# A simple method to identify research priorities when initiating research systems in developing countries[1]

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**ABSTRACT**

**To facilitate planning, a priority classification system was developed to identify, by state, the national soybean research needs of Brazil. The system includes: (1) identification and classification of those research information needs that are most important when introducing a crop, such as soybeans, into a new area; (2) estimation of the existing level of knowledge in these priority areas on a state basis, and (3) by multiplication of the graduated importance of research information needs by level of knowledge, a final classification of research priorities according to immediate need and importance. The system is open-ended: research information needs can be added or deleted, and the scheme is adaptable to single crops, cropping systems, and development programs.**

**Additional index words: Research Priority Classification; Research Information Needs; Level of existing knowledge; Research Classification Methodology; Soybean Research Development Program; Brazil Research Development.**

WHEN building research programs in developing countries, a major problem is to properly identify the research priorities within each country. This step is critical when foreign technicians are unfamiliar with local surroundings, resources, research, knowledge, and crop problems. Rapidly identifying research priorities could mean the difference between success or failure.

High returns have been gained through research. Jennings (2) estimated that in Colombia, the value of the additional production associated with new rice technology during the period 1967 to 1972 was about $100 million (USA). This amount more than paid for government investments in research, extension, and education for all crop and animal programs during this period. The Colombian program has had a significant influence elsewhere in Latin America, so that the total return may be three or four times greater. Worldwide, an increase of $2.5 billion in additional rice production since 1966 can be attributed to research.

The interinstitutional part in identifying research priorities and development of programs is important (1). After the disastrous epidemic of southern corn leaf blight in the USA in 1970, a committee of the National Academy of Sciences (NAS) investigated the epidemic and examined the question of whether or not other major crops are also vulnerable. Recognizing the significance of the 1972 NAS study, leaders from USDA and the National Association of State Universities and Land Grant Colleges established a committee, "to provide a framework of proposed actions and policies within which the agricultural science community can move with vigor to meet its responsibilities to prevent genetic vulnerability".

Today much emphasis is being placed on modeling and on multidiscipline/interdiscipline approaches to agricultural research. Witz (4) has discussed a number of considerations necessary to this approach. Among the principles of systems philosophy are the requirements of having a complete picture and including all relevant elements that influence a decision or response. The multidiscipline approach is also basic to systems philosophy, because the specialized knowledge of a myriad of details needed to carry out a typical system study cannot usually be found in one person or in one discipline. In applied research, the system model becomes an important tool for performance evaluation. The first step in suing this tool is the definition of a measure of system performance. This step requires the researcher to quantify what is desired of the system, and costs to be incurred to realize the desired performance, the desired control

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**Table 1—Classification of research necessities in relation to their level of importance**

| Scale of Graduation of Research Necessities† | | | |
|---|---|---|---|
| 4 | 3 | 2 | 1 |
| Introduction of cultivars | Calibration of soil analyses | Breeding | Depth of seeding |
| Competition of cultivars | Spacing density of planting | Residual effect of fertilization | Storage of seed and grain |
| Time of planting | Determination of damage of disease | Efficiency of fertilizer materials | Treatment of seeds |
| Response to lime | Determination of damage of insects | Preparation of the soil | |
| Response of P & K | Ecology of insects | Fertilizer placement | |
| Necessity of micronutrients | Ecology and Epidemicology of diseases | Control of moisture | |
| Availability and efficiency of *Rhizobium* | Control weeds | Conservation of the soil | |
| Identification of diseases | Factors of seed quality | Mechanization | |
| Identification of insects | Harvest problems | Control of insects | |
| | | Control of diseases | |

† Scale of Graduation.
4—High initial priority to identify adaptability and production problems.
3—High research priorities when crop has been shown to be adaptable to an area.
2—Secondary priorities when specific problems in adaptation and management need research.
1—Technology of the nature that can be transferred.

strategy, and the calculation model. The model can facilitate interdisciplinary communication. Some techniques seem to break down with the large, complex models; modelers in biological and agricultural science feel that this is a significant weakness.

Moseman (3) pointed out that a major deficiency in most cooperative efforts has been omission of the ultimate goal when building and increasing education and research into a national, self-sustaining system. One challenge of increasing urgency is to associate separate, specialized projects of technical assistance that is currently available to a nation into a coordinated effort to establish a national research system. Establishing priorities is a necessity to strengthen national research. This paper describes a method used by our team in Brazil to identify research priorities and to enhance effective use of resources there.

## METHODOLOGY

To tap all sources for the National Soybean Research Program, a National Soybean Commission was formed, consisting of 10 members representing the 7 southern states in Brazil. Four regional coordinators collected information on the research underway and the problems limiting the expansion of the crop. Much of this information was also utilized to prepare a "national reference mark" and an overall "research development program." A numerical system, based on the following criteria, was devised to describe individual discipline priorities: (A) the necessity of a specific type of "research information need" for successful establishment of a new crop or expansion of an existing one and (B) the ".eve. of existing knowledge" in the area of each specific type of information needed. By multiplying (A) and (B), an index was obtained for each type of research information needed. The index (C) would be used for each state or region and permitted identification of those research areas requiring "intensification." Each research area receiving a high intensification rating was referred to as a "research priority."

First we identified research information needs that were realistic. Those types of technical information required to introduce soybeans into a new ecological area were classified on a numerical scale:

4—High need for *initial* information to identify adaptability and production problems;
3—High need for research information when crop has been shown to be adaptable to an area;
2—Secondary information needs when specific problems in adaptation and management require refinement of research.
1—Technology that can be transferred.

The relation between types of soybean research information and a graduated scale of the necessity for research are presented in Table 1.

Second, we classified the state of knowledge for individual research, using the following scale:

1—Local data satisfactory; other studies in this area may be advantageous.
2—Strong program underway that will furnish data, which may need some refinement.
3—Only preliminary information available.
4—No local information available.

Existing information on the various aspects of soybean production technology were reviewed, by discipline, for each soybean-producing state. The graduation of existing information is presented in Table 2. These graduations allow us to anticipate output of established research.

Third, we used the classification of needs for soybean research information and present knowledge to identify new areas of research that would be necessary. In this procedure we multiplied the graduation of the importance of each research information need (Table 1) by the knowledge of an actual situation (Table 2). The final score indicated the "level of necessity" to intensify each of the areas of research. The graduated evaluation of the level of knowledge and final classification by discipline are presented in Table 3.

## RESULTS OBTAINED

The graduation of research needs to be considered were soybeans to be introduced into a new area is presented in Table 1. In this evaluation, only 31 research areas in 5 disciplines were included, of which only 18 can be considered to be

**Table 2—Graduation of necessities of programs underway in soybean research in southern Brazil**

| Research Necessities | Graduation by Scale† RS/SC‡ | PR‡ | MT‡ | SP‡ | MG‡ | GO‡ |
|---|---|---|---|---|---|---|
| I. Fertility and Land Use | | | | | | |
| 1. Response to P and K | 2 | 3 | 3 | 2 | 3 | 3 |
| 2. Response to lime | 2 | 3 | 4 | 2 | 3 | 3 |
| 3. Necessity of micronutrients | 3 | 3 | 4 | 2 | 4 | 4 |
| 4. Calibration of soil analysis | 2 | 4 | 4 | 3 | 3 | 4 |
| 5. Effect of residual fertilizer | 3 | 4 | 4 | 3 | 4 | 4 |
| 6. Efficiency of fertilizer materials | 3 | 3 | 4 | 3 | 4 | 4 |
| 7. Availability and efficiency of *Rhizobium* | 1 | 1 | 3 | 2 | 3 | 3 |
| 8. Conservation of soil | 3 | 3 | 4 | 4 | 4 | 4 |
| II. Cultural Practices | | | | | | |
| 1. Time of planting | 1 | 2 | 3 | 1 | 2 | 2 |
| 2. Preparation of the soil | 3 | 3 | 4 | 3 | 4 | 4 |
| 3. Placement of fertilizer | 3 | 4 | 4 | 3 | 4 | 4 |
| 4. Depth of seedling | 2 | 3 | 4 | 2 | 4 | 4 |
| 5. Spacing and density | 2 | 2 | 3 | 2 | 2 | 3 |
| 6. Control of weeds | 3 | 3 | 4 | 2 | 3 | 3 |
| 7. Control of soil moisture | 3 | 3 | 4 | 3 | 4 | 4 |
| 8. Harvest problems | 3 | 3 | 4 | 3 | 4 | 4 |
| 9. Mechanization | 3 | 3 | 4 | 3 | 4 | 4 |
| III. Entomology | | | | | | |
| 1. Identification | 1 | 1 | 3 | 1 | 2 | 3 |
| 2. Determination of damages | 4 | 4 | 4 | 4 | 4 | 4 |
| 3. Ecology | 3 | 3 | 4 | 3 | 3 | 4 |
| 4. Control of methods | 2 | 2 | 4 | 2 | 3 | 4 |
| IV. Plant Pathology | | | | | | |
| 1. Identification | 2 | 2 | 3 | 3 | 3 | 3 |
| 2. Determination of damages | 4 | 4 | 4 | 4 | 4 | 4 |
| 3. Ecology | 3 | 3 | 4 | 3 | 4 | 4 |
| 4. Control methods | 3 | 3 | 4 | 3 | 3 | 4 |
| V. Breeding and Varietal Evaluation | | | | | | |
| 1. Introduction of varieties | 1 | 2 | 3 | 2 | 2 | 3 |
| 2. Competition of varieties | 2 | 2 | 3 | 2 | 2 | 3 |
| 3. Breeding for adaptation | 2 | 3 | 4 | 2 | 3 | 4 |
| —Resistance to diseases | 3 | 3 | 4 | 3 | 3 | 4 |
| —Resistance to insects | 4 | 4 | 4 | 4 | 4 | 4 |
| —Level of soil and protein | 3 | 3 | 4 | 3 | 3 | 4 |

† Graduation Scale:
1. Local data satisfactory; other studies in this area maybe advantageous.
2. Strong program underway that will furnish data, which may need some refinement.
3. Only preliminary information available.
4. No local information available.

‡ States: RS/SC—Rio Grande do Sul and Santa Catarine; MT—Mato Grosso; SP—São Paulo; MG—Minas Gerais; GO—Goías.

**Table 3—Graduation of necessities to intensify soybean in southern Brazil**

| Research Necessity to Intensify | Graduation by State† RS/SC‡ | PR‡ | MT‡ | SP‡ | MG‡ | GO‡ |
|---|---|---|---|---|---|---|
| I. Fertility and Land Use | | | | | | |
| 1. Response to P and K | + | ++ | +++ | + | ++ | ++ |
| 2. Response to lime | + | ++ | +++ | + | ++ | ++ |
| 3. Necessity of micronutrients | ++ | ++ | ++ | + | +++ | +++ |
| 4. Calibration of soil analyses | + | ++ | ++ | ++ | ++ | ++ |
| 5. Effect of residual fertilizer | + | + | + | + | + | + |
| 6. Efficiency of fertilizer | + | + | ++ | + | + | + |
| 7. Availability and efficiency of *Rhizobium* | – | – | ++ | + | ++ | ++ |
| 8. Conservation of soil | +++ | +++ | +++ | +++ | +++ | +++ |
| II. Cultural Practices | | | | | | |
| 1. Time of planting | + | + | +++ | + | + | ++ |
| 2. Preparation of the soil | + | +++ | ++ | ++ | + | + |
| 3. Localization of fertilizer | + | + | + | + | + | + |
| 4. Depth of seeding | – | – | – | – | – | – |
| 5. Spacing and density | ++ | + | +++ | ++ | + | + |
| 6. Control of Weeds | ++ | +++ | ++ | + | ++ | + |
| 7. Control of soil moisture | + | – | + | + | + | + |
| 8. Harvest problems | + | + | + | + | + | + |
| 9. Mechanization | ++ | ++ | – | ++ | – | – |
| III. Entomology | | | | | | |
| 1. Identification | – | – | ++ | – | + | ++ |
| 2. Determination of damages | ++ | ++ | ++ | + | ++ | ++ |
| 3. Ecology | ++ | ++ | ++ | ++ | ++ | ++ |
| 4. Control | ++ | ++ | + | ++ | + | + |
| IV. Plant Pathology | | | | | | |
| 1. Identification | + | + | ++ | ++ | ++ | ++ |
| 2. Determination of damages | ++ | ++ | ++ | ++ | ++ | ++ |
| 3. Ecology | ++ | ++ | ++ | ++ | ++ | ++ |
| 4. Control | + | + | + | + | + | + |
| V. Breeding and Varietal Evaluation | | | | | | |
| 1. Introduction of varieties | – | + | ++ | + | + | ++ |
| 2. Competition of varieties | + | + | ++ | + | + | ++ |
| 3. Breeding for adaptation | – | ++ | + | – | + | + |
| —Resistance to diseases | + | ++ | + | + | + | + |
| —Resistance to insects | + | + | + | + | + | + |
| —Level of oil and protein | + | + | + | + | + | + |

† Graduation Scale:
– Information satisfactory according to need.
+ Information available must be refined
++ Research must be amplified to furnish conclusive results.
+++ No local information, must initiate research programs.

‡ States: same as Table 2.

of high priority. As the research programs were started in new ecological areas, the number of priorities included in the classification increased to more than 100. With this system, the listing is open-ended, and a research need can be added, deleted, or graded higher or lower. Soil fertility, land use, and cultural practices seem to be naturally related, because factors of management and research of similar background are involved in each. The same can be said for entomology and plant pathology. Plant breeding, on the other hand, in this graduation shall be treated separately.

### Soil Fertility and Cultural Practices

Soybean production in Brazil first expanded in the states of Rio Grande do Sul, Santa Catarina, and São Paulo. The graduation by scale knowledge for these states reflects the strong programs underway in those areas of research of greatest importance when introducing a crop into a new area (Table 2, I. and II.). In other states, only preliminary information was available for these same research areas. Table 3 shows that those research necessities that were graduated (++) and (+++) were selected as requiring research during initial stages and were research priorities. The final graduation between states for each of the research necessities differs markedly. Considerable effort was required to begin research necessary to meet the needs.

### Entomology and Plant Pathology

Table 2 indicates that, for entomology, few data are available concerning the damages caused by and the ecology of soybean insects. In plant pathology, other than identification, only preliminary information was available. Table 3 suggests that research in entomology should be done to determine the extent of damages caused by insects, their ecology, and methods of control. In plant pathology the re-

search program, as classified, would be centered around the determination of the damages caused and the ecology of the diseases. As specific entomological and pathological problems are identified, respective research needs could become more definitive for specific problems.

### Breeding and Varietal Research

Soybean breeding and varietal research has been quite active and extensive for a number of years in Brazil. Many varieties have been selected from lines introduced from the USA and have proved adaptable to southern Brazil. Therefore, in areas with a high potential for growing soybeans, the introduction and competition of varieties or known lines was emphasized. In the more mature regions, the emphasis was to select for specific problems, such as resistance to diseases and insects, tolerance to soil acidity, and morphological characteristics. Tables 2 and 3 present classification of the research necessities for initiation. It has proved necessary to identify more specific limitations in the present varieties used in Brazil before a program can be initiated to substantially improve them.

The information collected for this evaluation was also used to estimate the human resources needed for undertaking priority research. This process was aided by knowing the research necessities in each of the areas and within each discipline. The final strategy was to plan an "infrastructure" in line with the research priorities and disciplines involved toward the end results of problem-solving.

## SUMMARY

The above-presented method was proved a useful tool to classify the research necessities and to identify priorities to develop soybean technology in Brazil. The Brazilian Ministry of Agriculture through the Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA) has adopted the same method to evaluate the research necessities for their research programs in all the plant and animal sciences. Visiting scientists have adopted the methodology to develop programs, including other disciplines in other countries, to identify their priorities. This method has proved easy to use in identifying research priorities for new programs with a minimum of effort and a maximum of local input.

## LITERATURE CITED

1. Agriculture Research Policy Advisory Committee. 1973. Genetic vulnerability of crops—A worldwide problem of rising concern. Agric. Sci. Rev. 11:49-55.
2. Jennings, P. R. 1974. Rice breeding and world food production. Science 186:1085–1088.
3. Moseman, A. H. 1970. Building agricultural research systems in the developing nations. The Agricultural Development Council, Inc., 630 Fifth Avenue, New York, NY 10010.
4. Witz, J. A. 1973. Integration of system science methodology and scientific research. Agric. Sci. Rev. 11:37-48.