SOIL AND PLANT NUTRITION

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Plants derive their nutrients from the soil which are added to it in the form of fertilizers and manures. Indian soils which are being cultivated from about 3000 B.C. are at a very low level of nutrition at present.

In India, as elsewhere, land uses are in three stages of development :

In the first stage the population density is low and industrialisation is negligible or at a low level so that the land is in plenty and extra land can be brought under the plough by individual efforts when soil fertility of a cropped area goes down. In the second stage there is a demand on land for various purposes like buildings, roads, recreation grounds etc., because of an increase in the density of population industrialisation of the country and, therefore, extra land can not be brought under cultivation by individual efforts but Government efforts like irrigation projects, reclamation schemes etc. can bring extra land under the plough. In the third stage most of the culturable land has been brought under cultivation and in fact extension of industries begins to encroach on the agricultural land. India is now in transition stage from the second to third phase of land use development. This is illustrated by Table I.

Table I. Expansion of town-ships due to increased population and industries in some parts of India

Town/City	Area in thousand hectares	
	1951	1961
Ahmedabad	5·24	9·29
Chandigarh	0·00	3·16
Delhi (New and Old)	10·24	28·36
Greater Bombay	20·53	43·77
Hyderabad	13·47	18·69
Lucknow	4·66	10·36
Nagpur	5·20	21·75
Srinagar	2·84	4·14

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Increasing expansion of town-ships has consumed good agricultural land as indicated in Table II below.

Table II. Land not available for cultivation in India owing to expansion of industries and town-ships

Year	Thousand hectares
1950–51	47·5
1955–56	48·4
1960–61	50·0
1965–66	50·7

However, the net area under cultivation in the country has increased from 118·7 million hectares in 1950–51 to 138·1 million hectares in 1964–65 and came down to 136·2 million hectares in 1965–66 and again increased to 137·0 million hectares in 1966–67.

Such an increase in the net area under cultivation has been achieved by bringing more and more culturable waste land under the plough. It is estimated that due to limitations in topography and other unfavourable conditions the maximum net area which can be brought under the plough by adequate soil conservation measures is 144 million hectares. The agricultural land use statistics of 1966–67 show that there are about 17·1 million hectares of culturable waste land, the reclamation of which has been underway during the plan periods (Table III).

Table III. Reclamation of waste lands during the plan periods

Waste lands reclaimed	(in million hectares)
First plan	1·13
Second plan	0·93
Third plan	1·82
1966–67	0·12
1967–68	0·14
1968–69	0·16
1969–73	1·00 (Expected target)
Total	5·30 (Expected)

Indeed, more than half of the total increased agricultural production in India from 1948–62 has been ascribed to increased area brought under cultivation as is shown by some typical USDA data given in Table IV.

Table IV. Changes in agriculture in developing countries (USDA data)

Country	Time span	Annual rate of increase in crop output (%)	Area (%)	Crop pattern (%)	Crop yield (%)	Total (%)
Israel	1948–63	9·7	28·5	—2·6	76·8	100
Sudan	1948–62	9·1	30·8	22·2	47·0	100
Mexico	1948–60	6·3	53·4	—0·1	46·7	100
Brazil	1948–62	4·2	84·3	1·5	14·2	100
India	1948–62	3·1	59·1	8·0	32·9	100
Japan	1948–63	2·8	2·8	20·2	77·0	100

It appears that we are losing good agricultural land and instead, are increasing the net area cultivated by bringing culturable waste land under the plough. Therefore, the average yield per hectare of agricultural crops is not increasing as rapidly as it is desired, specially in view of the more recently adopted extensive high yielding varieties programmes, including all package inputs like increased fertilizer use, irrigation and use of pesticides. This is illustrated for rice and wheat in Table V.

Table V. Average yield of rice and wheat in India

Year	Rice Quintal/hectare	Wheat Quintal/hectare
1950–51	6·68	6·63
1955–56	8·74	7·08
1960–61	10·13	8·51
1964–65	10·78	9·13
1966–67	8·63	8·87
1967–68	10·32	11·03
1968–69	10·76	11·69

There are three cardinal principles in land use planning, particularly for a country like India which is covered by a large number of small holdings.

(i) Optimum use for any piece of land in national interest e.g. growing cash crops or horticultural crops instead of cereal crops and vice-versa.

(ii) Multiple cropping is both desirable and possible.

(iii) Complete elimination of waste lands.

The index of multiple cropping in India ie. gross area sown/net area sown is 1·14 (1967–68) whereas for a country like Thaiwan it is as high as 2·00. Attempt is, however, being made to resort to as high intensity of cropping as possible, particularly in areas under irrigation. The impact of the use of high yielding varieties, fertilizers and pesticides is already felt and will be fully realised in the near future.

In respect of irrigation it has been estimated that out of the potential net area which may be brought under cultivation by increased soil conservation measures (144 million hectares), 81·7 million hectares may be ultimately irrigated. By 1968–69 the gross irrigated area was about 36·00 million hectares, out of which 17 million hectares by major and medium irrigation and the rest by minor irrigation.

Thus, the problem before the country is to increase agricultural production considerably during the fourth plan period. In respect of food grains, the target of increase is from about 94·01 million tonnes in 1968–69 to 129·00 million tonnes in 1973–74. Great emphasis has been laid on intensifying the high yielding varieties programme by raising the area from 8·40 million hectares in 1968–69 to 24 million hectares in 1973–74. In fact, 60 per cent of the targetted consumption of fertilizers during the fourth plan period is expected to be used in the high yielding varieties programme. This ambitious programme would require concentrated efforts from agricultural scientists of all disciplines viz., Agronomists, Geneticists, Soil Scientists, Plant Physiologists, Agricultural Entomologists, Plant Pathologists, Agricultural Engineers, Extension workers and others.

For building up fertility of Indian soils, particularly for small holdings, a careful study of the soil is needed. Close co-ordination of soil survey and soil testing, which is at present lacking, should be given effect to so that the precision of the prediction value of soil test for fertilizer recommendation is considerably

improved to at least 70–80 per cent. At present the prediction value is about 30 per cent. Addition of bulky organic manures, wherever available, will be very useful in maintaining and improving soil fertility. However, if bulky organic manures are not available adequate chemical fertilizers, as determined by soil tests and field trials, should be added.

The following lines of work of increased intensity, from plant physiology point of view, are suggested in the field of soil and plant nutrition :—

(i) Work for building up knowledge of deficiencies of micronutrients in Indian soils and demarcate the regions.

(ii) Work on mutual interference of the uptake of the various plant nutrients including micronutrients.

(iii) Work on the optimum levels of nutrients required by various crops.

(iv) Work on spray fertilisation of micronutrients and of urea so as to increase their efficiencies in increasing crop yield.

(v) Work on biuret toxicity of urea when it is sprayed on the crops, particularly in arid and semi-arid regions.

(vi) Work on the development of drought resistant varieties for dry farming areas.