early rain could provide an effective green ground cover, less prone to fire hazard, in the savanna regions. The plants can be eradicated mechanically with the residue providing mulch suitable for no-tillage cropping. The potential contribution of N to the soil and protein for human and animal consumption are other factors that warrant further investigation of *Cajanus cajan* in savanna cropping systems.

On-farm trials—*Leucaena*-maize systems

The main objectives of the long-term, alley cropping farm trials that began in 1980 are as follows: (1) to identify and enlist the cooperation of a set of participating farmers, representing a range of farming systems and farmer types involved in the production of yam and maize in Nigeria; (2) to instruct the farmers on the agronomy of the prototypical *Leucaena*-maize-yam alley cropping system; and (3) to see to the establishment of the *Leucaena* hedgerows as an understory intercrop with first season maize in preparation for use as live *in situ* yam vine staking next year.

Trials were established on 9 plots at 6 different locations across the yam belt of Nigeria (Fig. 46). Periodic visits were made to each site to provide basic guidance and monitor progress. In all cases, the farmers were encouraged to feel free to modify the system to fit their needs. Information on such modifications provides for a better understanding of the working principles of appropriate alley cropping systems for smallholder conditions.

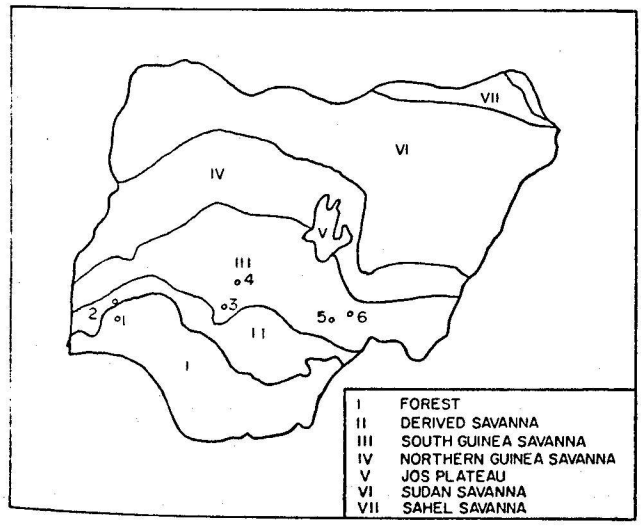

Fig. 46. Map of Nigeria showing ecological zones and sites of the* Leucaena*-maize-yam alley cropping system. Farm trials in 1980. 1. Lagbe 2. Ijaye 3. Osara 4. Tawari 5. Yandev 6. Zaki Biam.

First year trials have yielded a number of preliminary findings. *Leucaena* has been found to be a very hardy plant that established well even under extremely adverse conditions. A severe first season drought caused failure of the maize intercrop in most sites, but *Leucaena* growth continued at moderate levels. In order to cope with the economic effects of the drought, farmers attempted to substitute other intercrops such as cowpea and sorghum. Heavy shading under cowpea retarded *Leucaena* growth somewhat but from the standpoint of risk-aversive small farmers, suboptimal establishment growth of *Leucaena* appears to be a small price to pay for steps taken to obtain an economic yield from their fields in a bad year.

Where mechanized yam culture is likely to be an attractive way to reduce the labor costs of yam production, the trials indicate that a 4 m between-row spacing for *Leucaena* may be more suitable than the experimental 2 m spacing. Wider spacing may also be preferred where farming traditions favor multiple vine support by fewer stakes such as in the "tent staking" system of Tawari, Nigeria. While allowing for such modifications, it seems advisable to maintain a sufficient population of *Leucaena* to provide adequate mulch material, firewood and other by-products to maximize overall returns. Where firewood scarcity is a problem, the wood yield may be a significant component of the net economic return from the alley cropping system. The possibility of a double *Leucaena* row in the 4 m spacings should be investigated.

One potential variant, which aroused considerable interest among farmers for whom the labor costs of weeding are a major farm management constraint, is the use of *Leucaena* shade to control *Imperata cylindrica* and other heliophytic weeds. Although this use of alley cropping has yet to receive systematic attention, a possibility might be to rotate a 1 or 2 year closed-canopy fallow through a large field set up for alley cropping. If, for example, the field were divided into 4 sections, three-fourths could be in alley crop production in any given year with the remaining one-fourth in rotating fallow. Research is needed to evaluate the actual weed control potential of this alley cropping modification, but farmers indicate any innovation that minimized the herbicide need would be a major step toward making no tillage and mulch farming techniques more widely acceptable.

Linear programming model of *Leucaena*/rice alley cropping system

A linear programming model was developed to evaluate the economic attractiveness of an experimental *Leucaena*/-rice alley cropping system under West African smallholder conditions. Using production data representative of upland family rice farms in Sierra Leona and N response data from the Rokupr Rice Research Station in Sierra Leone, the model was used to explore the relative profitability of various rice growing activities at 0, 20, 40, 60, 80 and 100 kg N/ha from 3 different sources: urea; ammonium sulphate and *in situ Leucaena* hedgerows.

The main results indicate that under the conditions of smallholder production in the model, it is consistently more profitable to grow rice with N from *Leucaena* hedgerows than from either of the 2 mineral N sources. Furthermore, with labor as the limiting production factor, the 2 components of the *Leucaena*/rice alley cropping system always combine in the same economically optimal proportions of 0.37 ha (3,700 linear meters) of *Leucaena* hedgerow to 1.28 ha for rice, grown in the alleys between the hedgerows, for an optimum field size of 1.65 ha.

In order for rice production with urea or ammonium sulphate to become competitive with *Leucaena*-based rice