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REPORT TO:

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USAID/NEPAL
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SEED TECHNOLOGY RESEARCH NEEDS IN NEPAL

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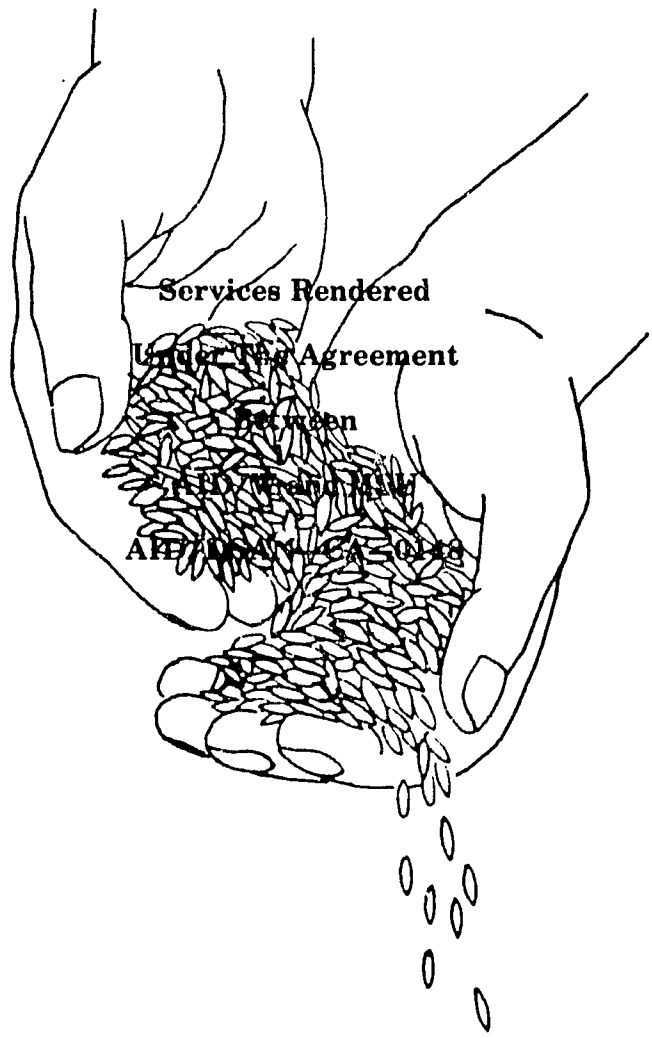

September 26 - October 10, 1982

SEED TECHNOLOGY LABORATORY
MISSISSIPPI STATE UNIVERSITY
MISSISSIPPI STATE, MISSISSIPPI

REPORT SUMMARY

TITLE: Seed Technology Research Needs in Nepal

CONTRACT: AID/DSAN-CA-0148 with MSU

CONSULTANT: James C. Delouche

PERIOD OF VISIT: September 26 - October 10, 1982

SUMMARY

Mississippi State University was requested to provide a consultant for about 14 days under the MSU-AID/DSAN-CA-0148 cooperative agreement to review seed technology research needs in Nepal and develop appropriate recommendations.

I was named as the consultant. I travelled to Nepal for visit during period September 26 to October 12, 1982. On my return to MSU, I revised the layout for the new Seed Technology Building and transmitted it to Mr. S. S. Bal, SPIS project. The attached report covers some observations made during the visit, a review of seed research needs, and recommendations on the types of research that can and should be done.

Acknowledgments

Mr. Gary Alex, USAID/Nepal, arranged for the consultation and provided many services. I'm most grateful to Mr. S. S. Bal, SPIS project for providing transportation, office space and arranging for visits. Discussions with Mrs. K. Rajbhandary, Chief, Seed Section, Botany Division, were most helpful, as were discussions with Peter Rood, SPIS project.

Background

The Seed Production and Inputs Storage (SPIS) project is being implemented to provide for seed production and supply (and storage of inputs) in the "hills" area of Nepal. Previous assistance from UNDP, German Technical Assistance, USAID, etc., has established a "developing" seed production and supply system in the Terai. The operating agency in terms of seed production and supply is the Agricultural Inputs Corporation, which is also engaged in the procurement, storage and distribution of fertilizer and pesticides.

The Botany Division-DA has an important supporting role in seed production and supply operations throughout Nepal. It is reponsible for seed testing, field inspections, building and storage inspections, and "certification" of seed. The Seed Unit of the Botany Division has also been at the forefront in developing solutions to seed problems and establishing realistic seed standards and operational procedures for the developing seed program in Nepal.

Mississippi State University (MSU) was requested to provide the services of a senior seed specialist to assist SPIS and the Botany Division in identifying problem areas that can be and should be resolved to the extent possible by "problem-solving" work in Nepal. Dr. James C. Delouche of MSU undertook the assignment and visited in Nepal from September to October, 1982. Since he and other members of MSU's Seed Technology Laboratory had been in Nepal on other technical assistance assignments connected with seed production and supply, and maintain contact with developments in Nepal, the period of the assignment was

adequate.

Seed Problems in Nepal

The developing seed program in Nepal is beset by most of the "problems" common in developing seed programs, and by problems peculiar to Nepal that arise from the topography and stage of development of the country. Although many of the problems fall out-side the researchable or problem-solving category which was the theme of the consulting assignment, they are reviewed briefly below to provide a frame for more specific consideration of researchable problems.

Organization

The Agriculture Inputs Corporation (AIC) has operational responsibility for seed production and supply. However, it (AIC) appears to accept this responsibility as reluctantly now as it did in 1977 when the SPIS project was being first formulated. To some extent the apparent attitude of AIC is understandable. It is much easier to procure fertilizer and pesticide from external suppliers and to distribute them under terms of subsidized arrangements, than to locally produce, process, store, and distribute seed. Fertilizer is procured in a manufacturered, ready-to-use state, is not very perishable, and has few quality problem (almost none that can be discerned by the farmer user). Seed on the other hand generally have to be produced in Nepal under contractural arrangements with farmers which requires supervision, then the produced seed have to be taken in, stored, cleaned, packaged, stored again, and distributed to the farmer users. Seed are perishable and susceptible to a host of quality problems ranging from insect damage to physiological

deterioration to "old age." Seed production and supply, therefore, is much different than fertilizer, procurement and supply except in terms of physical distribution and marketing.

AIC has done relatively little to build competence in its seed operation and to install the quality assurance system that is crucial for the success of any seed program/industry. And, it does not seem to have committed its resources - managerial and physical - to the degree required to develop seed production and supply in the manner and direction it needs to be developed.

Good to excellent facilities have been available for the cleaning and storage of seed in the Terai. They have not been used in a very effective or efficient manner. Indeed, they have been allowed to deteriorate to the extent that most of the facilities are in need of substantial repairs after only 4-5 years of operation.

The apparent lack of committment on the part of AIC to fully shoulder its assigned responsibilities in the seed area is recognized and has been pointed out by most of the SPIS consultants and in the recent evaluation report. The result of AIC's lack of committment is loss of confidence by farmers in the seed distributed and made available to them by AIC.

The developing seed program in Nepal is at a crossroads. Decisions have to be made regarding AIC's capability (and interest) to act in its present role as seed production and supply is extended into the hills and improved in the Terai - as it must be. If AIC cannot or will not commit itself to the tasks that lie ahead, and especially to a program

designed to regain the confidence of farmers, then alternatives must be considered. Most of the alternatives, however, would be confronted with the herculean task of developing a storage and distribution system on its own. In view of this situation, any alternative to AIC should focus on the tasks of estimating demand, scheduling and supervising production, processing and processing point storage, scheduling of distribution, and then working together with AIC for physical distribution and market point storage.

The question of private sector involvement in seed production and supply in Nepal has been raised. Although experience and precedents in other LDCs suggests that economically attractive opportunities for private sector involvement are not great, even limited and local involvement would be most beneficial. Certainly, the private sector ought to be involved in vegetable seed production which is usually economically attractive. Every effort should be made to encourage private sector involvement in vegetable seed production and supply - even to the extent of providing incentives such as tax concessions, low cost foundation seed, and the gradual withdrawal of AIC from vegetable seed marketing except in remote areas.

There is also good opportunity for private sector involvement in maize seed production in areas and valleys of such size as to constitute a viable market. Similarly, opportunities exist for private sector participation in wheat seed production and supply in the Terai.

Farmers' with experience in producing seed for AIC are being encouraged to "go-on-their-own", i.e., to produce seed and market it

themselves. This is good and should not only be continued but expanded. All government agencies concerned with agricultural improvement and seed should support the efforts of farmers to produce and market seed. The existing processing plants and the mini-plants under SPIS should be made available on a custom basis for cleaning and packaging of seed produced by the farmer seed growers. The Seed Unit of the Botany Division, especially, should provide advice and inspection/ testing services to the beginning "entreprenuers."

The private sector should be encouraged by all possible means, but realistically, it must be assumed that some agency or agencies of the RNG will have to produce, distribute and market the major portion of the seed needed by farmers in Nepal for the forseeable future.

Coordination of Efforts

The "seed program" in Nepal is developing out of several doner-assisted projects. Some of the projects were terminated years ago, others more recently, and still others are on-going. While it is assumed that efforts are being made at high administrative levels to weave the legacies of terminated projects into those of newer on-going projects and to integrate all efforts/activities into some long range scheme or plan, there is little evidence of such integration at the operational levels.

In some countries National Seed Boards or Commissions have been established to "ensure" coordination of all seed production and supply activities and have been generally (but not invariably) successful. A board of commission of this type can - if constituted at a high level -

develop a long range plan for seed production and supply, oversee and support its implementation. It can also establish policies that encourage private sector involvement in the seed industry.

To be effective a national seed board or commission has to be constituted of persons at decision making levels, i.e., agricultural research, extension, credit, input supply, and should include representation from farmer associations, cooperatives, and private persons engaged in the supply of agricultural inputs. If a board or commission of the type described is not constituted in Nepal, the development and appointment of a suitable body ought to be considered. If a body of the general type described already exists, its constitution and function ought to be reviewed, clarified and strengthened.

Mangement

Organization and coordination are, of course, major responsibilities of management. These aspects were previously discussed. The following comments are offered regarding management at the AIC Seed Division level.

The AIC Seed Division has had several managers. The managers are usually seconded from Department of Agriculture units for "tours of duty" of 2-4 years. The last two managers - including the present manager - were trained plant breeders. Management of AIC's seed operations does not really further the professional careers of persons trained in planting breeding when the position is temporary and the managers know they will return to research or research administration after their tour with AIC. Viewed from the opposite perspective,

training as a plant breeder (or soils specialist, pathologist, etc.), is not the best background for management of a production unit for seed or any other product. It seems, therefore, that the practice of posting a technician or scientist to the managership of AIC's seed division in disadvantages from both the posted manager and AIC's standpoints.

Under these conditions it is not surprising that management of AIC's seed operations appear to be poor. The posted manager has little incentive to "learn management" because he will probably be back in research in a few years. His authority is probably also so limited that improvements in management would be difficult at best even if he was so inclined in that direction. Since the manager is not from the AIC organization, he doesn't have the influence or "know-the-ropes" within AIC which are crucial for management of any unit within a larger organization. AIC, on the other hand, doesn't appear to be very helpful in assisting the posted manager in getting himself established. After-all, since the manager is not part of the AIC organization, AIC is accorded a convenient excuse for deficiencies in the management of its Seed Division - its not really their affair since other parties provided a manager from outside their organization.

In my view the management deficiences in the AIC Seed Division are largely the result of the reluctance of AIC to commit itself to seed production and supply. If AIC considered seed production and supply as an opportunity rather than a burden, it would assign one of its most experienced managers to the top position in the Seed Division and utilize scientists or other technicians from other agencies in technical

capacities for which they are best suited. This might insure both good business and sound technical management of seed operations. AIC's seed operation are, afterall, a business and should be managed in a business like manner.

Technical Problems

The technical problems that attend the developing seed program in Nepal are not different than those that plague seed program development efforts in other LDCs: field deterioration of seed; inexperience of seed growers; varietal mixtures; loss of germinaton and vigor during storage; storage insect infestations; and so on. While the problems are not different, they are more difficult to resolve in Nepal because of the topography and deficiencies in communications and transportation.

It must be stated at the beginning that improvements in management - operational management - would reduce many problems to a minimum, and provide the "operational climate" needed to resolve the other problems to a satisfactory degree. Or, viewed from the opposite perspective, the technical problems with which the seed program is confronted will be very difficult to resolve satisfactorily in the absence of improvements in operational management. This thesis is not original: it has been pointed out in the reports of most of the consultants retained by the SPIS project.

The main terms of reference of the present consultation were to review applied research needed in the area of seed technology and to make appropriate recommendations. These items are addressed in the remainder of this report.

Applied Research Needs in Seed Technology Area

Previous Work

The Seed Laboratory, Division of Botany, has been engaged in applied seed research for many years in addition to its quality evaluation and control responsibilities in seed program development in Nepal. Seed testing methods have been developed or adapted for the main kinds of seed in Nepal. These include not only purity and germination testing procedures, but also special tests for varietal purity, and quick estimates of germination. The Seed Laboratory has also made some excellent studies on seed storage and the efforts of packaging materials on maintenance of germination during storage.

Although the research efforts of the Seed Laboratory have produced good, practical information and technology, much more work is needed. The new Seed Laboratory that will be constructed should provide space and facilities needed for an expansion of the applied seed research effort. Additional personnel with specific duties in research will be needed, and should be provided by the Division and Department.

Priority Research Needs

Harvesting: Information is needed on the best time to harvest the different crops. Much of the information needed is already known for other countries. The applicability of this information to conditions in Nepal needs to be looked at. Simple procedures for roughly estimating seed moisture content at the grower site would be very helpful. In this connection, the use of paper humidity indicators as a means of estimating seed moisture content needs to be evaluated. A batch of the

humidity indicators is being sent under separate cover. They indicate humidity by a color change (pink to blue), and with a little experience can be read with an accuracy of ± 5% relative humidity. Use of the paper indicators is relatively simple. One only needs a sealable container of about 500 ml. volume (pint or ½ quart). Seed can be rubbed from plants in the field, or heads on the drying floor, or a sample taken from threshed seed. The seed are then placed in the container so as fill it (the container) about half-full. The paper humidity strip is placed in the container and the container is sealed. It takes about 2 hrs. for the equilibrium to be attained. The relative humidity % is then read from the strip and the reading can be roughly converted to a seed moisture % by reference to a table of seed moisture contents in hygroscopic equilibrium with different percentages of relative humidity.

Evaluation of this simple "seed moisture tester" would provide the experience and information for its wide use in Nepal. B. P. Parajuli worked with a similar method during his studies and MSU and is familar with the principles involved.

Application of the simple seed moisture tester would, of course, not be limited to the harvesting phase. It could be used during any phase of the seed operation where knowledge of the moisture content of the seed is important and an electric moisture tester is not available.

In connection with the harvesting phase, the following information is needed:

a. Best seed moisture content for harvest

b. Maximum allowable period between harvest and the beginning of drying.

Drying: All of the seed crops in Nepal needed to be dried. In situations where drying facilites are not available, sun drying will have to be used. Applied research is needed to determine the procedures and regimes for sun drying of seed that best maintain germination. These procedures and regimes might turn out to be quite different than the traditional procedures used for drying "grain."

Improved procedures and regimes for sun drying at a given site can only be developed through a detailed study of the current drying procedures used. This is the first step. The currently used procedures then must be "analyzed" to determine their effects on seed quality. Finally, practical alternative procedures have to be established and evaluated. The best alternative procedures can then be adapted and demonstrated to the growers. Particular attention needs to be given to the "time period" between harvest and the beginning of drying, between the beginning and completion of drying and between the completion of drying and pick-up of the seed by AIC or other agency that contracted for production.

Storage: Despite good improvements in storage through use of plastic lined jute bags, there are still serious storage problems. The problems are of two types: deterioration of the seed as a result of high seed moisture content and temperature; and infestations of storage insects which are favored by the high seed moisture contents and temperature.

Observation type "research" is needed to locate the most favorable climatic conditions for storage in the area (accessible sites, of

course). This is being done to some extent. More work is needed on packaging as the plastic laminate in the jute bags presently in use is very thin and tends to rupture when the bags are loaded and moved about. The possibility of thickening the plastic laminate should be looked into. The present laminate is said to be 2 mil (.002 in. thick) but it does not appear to be even 1 mil. A uniform 2 to 3 mil laminate would be very helpful.

Other packaging alternatives should be evaluated. For example, seed might be packaged in plastic bags of 5 to 10 kg. capacity (plastic should be at least 2 to 3 mil, polyethylene), and then the small packages could be placed in a large jute bag with regular plastic laminate for transport and storage until actual distribution. This system is used effectively in Indonesia. It would give "double" protection to the seed, and would also put the seed in more convenient size packages for the farmers. The present large bag contains more than enough seed for most farmers. There would, of course, be more labor involved in packaging and heat sealers would have to be provided for closing the plastic bags. The system outlined would need to be evaluated in terms of its cost, its effectiveness, and the best moisture content of the seed for packaging of this type.

Other types of packages and "stores" need to be evaluated: enameled earthenware containers; large plastic bags for use by farmers; and a combination of earthernware containers and plastic bags.

The development of better packages for retarding the reabsorption of moisture by the seed during periods of high humidity combined with

selection of the most favorable sites for storage would substantially improve maintenance of seed quality during storage.

Malathion dust is liberally used to control storage insects. The insects, however, are becoming resistant to malathion, so this procedure is not too effective. Other insecticides need to be evaluated as replacements for malathion. "Reldan", a product of Dow Chemical, and "Actellic" a product of ICI, are used in some countries for storage insect control. Reldan is expected to be "registered" for use in the U.S. in early 1983. It is already in use in Western Europe and Australia. Actellic is in use in some countries in Europe and Latin America, but will probably not be registered for use in the U.S. Both chemicals appear to be much superior to malathion. And, there are other insecticides known to the Entomology Division which should be evaluated.

The first step in control of storage insects, however, is not fumigation or use of insecticides. It is sanitation and quality control. The practice of accepting insect infested seed, cleaning the seed, packaging them and placing them in storage with <u>live</u> insects crawling out of the bags has to be halted in some way. If a seed lot is infested with insects, it must be properly and effectively fumigated before it enters the seed plant, or it should be diverted to grain use. The seed plants and, especially, the storehouses must be cleaned and sprayed with an insecticides before non-insect infested seed are introduced. <u>Sanitation</u> is the first step in control of storage insects. The use of insecticides is an essential, but second step.

<u>Seed Treatment</u>: Vitavax is being used as a seed treatment to control some of the bunt diseases and smuts. The chemical is very

effective if applied properly.

Presently Vitavax is applied as a dust. The dust appears to "dust off" and collect in the bottom of the seed bag. Applied research is needed to determine if sufficient Vitavax remains on the seed after "dusting off" to provide effective control. The evaluation should include the present dust treatment, Vitavax applied as a "slurry", and an untreated control.

Other treatments should also be evaluated. The chemical hexaclorobenzene (HCB) is effective against common bunt and might be less expensive than Vitavax. Loose smut, which is seedborne internally, is subject to control by hot water treatment - a very exacting process. The procedure is to soak the seed in water at 54C for 10 minutes, cool immediately in cold water, and then to spread the seed for sun drying. In practice, the seed are presoaked 4 to 5 hours in cold water to "activate" the mycelium and render it more sensitive to heat. This is followed by a few minutes soak in 48-50C water to pre-warm the seed followed by the 10 min. at 54C main treatment, cooling in cold water, and spreading out the seed for drying. A solar heat method for the small farmer has been used in India (Indian Phytopathology Vol. 10, pages 133-137, 1957). The seed are pre-soaked in water 4 hours, and then exposed to the sun in a thin layer for 4 hours.

Inherent Seed Quality: Some seed quality problems can probably be relieved to a great extent by working closely with the plant breeders. For example, there is the problem of wheat sproutng in the head. Germination in the head, or vivipary as it is called, is related to rainy

conditions at harvest time and a low level of seed dormancy. Dormancy, or the degree of dormancy, is under genetic control. Breeders should be aware that a moderate degree of dormancy is important to reduce germination in the ear. The Seed Laboratory, Botany Division, is already looking at methods which might be helpful to the breeders in screening advanced lines for tendency to germinate in the head. This work should be accelerated and expanded to include other crops such as rice, millet and sorghum. Maize doesn't have dormancy, so other characters such as husk cover, tightness of husk closure at the tips, and so on, have to be considered. These are much the same characters that reduce field infestation of maize by grain insects.

Quality Control Techniques: The distance of seed production sites from seed testing services, poor transportation, and the week or so required to test for germination hamper efforts to be more selective in terms of seed "lifted" from the contract seed growers. More rapid tests are needed - tests that can be made at the site of seed growers with a minimum of equipment.

A possible simple seed moisture tester (paper humidity indicator) was described under harvesting (a package of the indicators is being sent). If successful, the simple seed moisture tester (or estimator) combined with a quick, simple test for estimating germination would provide the means to establish rigourous quality control at the grower site. The best and well proven method for estimating germination is the tetrazolium (TZ) test. The test is well known to the Seed Laboratory, Botany Division. It is relatively inexpensive and can be completed in

about 6 hours for wheat, maize and rice. It is also portable. The only requirements are a bottle of TZ solution, small plastic or glass bottles for soaking the seed, razor blades for cutting the seed, small plastic dishes for placing the cut seed in the TZ solution and a hand magnifier for interpretation.

An "inspector's kit" could be developed and evaluated for use in grower site quality evaluation and control. The kit should include the simple moisture tester materials, TZ test materials, and could also include phenol test materials for wheat varietal purity testing as possible. The phenol test is presently in use in the Seed Laboratory. The addition of small vials containing authenic samples of the main crop varieties in the area would provide an additional aid for evaluating varietal purity.

Effective use of the "inspector's kit" would require training of the inspectors who visit seed growers to determine what seed lots are to be lifted for seed. Seed lots that do not meet the quality standards established should <u>not be lifted</u>. There is no reason to <u>accept</u> seed from a contract grower that does not meet germination and varietal purity standards.

<u>Seed Testing</u>: Seed testing methods are available for most kinds of seed produced in Nepal. The only testing problems are related to seed dormancy problems when testing is done at sites which are not provided with heated air ovens for breaking rice seed dormancy, and refrigerators for the low temperature needed to break dormancy in cool season crops such as wheat and some of the vegetables. Dormancy in rice can usually be broken by placing a small sample of the seed in a thin layer on a

metal roof or piece of roofing sheet so that the temperature of the seed gets up to 45-50C. About one to two days are required. Cool temperatures in remote areas could be obtained by using plastic foam insulated boxes ("picnic-type") as a pre-chill chamber and placing ice in the bottom of the container. Alternatively, in areas where the night temperature gets down to 10C or so, the tests could be planted in evening, placed in the plastic foam box with cover off to chill, then covering the box the next morning to hold the chill temperature. This would need to be repeated 5 to 7 days to get the proper degree of chill to break dormancy. In areas where the stream water is cold (10 to 12C), water could be placed in insulated box to produce the chill.

Dormancy in some other kinds of seed is difficult to break. The result is that germination tests take a long time and the test results are erratic. Methods need to be developed to release the dormant condition so that the test period can be reduced.

A lot more work needs to be done to establish laboratory tests for evaluating trueness-to-variety or varietal purity. Phenol reaction and coleoptile color needs to be determined for all varieties of wheat so that these characters can be used in checking varietal purity. Detailed studies should be made of the morphology of seed of varieties of maize and rice to identify characters useful in distinguishing one variety from another. In cases where seed characters do not differ, the studies should be extended to seedling characteristics.

Seed Processing: The main problems in seed processing derive from poor management, lack of training of operators, and poor maintenance of the processing equipment. There is adequate processing equipment in

Nepal to accomplish the objectives of processing. More training is needed and maintenance needs to be improved.

One possible area for research in seed processing is an evaluation of the air systems of air screen cleaners and the gravity table at Hateura as a means of upgrading germination of wheat, maize and rice seed. Research of this type would involve different adjustments of the air systems, sampling before and after air separation (or gravity separation) to determine the effects on germination, and records on the percent s of seed lost (rejects) for each setting.

Seed Pathology: There is a need for more work in the area of seed pathology. Specifically, serious seed borne diseases should be identified, assay methods established, quality standards established, and control procedures developed as possible. The techniques for this kind of work are well documented and much of the information is available. It only needs to be searched for and evaluated for applicability to conditions in Nepal. The work in the area of seed pathology should be under the leadership with the Division of Plant Pathology but closely coordinated with the Botany Division's Seed Laboratory.

Summary

Several problem areas in the seed program development effort in Nepal were discussed. Research needs in the area of seed technology were emphasized.

The types of research outlined are well within the capabilities of the various units involved in seed program development. Facilities presently available and those coming on-stream are adequate for the

research outlined. The main ingredients will be determination on the part of the workers involved in the research, and support of the research effort by department and division heads.