CHAPTER I

GENERAL INTRODUCTION
Nutritionists are in agreement that protein deficiency is the most prevalent and the most serious nutritional problem in developing countries. In these regions 60 to 80 per cent. of the calories are supplied by cereals. The consumption of animal products is very low and inclusion of roots and tubers in high-cereal diets, reduce still further the unfavourable ratio of protein to calories. Protein deficiency has been demonstrated as being one of the principal causes of physical deformities and of damage to brain tissue.

In India, all the nutrition starts from an adequate supply of dals (pulses) which are by far the most important source of protein for common man. The euphoria of the green revolution in this country has not lasted long. Much of the increased production of wheat and rice has been accompanied by an alarming drop in the production of dals. The daily availability of dal per head averaged 70 grams in 1956, fell to 50 grams in 1971 and was less than 40 grams in 1973. With the current prices of pulses as high as they are, the poorer sections have to manage with even less than 40 grams.

Because of the limited availability of both animal products and fish and their consequential high prices, animal protein intake has been poor. Also, a fair section of the population being vegetarian, meat and fish consumption
has not been as universal as in advanced countries. Although we have one-fifth of the total population of cattle in the world, the average per capita milk and milk product consumption per day is only between 2 to 5 ozs compared to 20 to 60 ozs in western countries. The problem of protein deficiency has thus assumed serious proportions and it can no longer be ignored or neglected, save at our peril.

Three courses could be followed to overcome this situation: (1) by importing protein foods; (2) by increasing the production of pulses and animal products and at the same time improving the quality of protein in cereals; and (3) by tapping of new protein sources.

Global protein pacts as suggested by some are good for those nations who have enough foreign currency to buy the necessary protein concentrates. India is certainly not one among those lucky. The supplemental feeding programme of 15 million children in this country depends on foreign assistance from organizations such as CARE, MFM, OXFAM etc. for nearly two thirds of the requirements. This is not a long time solution. Pirie (1969c) has rightly pointed out that schemes to despatch food gifts to starving areas all over the world smack compassion but hardly solve the basic problem. It is therefore encouraging that India, in order to be self-reliant, is pioneering more innovative approaches to total nutrition than any other developing country.
In recent years the production of meat, fish and milk is encouraged. Animal protein costs more than plant protein because one has to pay for the very inefficient process of converting plant protein into animal protein. Only 8 to 20 per cent. of the protein fed to farm animals is recovered as animal protein for human consumption. Hence, the poor in developing nations cannot afford high quality animal protein. Indeed, some have predicted that even the affluent may not be able to afford animal protein in the future. At this time, then, it is not feasible for the developing countries to increase their production of animal protein in order to meet their nutritional needs. They must concentrate on increasing the production and utilization of plant proteins.

In this country, efforts are being made to bring more area under cultivation of high yielding varieties of pulses and in upgrading the nutritional value of the cereal protein. An increase in the use of fresh vegetables, especially leafy vegetables and immature flowers, would give a useful supplementary supply of protein but, because of other components such as fibre in vegetables, their direct contribution to the protein supply is likely to remain at the most 2 to 5 per cent. of a person's daily protein intake.
The novel protein sources considered for filling the protein gap include: fish protein concentrate, the cakes and meals left after removal of oil from oilseeds, protein from coconut, leaf, algae, yeasts or other microorganisms. The potentialities of these protein sources have been discussed elsewhere (*Sci. Jour.* 4, 1968; *Econ. Bot.* 22, 1968; Pirie, 1969c) and need not be enlarged on here.

The exploitation of leaves as a source of protein in human nutrition has long been advocated (Pirie, 1942), and machinery has been developed at Rothamsted (Davys and Pirie, 1960; 1965) and at other places (Hollo and Koch, 1971; Kohler and Bickoff, 1971) to extract protein on a large-scale. Recent studies have shown that leaf protein has an excellent nutritive quality (Pirie, 1969a; Singh, 1969; Woodham, 1971) and could be satisfactorily blended into human foods (*Byers et al.*, 1965; Kamalanathan and Devadas, 1971; Oke, 1971b). It is felt that mechanical extraction may allow the harvest of protein from native plants not now suitable to our present agriculture (Stahmann, 1968) and by direct human consumption of the extracted protein the great turnover losses associated with milk and meat production can be avoided (Pirie, 1966a; Stahmann, 1968).

In India, interest in leaf protein was evident as early as 1943, when attempts were made to use leaf protein
during the Bengal famine (Guha, 1960). Since 1961, although some investigations on the production and use of leaf protein have been undertaken at several places, the work is intermittent at all but two centres. The work done at the Central Food Technological Research Institute, Mysore has shown that on a village-scale or in institutions, with unsophisticated machinery, protein curd can be made to supplement the daily protein share in small batches for local communities.

Early in 1965, it was thought that the main emphasis in the leaf protein research and development should be on increasing the production efficiencies of plants and animals on land for self-reliant food production. It seemed, at that time, that international cooperative research on leaf protein could be a suitable facet of work within the IBP. The International Sectional Committee for "Use and Management of Biological Resources" (UM) agreed that the leaf protein project was relevant to the International Biological Programme (IBP News No. 5, p. 57 and IBP News No. 9, p. 61) and it was one of the themes discussed at an IBP/UM Working Group meeting on "Novel Protein Sources" in 1966 (IBP News No. 7, p. 82).

In 1967, it was decided to undertake a research project at Aurangabad on plant physiology and agronomy involved in the husbandry of the crops from which leaf
protein would be made in this tropical belt. This project was later approved by the Indian Committee of the IBP and is being carried out since then in collaboration with the Rothamsted Group of the U.K. IBP. The agronomic aspects of work on leaf protein in this laboratory logically come within the compass of the section devoted to "Production Processes". The work presented in this thesis also forms a part of this programme and deals with (a) screening of local vegetation for leaf protein extraction; (b) investigating the possibility of growing berseem in this region for protein production; (c) studying the effects of nitrogen fertilization on the yields of extracted protein; and (d) exploring the possibility of using the by-product residue from lucerne and hybrid Napier grass as silage in order to make the process more economical.