.I.D. and Purdue Research Foundation covering research on inheritance and improvement in protein quality and content in maize; effective June 30, 1975, with March 31, 1978, as the completion date. Project No.: 931-17-130-524-73.

8. Amendment to No. 5 above, dated 6/30/75.

9. Annual report on inheritance and improvement of protein quality and content in maize; April 1, 1976 to March 31, 1977.

10. Brief overview of the project developments. Undated but distributed to team members by David V. Glover, Purdue, under date of April 7, 1978.

11. Improving the nutrient quality of cereals II. September 1976. Report of the second workshop on breeding and fortification. A.I.D. Edited by H. L. Wilcke.

MEMBERS OF THE EVALUATION TEAM

Elvin F. Frolik	Consultant to AID/W, Lincoln, Nebraska
Keith M. Byergo	AID/W
Paul H. Harvey	SEA-FR, USDA, Beltsville, Maryland
Winton Fuglie	AFR/DR, AID/W

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UNITED STATES DEPARTMENT OF AGRICULTURE
SCIENCE AND EDUCATION ADMINISTRATION

FEDERAL RESEARCH
NORTH CENTRAL REGION
Crop Production Research Unit
110A Curtis Hall
University of Missouri
Columbia, Missouri 65211

May 1, 1978

Subject: Review of the Purdue Corn Protein Quality Project

To: Paul H. Harvey
USDA SEA NPS
Beltsville, MD

Thank you for sending me a copy of your review of the Purdue work. I found it a very useful update in terms of my proposed trip to Kenya. I would tend to concur with AID's outlook regarding the non-productivity of the opaque-2 research program. As you emphasize, the primary problem is the lower yield found in all opaque-2 conversion work. However, I feel that these yield differences may not be of great significance in LDC's where yield levels are on the order of 20-30 q/ha. At that yield level, a 10-20% loss is much simpler to overcome by varietal introduction along with a basic agronomic package. I believe if an acceptable vitreous endosperm type were available to reduce insect damage and eliminate milling differences, this could be directly introduced as a new maize with a gain in yield and quality. Such a potential, I believe, exists in the Lowlands of Tanzania with a Tuxpeño type opaque-2. The yield level of Tuxpeño is comparable or better than that of the locally bred improved maize and better than that being used under the traditional agricultural system. The real difficulty, as I see it, is a mechanism by which this material can be introduced at the farmer level. In Kenya, we were planning on introducing the opaque-2 hybrids as a simple letter change on existing hybrids. This could easily be done in hybrids that were developed through the reciprocal recurrent selection program which would be improved with further cycles of selection as compared to the fixed three-way and double-cross hybrids. However, I was not encouraged by that section of your report which indicated no increase in yield with selection in populations. It may be that if this is true in the Kenya material, it will take a hybrid introduction into a new area versus competition with hybrids in existing areas. However, I do believe that lines extracted from the converted populations will be competitive with the existing lines. I suspect that the emphasis on opaque-2 work should be in programs such as in Egypt or Kenya, with the objective of a practical demonstration of introduction and utilization. From your report, further support of work at Purdue would not seem to be justified in terms of AID's mission.

15

I would like to discuss the Kenya opaque-2 program with you in some depth prior to my visit. At the moment, my plans would be to travel to Kenya at the beginning of September.

L. L. Darrah

Larry L. Darrah
Research Geneticist

Routed cc/ & ALC 5/11/78

UNITED STATES DEPARTMENT OF AGRICULTURE
SCIENCE AND EDUCATION ADMINISTRATION

Federal Research
National Program Staff
Beltsville Agricultural Research Center
Beltsville, Maryland 20705

May 9, 1978

Subject: Followup on the Purdue Corn Protein Quality Review

To: ✓Keith Byergo, AID
D. V. Glover, Purdue University

Following our visit at Purdue I sent a summary of the review to some of the other corn breeders and Dr. Larry Darrah has replied. Since Larry has had 6 years of experience in East Africa breeding corn, including work with opaque-2, I thought you might be interested in his response. You will notice in his last sentence that he does plan to return to Kenya in September. I have talked to Larry on the phone and he has agreed to my supplying you with his comments.

P. H. Harvey

P. H. Harvey
Staff Scientist
Corn and Sorghum
Plant and Entomological Sciences

Enclosure

cc:
H. O. Graumann
L. L. Darrah

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