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"MEJORAMIENTO DE LEGUMINOSAS FORRAJERAS, ESPECIALMENTE PARA SU ADAPTACION A SUELOS ACIDOS INFERTILES"

E. Mark Hutton

Breeding tropical pasture legumes, especially for adaptation to infertile acid soils.

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INTRODUCTION.

Why breed legumes for pastures when almost unlimited variation is found among the native legume ecotypes of tropical Latin America in general like Stylosanthes, Centrosema and Desmodium? A big range of these ecotypes are being collected, assembled in germplasm banks as at CIAT, and then evaluated in the field. However native ecotypes have usually evolved in ungrazed situations, and are often adapted to specific soil and climatic conditions. For example, the Brasilian ecotypes of Stylosanthes capitata are closely adapted to more acid soils of less than pH 5.

Any selected native ecotype rarely combines all the characters required in a legume for use in grazed pastures. The plant breeder can make an important contribution by taking the most promising ecotypes from legume evaluation programs, and genetically adapting them more closely to the soil -grazed pasture- climatic complex.

Legume breeding aims.

Specific aims are needed for any legume breeding program, otherwise much of the effort will be wasted. Aims of plant breeders in legume improvement vary but usually include characters like greater yield and persistence, better compatibility with grasses, good commercial seed yields, disease and insect resistance. Worthwhile aims can only be formulated if

the plant breeder collaborates closely with plant introductionists, legume agronomists, and pasture utilization scientists. A vital need in legume breeding is to ensure that all lines selected nodulate freely with effective Rhizobia, and this requires the collaboration of the Soil Microbiologist.

The most successful legume cultivars are those which persist and grow well with grasses under grazing over a wide range of conditions. The conditions on many farms include periodic overgrazing and mismanagement. Thus in legume evaluation and breeding programs, lines should be selected in the field only by growing them in association with a suitable grass under periodic grazing. Some plant breeders do not aim for wide adaptability in legumes. However, this is a most desirable characteristic in legumes for the improvement of pastures in the vast underdeveloped oxisol and ultisol areas of tropical Latin America. Wide adaptability is usually achieved by crossing legume ecotypes from radically different soil and climatic conditions.

Legume breeding techniques.

Most important legume species are principally self-pollinating, so pedigree selection and variations of this, are effective in screening progenies for recombinants with the desired characters. In most legumes it is possible to make many crosses and generate considerable variation. However, a plant breeder is only able to cope with relatively small numbers of crossbred progenies in a selection program aimed at increased adaptation of a particular legume to grazed pastures. Even a modest legume breeding

program involves considerable resources in glasshouse space, field sites and personnel and often takes about 10 years.

It would be a distinct advantage if large numbers of crossbred progenies could be screened concurrently, and the time involved in evaluation of selections significantly reduced. This can be achieved in programs involving selection for resistance to some diseases and insects when large numbers of seedling are screened in a relatively small space under controlled glasshouse conditions. When selecting legume progenies under grazing for important characters like yield, persistence and compatibility with grasses, it is difficult to advance rapidly through the various generations. If uniform field conditions can be obtained, it is possible to evaluate large numbers of F_2 progenies and select the best with some confidence, provided they are grown in association with a suitable grass under periodic grazing. The generations after F_2 could then be advanced rapidly to F_7 & F_8 by growing each generation in a glasshouse as small plants induced to flower quickly by light control etc, one seed being taken from each plant to give the next generation ("single seed descent"). After seed multiplication of the legume selections at the "fixed" F_7 or F_8 stage the legume selections can then be planted in small replicated plots and rated and grazed periodically. About 200 selections will conserve most desirable character combinations in the best crosses. This method has some disadvantages, but could at least halve the time involved in the development of new bred legume lines, as well as significantly reducing the resources required.

CIAT's Legume breeding program.

At CIAT resources are not unlimited, so it is essential to concentrate on only a few legume species for improvement by breeding. On the basis of the agronomic and grazing work in progress, the legumes selected include Stylosanthes capitata, Centrosema pubescens and the tree Leucaena leucocephala. In spite of all CIAT's work with S. guianensis, this species was not chosen because a high proportion of the ecotypes have considerable anthracnose and stem borer problems. Also S. guianensis does not compete well with vigorous grasses like Panicum maximum. In the selected legumes realistic aims and intense effort are required if significant improvement is to be achieved.

In S. capitata there are three main aims (1)High yield and seed production combined with ability to grow in the dry season (2) Active nodulation and retention of the high level of resistance to anthracnose and stem borer present in a proportion of S. capitata ecotypes. (3) Greater adaptability, especially to soils with different levels of fertility and pH. It is though that these aims can be achieved from intercrosses involving Brasilian and Venezuelan ecotypes. With the Brasilian S. capitata emphasis needs to be on the late and midseason ecotypes, although some of the early ecotypes appear to have the highest stem-borer resistance. A diallel crossing program is now in progress and we should have F_2 populations by early 1979. Although a S. capitata ecotype has recently been marketed in Brasil, cultivars of this species are not yet generally recognized among the commercialized legumes. CIAT has a good opportunity to develop a vigorous well adapted S. capitata

variety which will be commercialized and in strong demand from farmers.

Centrosema pubescens is probably the most important legume for tropical pastures over a range of conditions from the wet tropics to areas with a 6 month dry season. Present cultivars have several deficiencies which prevent their widespread use. In C. pubescens the main breeding aims are (1) Improved tolerance to soils with low pH and high Al-saturation combined with efficient P use and also adaptability to better soils, (2) Active early nodulation combined with more vigorous early growth, (3) Tolerance to insects and diseases combined with the ability to maintain a long-term vigorous association with grasses. A number of acid tolerant C. pubescens ecotypes were selected from a large group in a pot trial using Carimagua soil (pH 4.5, 90% Al-saturation). These are being incorporated in a diallel crossing program which will give F_2 progenies early in 1979 for acid tolerance screening under controlled conditions.

Leucaena leucocephala is a tree so it needs to be regarded as a special purpose legume. Also it needs different treatment in its establishment and management. Because of its ability to produce large quantities of high protein forage for animals in the wet and dry seasons, Leucaena will have an important future role in increasing the utilization of native tropical savannas and grasslands. Leucaena is indigenous to the neutral to alkaline soils of Central America so is not well adapted to acid tropical soils. The main breeding aims in Leucaena are high edible forage production combined with a low mimosine level and high tolerance to acid tropical soils. Fortunately Soil Microbiology is successfully selecting acid tolerant Leucaena Rhizobium for use under acid conditions.

At CIAT the CSIRO bred Cunningham Leucaena has shown good acid tolerance in a pot trial with Carimagua soil and this is probably due to its superior ability to take up calcium. Cunningham (104 chromosomes) was used as the recurrent parent in a series of backcrosses with Leucaena pulverulenta (56 chromosomes). Screening at CIAT of their fertile low mimosine progenies in Carimagua soil has given a number of promising acid tolerant plants. These will be grown shortly in the field on the fertile CIAT soil to observe edible forage production, mimosine levels, chromosome numbers, and seed production. Before the end of 1978 it should be possible to select trees at CIAT combining the desired characters, and commence screening their progenies for acid tolerance under controlled conditions. In 1979 this should result in promising Leucaena lines for preliminary field evaluation at Carimagua, Quilichao and Brasilia.

To back up the plant improvement program, chromosome counts and appropriate cytological work, as well as studies on breeding systems and crossing techniques are being made in the legumes being bred. Similar investigations are also in progress in other species with distinct promise in genera like Zornia and Desmodium.