

# The Indian Council of Agricultural Research

## REVIEW ON GREEN MANURING PRACTICES IN INDIA

BY

B. K. MUKERJI, PH.D., D.Sc.  
Director, Sugarcane Research, Uttar Pradesh

AND

R. R. AGARWAL, M.Sc., D.Phil.  
Agricultural Chemist to Government, Uttar Pradesh



सत्यमेव जयते

MANAGER OF PUBLICATIONS, DELHI.  
MANAGER, GOVERNMENT OF INDIA PRESS, SIMLA.  
1950

Price: Rupees 3/- or 5 sh.

### Editorial Board

R. L. SETHI, I. A. S.,

*Agricultural Commissioner with the Government of India.*

P. N. NANDA, M. R. C. V. S.,

*Animal Husbandry Commissioner with the Government of India.*

S. R. MALNI, I. A. S.,

*Secretary, Indian Council of Agricultural Research.*

### Editor :

U. N. CHATTERJI, D. PHIL., D. SC., F. N. A. SC.

## PREFACE

**T**HE purpose of the present review which has been written at the instance of Dr. W. Burns, late Agricultural Commissioner with the Government of India, is to set forth as best as possible all the available information on the green manuring work done in this country. Wherever necessary, a reference has been made to some of the more important investigations carried out abroad with a view to institute a comparison of Indian conditions with those in the other countries. The review might also serve the purpose of indicating the lines on which work on the different or more important aspects of green manuring could be taken up in the different parts of India, so as to lead to an accumulation of data for filling in the gaps in our existing knowledge and thus provide a scientific background to the *raison d'être* of the entire practice of green manuring in India.

Our thanks are due to Mr. C. Maya Das, I.A.S., Director of Agriculture, United Provinces for his interest in the present work and Rao Bahadur B. Viswanath, Director, Imperial Agricultural Research Institute, New Delhi for providing library facilities to the senior author.

Department of Agriculture, U.P.  
*September 13, 1948.*

B. K. MUKERJI  
R. R. AGARWAL

# CONTENTS

	Page (i)
PREFACE . . . . .	1
I. INTRODUCTION . . . . .	1
II. GREEN MANURING CROPS . . . . .	2
SOME COMMONLY USED GREEN MANURING CROPS . . . . .	2
WINTER GREEN MANURING PLANTS . . . . .	3
CROPS SUITED TO DIFFERENT TRACTS . . . . .	3
LEGUMES AND NON-LEGUMES . . . . .	4
COMPOSITION OF GREEN MANURE PLANTS . . . . .	5
III. CULTURAL PRACTICES TO RAISE OR BURY GREEN MANURING CROPS . . . . .	8
TIME OF SOWING . . . . .	8
TIME OF BURIAL . . . . .	8
INTERVAL BETWEEN BURIAL AND SOWING OF A SUCCEDING CROP . . . . .	9
DEPTH OF BURIAL . . . . .	9
PLACE OF GROWTH . . . . .	9
SUNN GREEN MANURING . . . . .	9
GREEN MANURE TURNED INTO COMPOST . . . . .	10
GREEN MANURE CROPS AS INTER-CROPS . . . . .	10
BURNING GREEN MANURING CROPS . . . . .	11
IV. USE AND VALUE OF DIFFERENT GREEN MANURING CROPS . . . . .	11
QUANTITY OF GREEN MATTER AND NITROGEN ADDED TO THE SOIL . . . . .	12
APPLICATION OF DIFFERENT GREEN MANURES TO CROPS . . . . .	13
DIFFERENT PARTS OF GREEN MANURING CROPS . . . . .	16
GREEN MANURING PLANTS FOR DUAL PURPOSES . . . . .	17
RESIDUAL EFFECT OF GREEN MANURING . . . . .	18
RELATIVE VALUE OF GREEN MANURING AND FARMYARD MANURE . . . . .	18
V. GREEN MANURING IN CONJUNCTION WITH ARTIFICIALS . . . . .	20
APPLICATION OF FERTILIZERS TO THE GREEN MANURING CROP . . . . .	20
FERTILISING EFFECT OF ARTIFICIALS WITH GREEN MANURING . . . . .	21
VI. GREEN MANURING AND ROTATION OF CROPS . . . . .	24
LEGUMES IN ROTATION . . . . .	24
ROTATIONS FOR SUGARCANE . . . . .	25
VII. ECONOMICS OF GREEN MANURING . . . . .	27
COST OF GREEN MANURES . . . . .	27
GREEN MANURING PADDY . . . . .	28
GREEN MANURING SUGARCANE . . . . .	29
GREEN MANURING OTHER CROPS . . . . .	29
GREEN MANURING FOR DUAL PURPOSES . . . . .	30
VIII. SOILS AND GREEN MANURES . . . . .	34
SOIL TEXTURE . . . . .	34
SOIL REACTION . . . . .	34
SOIL NITROGEN . . . . .	35
SOIL MOISTURE . . . . .	35
IX. DECOMPOSITION OF GREEN MANURES IN THE SOIL . . . . .	35
CARBON . . . . .	36
NITROGEN . . . . .	37
CARBON-NITROGEN RATIO . . . . .	37
DECOMPOSITION OF CELLULOSE AND LIGNIN FRACTIONS . . . . .	38
NITRIFICATION OF GREEN MANURES . . . . .	39
X. SUMMARY . . . . .	40
REFERENCES . . . . .	44
APPENDIX . . . . .	47

- REFERENCES
- Akhurst, C. G. (1932). *Malaya Rub. Res. Inst. Quar. J.* 3, 131
- Allan, R.C. (1915). *Agric. J. India* 10, 380
- (1935). *Proc. Bd. Agric. and Ani. Husb. India, Crops and Soils Wing (1st meeting)*, 328
- (1937). *Proc. Bd. Agric. & Ani. Husb. India, Crops and Soils Wing (2nd meeting)*, 173
- Allen, O. N., Abel, F.A.E., and Magistad, O.C. (1934). *Trop. Agric. (Trinidad)* 2, 285
- Arnold, H. C. (1931). *Rhod. Agric. J.*, 28, 541
- Bal, D. V. (1922). *Agric. J. India*, 17, 133
- (1935). *Proc. Bd. Agric. and Ani. Husb. India, Crops and Soils Wing (1st meeting)*, 316
- (1936). *Nagpur Univ. J.*, 2, 43
- (1937). *Proc. Bd. Agric. and Ani. Husb. India, Crops and Soils Wing (2nd meeting)*, 195
- Barakzai, M. U. (1935). *ibid.*, (1st meeting) 322
- Basu, J. K. (1937). *Proc. Bd. Agric. and Ani. Husb. India, Soils and Crop Wing (2nd meeting)*, 28
- Benton, S. F. (1927). *Indian Tea Ass. Quarter, J.* 3, 114
- Briggs, G. W. (1938). *Third W. Afric. Agric. Conf. (Nigeria)* 1, 1
- Briscoe, C. F. and Harned, H. H. (1918). *Miss. Agric. Exp. Bull.* 8, 185
- Christensen, R. K. (1919). *Tidsskr, Plantavl*, 26, 335
- Coleman, L. C., Iyengar, B.N. and Sampatiengar, N. (1912). *Mysore Dept. Agric. Gen. Series Bull.*, 1, 22
- Crowther, E. M. and Mann, H. H. (1933). *J. Roy. Agric. Soc.* 94, 128
- Daji, J. A. (1934). *J. Agric. Sci.* 24, 1
- Desai, B. B. (1935). *Proc. Bd. Agric. and Ani. Husb. India, Soils and Crops Wing (1st meeting)* 324
- Desai, S. V. (1933). *Indian J. Agric. Sci.* 3, 301
- (1934). *Indian J. Agric. Sci.* 4
- Dhar, N. R. (1936). *Nat. Acad. Sci. India* (Presidential Address)
- (1937). *Nat. Acad. Sci. India* (Presidential Address)
- Dobbs, A. C. (1915). *Bull. Agric. Res. Inst. Pusa* 56
- Eden, T. (1936). *Tea Quart.* 2, 59
- Fuggles-Conchman, N. R. (1939). *East Africa Agric. J.* 5, 208
- Fulmar, H. L. (1917). *Soil Sci.* 4, 1
- Gadgil, V. V. (1937). *Proc. Bd. Agric. and Ani. Husb. India, Soils and Crops Wing (2nd meeting)* 185
- Grazia, S. de (1907-08). *Ann. R. Staz. Chim. Agri. Sper.* Roma 2, Series 2, 33
- Gainey, P. L. (1929). *J. Amer. Soc. Agron.* 21, 323
- Hartweel, B. L. and Pember, F. R. (1924). *J. Amer. Soc. Agron.* 16, 750
- Harrison, W. H. and Aiyer, P.A.S. (1913). *Mem. Dept. Agric. India (Chem. Series)* 3, 3; 4, 1
- (1916). *Mem. Dept. Agri. India, (Chem. Ser.)* 5, 1
- Heck, A. F. (1929). *Soil Sci.* 27
- Heintze, B. (1909). *Landw. Mitt. Prov. Sachsen v. Nach Halle*, 169
- Holland, J. H. (1931). *Trop. Agric. (Ceylon)* 75, 135
- Howard, A. (1913). *Bull. Agric. Res. Inst. Pusa* 33
- Howard, A. and Howard, G. L. C. (1915). *Bull. Agril. Res. Inst. Pusa* 51
- Hutchinson, C. M. (1919). *J. Agric. Sci.* 107
- Hutchinson, C. M. and Milligan, S. (1914). *Bull. Agric. Res. Inst. Pusa*, 40
- (1916). *Bull. Agric. Res. Inst. Pusa*, 63
- Hutchinson, H. B. (1919). *J. Agric. Sci.* 9, 107
- Hutchinson, H. B. and Clayton, J. (1918-19). *J. Agric. Sci.* 9, 141
- Iyer, P. V. K. (1939). *Scientific Rep. Agric. Res. Inst.* 55-59
- Jenkins, W. J. (1935). *Proc. Bd. Agric. and Ani. Husb. Soils and Crops Wing (1st meeting)*
- Jensen, H. L. (1929). *J. Agric. Sci.* 19, 71
- Joachim, A. W. R. (1925). *Trop. Agric.* 65, 325
- (1926). *Trop. Agric.* 63, 4-5, and 67, 4
- (1927). *Trop. Agric.* 63, 5
- (1931). *A manual of green manuring (Ceylon)*.
- Joachim, A.W.R. and Panditteskere, D.G. (1928). *Trop. Agric.* 71, 3
- Joshi, N. V. (1919). *Agric. J. India* 14, 395.
- (1922). *Bull. Agric. Res. Inst. Pusa*, 141
- Khan, M. A. S. (1923). *Punj. Dept. Agric. Rep.*, 2, 1-45

- Lander, P. E. (1935). *Proc. Bd. Agric. and Ani. Husb. India Soils and Crops Wing (1st meeting)* 311
- (1937). *Proc. Bd. Agric. Anim. Husb. India, Soils & Crops Wing (2nd meeting)*, 182
- Lander, P. E., Wilsdon, B. H. and Lal, M. (1923). *Bull. Agric. Res. Inst. Pusa*, 149
- Leukel, A. S. and others (1929). *Soil Sci.* 28, 347
- Lohnis, F. (1926). *Soil Sci.* 22, 253
- Lyon, T. L. and Wilson, B. D. (1928). *Cornell Univ. Agric. Exp. Stn. Mem.* 115
- Mann, H. H. (1907). *Indian Tea Assoc.* 284
- Mann, H. H. and Hutchinson, C. M. (1905). *Indian Tea Assoc. Pamphlet* 2, 8
- (1906) *ibid*, 43
- (1907) *ibid*, 26-32
- McCall, A. G. (1924). *Maryland. Stn. Bull.* 268
- Mitra, A. K. *Private communication.*
- Mitra, S. K. (1935). *Proc. Bd. Agric. and Ani. Husb. India, Soils and Crops Wing (1st meeting)*, 307
- Molegode, W. (1918). *Trop. Agric.* 51, 349
- (1926). *Trop. Agric.* 66, 160
- Mukerji, B. K. (1937). *Proc. Bd. Agric. and Ani. Husb. India, Soils and Crops Wing (2nd meeting)*, 28
- (1937-40). *Ann. Rept. Dep. Agric. U.P.*
- (1940-42). *Ann. Rept. Dept. Agric. U.P.*
- Mukerji, J. N. (1923-24). *Rep. Imp. Agric. Chemist, India*, 24-25.
- Mysore (1919-20). *Mysore Dept. Agric. Rep.* 1-46
- Narayan Iyer, K. R. (1935). *Proc. Bd. Agric. and Ani. Husb. India Soils and Crop Wing, (1st meeting)* 313
- (1937). *Proc. Bd. Agric. and Ani. Husb. India, Crops and Soils Wing (2nd meeting)*, 178, 179, 180
- Neller, J. R. (1920). *Soil Sci.* 10, 29
- Nicol, H. (1933). *Emp. J. Exp. Agric.* 1, 22
- Patel, B. S. (1935). *Proc. Bd. Agric. and Ani. Husb. India Soils and Crops Wing (1st meeting)*, 247
- (1937). *Proc. Bd. Agric. & Ani. Husb. India, Crops and Soils Wing (2nd meeting)* 191
- Pieters, A. J. (1927). *Green manuring*, John Wiley and Sons, Ltd., N.Y.
- Potter, R. S. and Snyder, R. S. (1917). *J. Agric. Res.* 11, 677
- Ramiah, K. (1935) *Proc. Bd. Agric. and Ani. Husb. India, Soils and Crops Wings (1st meeting)* 313, 318, 321
- Rao, D. C. Ramchandra (1923). *Trop. Agric.* 61, 248
- Rege, R. D. (1935) *Proc. Bd. Agric. and Ani. Husb. India, Soils and Crops Wing (1st meeting)*. 308
- (1941). Fertilizer Experiments on Sugarcane in India, *Misc. Bull. I.C.A.R.* 41
- (1927). *Ann. Appl. Biol.* 14, 1-44
- Roberts, W. (1935). *Proc. Bd. Agric. and Ani. Husb. India, Soils and crops wing (1st meeting)*
- Ronald, Mckee (1935). *U. S. Dept. Agric. Farm. Bull.* 1750
- Sahasrabudhe, D. L. — (1934). *Experiments in manuring crops, Bombay (1896-1931)*
- (1935). *Proc. Bd. Agric. and Ani. Husb. India, Soils and Crops Wing, (1st meeting)* 310
- Sayer, W. (1935). *Proc. Bd. Agric. & Ani. Husb. India, Crops & Soil Wing*, 334
- Sen, K. C. (1938). *Misc. Bull. I.C.A.R.* 25
- Sethi, R. L. (1938). *Pusa Agric. Res. Inst. Bull.* 186
- (1940). Manuring of Paddy. *Misc. Bull., I.C.A.R.* 38
- Sethi, R. L. Pramanik, B. N., Khan, A.D. and Rao, R.B. (1938). *Bull. Dept. Agric. U.P.* 72
- Sievers, F. J. and Holtz, H. F. (1926). *Wash. Exp. Stn. Bull.* 206
- Singh, B. N. and Singh, S. N. (1936). *J. Amer. Soc. Agron.* 28, 216
- (1937). *J. Amer. Soc. Agron.* 29, 889
- Singh, Ujjal (1937). *Proc. Bd. Agric. and Ani. Husb. India, Soils and Crops Wing (2nd meeting)*, 17
- Sornay, P. de (1916). *Green Manures and Manuring in the Tropics*. John Bale Sons and Danielson, Ltd.
- Starkey, R. L. (1924). *Soil. Sci.* 17, 141
- Thadani, K. I. (1937). *Proc. Bd. Agric. and Ani. Husb. India, Soils and Crops Wing (2nd meeting)* 184

- Theron, J. J. and Van Wyk, L. P. (1933). *Univ. Pretoria Series* 1, 26
- Thorne, C. E. (1929). *Maintenance of Soil Fertility*. Orange Judd Pub. Co. N.Y., 274
- Thomas, R. and Raju, J. C. (1914-18). *Palur (Madras) Agric. Exp. Stn. Reports*.
- Thompson, A. R., Johnson, M. O. and Sahr, C.A. (1917). *Hawaii Agric. Stn. Bull*, 52
- Turk, L. M. (1932). *Miss. Agric. Expt. Stn. Bull.* 173
- Viswanath, B. (1932). *Some Aspects of Plant Nutrition*, Soc. Biol. Chem. India, 24-26
- (1935). *Proc. Bd. Agric. and Ani. Husb. India, Soils and Crops Wing (1st meeting)*.
- (1937). *Proc. Bd. Agric. and Ani. Husb. India, Soils and Crops Wing (2nd meeting)*.
- Waksman, S.A. (1924). *Soil Sci.* 17, 141
- Waksman, S.A. and Tenny, F. G. (1927). *Soil Sci.* 24, 317 ; 217
- (1928). *Soil Sci.*
- Waksman, S.A. and Skinner, C.E. (1926). *Soil Sci.* 23, 137
- Whiting, A. L. (1926) *J. Amer. Soc. Agron.* 18, 854
- Wright, H. (1905). *Cey.-Circ. Agric. J. Roy. Bot. Gardens* 3, 137

## APPENDIX

## EXTRACTS FROM THE REPORT ON THE SURVEY OF GREEN MANURING PRACTICES IN INDIA BY SARDAR SURJAN SINGH SIDDHU—I.C.A.B. 1947.

DURING 1946-47 the Indian Council of Agricultural Research sanctioned a scheme on Survey of Green Manuring Practices in India. The object of the survey was to find out the present state of green manuring of crops in India, the obstacles and difficulties that are experienced in the expansion of this method of manuring and the maximum limit to which the practice can be expanded under normal circumstances. The report was submitted by Sardar Surjan Singh Siddhu, Special Officer in 1947 and brief extracts from the report are given as under.

*Difficulties in the wide spread use of green manuring*

Green manuring can raise the fertility of the soil but the application and utility of this practice depends on various factors. These factors are climate, land, labour, capital and management. If these factors are not favourable the practice could not be easily taken up by the cultivator.

The unbalanced and uncontrolled rural economy does not favour green manuring as a regular practice. The *zamindar* is unprogressive and does not function properly in our agricultural economy. He does not encourage any agricultural development by his tenants. The tenants, on the other hand, have no fixity of tenure. They pay more attention to immediate gains and cannot afford to invest any capital outlay on any long-term improvement. The low precipitation and lack of irrigation facilities are other major obstacles since green manuring gives best results only where there is plenty of moisture in the soil. Moreover, there is shortage of labour, difficulty in getting green manure seeds and canal water at the right time. There is also not proper propaganda or education with a view to develop the practice of green manuring in the different states and provinces of India.

Green manuring for *kharif* crops like paddy becomes difficult as very little time is left for the growth of the green manuring crop if early rains are not assured. Moreover, severity of hot weather preceding the *kharif* season becomes detrimental to the young green manuring crop in case there are long breaks in rains and no irrigation facilities available. Small and scattered holdings also react adversely on this practice in general.

*Ideal agricultural characteristics of green manuring plant*

The plant should be of rapid growth so that it may produce early and bulky organic matter. It should have abundant succulent and soft tops which may add to the soil easily available plant food material for the next crop. The plant should have the ability to grow on a poor and sandy soil and should not be handicapped for want of good soil. The plant should have higher percentage of moisture which would help in quicker decomposition in the soil. It should be a legume to assist nitrogen fixation from the atmosphere. It should be less woody and fibrous otherwise it may not rot easily. It should have less water requirement for its growth.

*Plants used for green manuring*

Leaves of trees near hills and forest are used extensively as green manure in Madras. *Sanai* is the chief green manuring crop which is sown in mid-May and ploughed in as six week's old crop for paddy. Green leaves are similarly puddled. Wild indigo (*Tephrosia purpurea*) is purchased by the cultivators from the people who bring it from the adjoining hills and applied to sugarcane. It is also sown broadcast before the harvest of paddy in November or if there be not enough moisture then in January when winter rains are expected,

and ploughed in next July for paddy. Portial (*Thepesia populnea* N.O. *Malvaceae*) and *Pongamia glauca* are common trees with plenty of soft broad leaves. The leaves of these trees are commonly used for green manuring and are considered very good for this purpose. Other varieties for green manuring are *Prosopis juliflora* which is grown on bunds and the leaves are lopped every now and then; *Sesbania spiciosa* a new variety of *Sesbania* obtained from South Africa which is softer than *S. aculeata* and is therefore considered better; and *Sesbania grandiflora* which is a bigger plant and gives bigger leaves.

*Pongamia glabra* known locally as *karajwa* is a tree growing extensively in dry regions of Mysore and Madras with a rainfall of 20 in. or less. It has heavy foliage with big individual leathery leaves. It supplies as much as 50 to 150 md. of green leaf from a single tree. Besides, the nut yields a kernel having high percentage of oil which could be used for burning purposes or for soap making. The oil-cake makes a valuable fertiliser.

*Different crops used for green manuring*

*Guar* (*Psymopsis psoroloides*) is a green manuring crop of Eastern Punjab and Sind and is suitable for dry climates. It can be used as green manure only under irrigated conditions. It is a good and nutritive cattle fodder. For green manuring the seed could be drilled in or broadcast in May or June. It gets a good start with rain or irrigation and can be ploughed in before the middle of September. It is used for wheat in the Punjab and to some extent in Sind.

*Crotolaria striata* is suitable for moist regions like Malabar. It is not used *in situ* but grown outside and two cuttings of green matter of about 8,000 to 15,000 lbs. are available which could be used for sugarcane, coconut, areca nut or vegetables. *Sanai* (*Crotolaria juncea*) is a crop grown in Northern India for fibre and green manuring. In Madras it is also grown for green fodder and hay. It is a very quick growing crop. It is sown broadcast with the break of the monsoon and is ready for ploughing in after 8 to 10 weeks. It makes 5 feet tall crop, with succulent and soft tops and is ideal for decomposition in the soil. Light sandy soils are eminently suitable and heavy clay soils with bad drainage are unsuitable for this crop. However, it grows in wet paddy lands of Madras.

*Dhaincha* (*Sesbania aculeata*, *S. spirulosa*, *S. gigantea*) common variety is *S. aculeata* which is a plant used for green manuring in wet regions. It can tolerate good amount of salinity in the soil. It is used extensively in Bengal from where the seeds are exported to Madras and Orissa. It is sown broadcast at the rate of ten lb. per acre. It has a quick growth second to *sanai* and is quite soft and succulent in early stages when it should be ploughed in as green manure. On being mature it becomes very woody.

*Kalonji* (Madras), *Sarphanki* (U.P.), wild indigo (*Tephrosia purpurea*) is a common weed of the uncultivated lands of Northern India. It is a legume and has plenty of nodules in the roots. In Madras it is used as a green manure crop. The plant is hardy and can grow in any type of soil. It thrives well generally in the driest part of the year, viz. January to June. It has a very low water requirement for it can grow with the scantiest moisture contents of the soil which would not support any other vegetation. It sheds its leaves during the hot weather, but with rains or irrigation it shoots forth fresh foliage. The seed is hard and slow to germinate and hence it is given some pre-treatment before sowing. Seed could be sown in September, October, November or even upto February in the standing field of paddy. It will grow and give a stand of 4 ft. high crop. In hot weather it will shed all its leaves but will throw out fresh leaves with the first break of monsoon. It could then be puddled in the field and paddy transplanted. It gives about 4000 to 5000 lb. of green matter.



Leguminous weeds which are found in U.P. and which could be adapted as green manuring crops are *Cassia obtusifolia* (panwar or chakor), *Tephrosia purpurea*, *Indigofera* sp., *Lathyrus aphaca* (matri), *Lathyrus cativus* (lesari), *Lathyrus sphaericus*, *Vicia sativa* and *Vicia hirsuta*.

*Pillipesara* (*Phaseolus trilobus*) is an important leguminous fodder crop grown in the Circars of the Madras Presidency. It is a trailing herb with many branches prostrate on the ground which reach a length of even six feet. The root system is full of nodules. It is a very nutritive green fodder. It can be used as a green manure crop. Seed is sown broadcast in the standing crop of late paddy just before its harvest at the rate of about 15 lb. per acre. Irrigation is given to the crop and the crop is ready for green manure in next July. For sugarcane it is sown in September. The first few cuttings are used as fodder when in December the land is ploughed for sugarcane. The yield is about 25,000 lb. when grown from November to July.

In *rabi* few crops are used as green manures since all leguminous crops are valuable seed or fodder crops. Pea is used very rarely as green manure. The last cutting of berseem can be ploughed in as green manure for sugarcane but it is a valuable fodder crop. Same is the condition with *shaftul* (*Trifolium alexandrum*) and *metha*. *Senji* (*Melilotus parviflora*) may have some possibilities as green manure due to its bulk for sugarcane. *Kesari* (*Lathyrus sativus*) is sometimes used as green manure in Sind.

#### Technique of green manuring

Green manuring is practicable only in those areas which have well distributed rainfall over the growing and post-burial period of the green manuring crops. It could also be adapted in regions where timely irrigation facilities are available. It is, however, an unsuitable practice for unirrigated areas with 20 in. or less precipitation.

In wet lands where paddy is the usual crop green manuring has been taken up with success. The technique of green manuring in wet lands is very simple and needs no special care or attention. Not much propaganda is necessary for spreading the use of green manuring in such areas, the only help that cultivator wants is the timely supply of good seeds for green manure crops. In Madras, seed of *sana* is not easily available. In the local markets the cost of the seed was very high and cultivators had to depend on the Departmental supply. It is difficult to raise green manuring seeds in low-lying paddy lands. Seed raising should, therefore,

be done on dry high lands. Poor quality high level lands could easily be utilised for raising seeds of green manuring crops which being legumes will require little cost for production but would give a fairly good return. Seed raised on such high lands should be moved to low-lying wet areas through Departmental agencies by obtaining priority over transport.

In dry lands the factors that affect the suitability or otherwise of green manuring are :—

- (a) *Soil*—light soil is the best and heavy the worst.
- (b) *Moisture*—scarcity and excess are harmful.
- (c) *Temperature*—extremes undesirable.
- (d) *Soil aeration*—poor aeration harmful.
- (e) *Cultivation*—Time and type of cultivation a vital factor.
- (f) *Crop to be green manured*—these have to be carefully selected.

#### Research

Useful plants should be discovered which could be utilised as green manures. For example white clover which is found in Ootacamund and in Simla in hot weather at a height of 1000 ft. forming a thick mat of vegetation on the surface is a leguminous weed and could be cultivated in winter months on the plains. It may turn out to be a fine fodder and an excellent legume. A tree *Pongamia glabra* which yields a large quantity of green leafy material may turn out very valuable for green manuring purposes if planted on village-common lands, waste lands, road sides etc. The tree also yields a nut the kernel of which gives an oil for burning or soap making leaving the cake which is an excellent fertiliser. This tree is very common in East Mysore with a rainfall of about 20 in. per annum.

Further research on green manuring should proceed on selection of suitable leguminous plants which grow as local weeds and which have all the good points of a green manuring plant. Plants growing both in the *kharif* and *rabi* should be studied from this point of view. The main consideration should be that the plants selected should be quick growing, succulent, easily decomposable with low moisture requirement and low co-efficient of transpiration, able to produce maximum amount of nitrogen and organic matter in shortest possible time and to fit in the existing practices of the agriculturists. Crops suitable for dry, moist, wet, hot and cold climates should be discovered so that the crops may suit the various parts of India.