CHAPTER - III

THE BASIC MATERIAL - RAW MATERIAL

Raw material is the key base which is responsible for the production of finished goods. Raw material has a great say in the determination of the final cost of the goods, and on it depends the economy of the final production. The part that the raw material plays in the final cost of the product depends on the product and on the material used. In certain cases, raw material accounts for about 80 per cent of the total cost of the goods. Therefore, factors like accessibility to the raw material, its cheapness and its supply in abundance, govern the price and production of the finished product.

Sugar is a 100 per cent sucrose. Sugar being a product of vegetable life, the sugar factory may be taken to be the machine for converting sugar present in the plant into crystals or pac-king the produce of many acres of land into the smallest possible compass. In other words, whatever sugar enters the factory in the form of sucrose, the same and nothing more is turned out by the mills in a marketable form. This brings home the importance of the raw material, in the production of the finished goods.

Sucrose is found in great many plants, dissolved in the sap. Although, it may be considered as one of the most universal constituents of plants, only a few of them contain it in such a percentage, as to allow its profitable and commercial extraction. India is fortunate enough to have grown the aforementioned plants, which yield sugar for sweetening purposes, but all these plants have not been tried commercially for the production of white sugar.

1. ANTS EXCUDE
2. A. BART
3. A. SACCHARUM
4. SAGU ARBICUMA
5. A. RUGOSO SACCHARUM
6. SITA VALENTA
7. BERA SITRA LEBELLIIPARIS
8. GRYCE VAURUS
9. PHCEIX SYLVESTRIC
10. SACCHARIUM OFFICINALE

(*) This is the common sugarcane of which there are in India, many a distinctive varieties.

The raw material from which sugar has commercially been manufactured is sugarcane, beet, palmyra etc. Sugarcane and beet, however, contribute the highest percentage of sugar in different parts of the world. Sugarcane is grown in India in abundance. The availability of this cheap raw material has enabled her to manufacture sugar from times immemorial. The product was brown sugar and was known as 'sir', 'bali' or Khandsari sugar etc.

Sugarcane is a gigantic stalk, often reaching 10 to 15 feet in height in the tropics. Its roots, like those of all grasses, are fibrous and lateral, stretching in all directions and usually not penetrating into the soil to a great length. Stalk is cylindrical and is composed of nodes and internodes. In the cells of the leaves, the green colouring matter during daylight manufactures starch from the carbonic acid gas of the air and the water brought from the roots. This starch is then changed and conveyed to all parts of the plant, large part of it is usually deposited in the pith cells of the stem in the form of sugar. Originally, only 4 species of Saccharum that is, S. Officinarum, S. Barberry, S. Sinense and S. Spontaneum were recognised. After this, another species S. Obstrum, was named for a group of canes found in New Guinea.

(2) Cultivation of Sugarcane, 1900 - William M.C. Stubbs page 12.
(3) Southern Field Crops, 1914. John Frederick Sugar - page 485
Sugar cane is a tropical plant and is grown in all parts of the tropics, where sufficient moisture is available either from rainfall or from irrigation. With 50 inches rainfall a year, it can be grown satisfactorily without irrigation, but where the rainfall is less, this requires addition from irrigation. Although, it is a tropical grass, it has been cultivated in sub-tropical regions also. It flourishes in a great variety of soils, ranging from the wind blown sands to heavy intractable clays. Each type requires its own particular form of treatment, to be produced profitably under varying conditions of climate and rainfall. At the same time, germination in sugar cane is one of the most important factor which determines its performance and its ultimate yield. Quicker the germination, the better are the chances of a good stand, and a higher yield. In sub-tropical areas, where cold weather prevails from November to March, the growing season accounts for usually 8 months and the sugar cane has to make all its growth during the monsoon months that is, June to September. In general, sugar cane flourishes more or less well in all soils, if it receives the manures, that its economy demands. It develops vigorously and supplies juice rich in sugar, if it is cultivated in a free and deep soil.

The climate of North India gives rise to two agricultural seasons that is, (i) the kharif or the tropical season, from June to October, and (ii) the rabi, or temperate season, extending from November to March. The kharif season is preceded by a dry and a hot weather. The South West monsoon usually reaches here in the latter half of June. The weather changes suddenly and there are heavy rains, and the monsoon withdrew as suddenly as it arrives. In the face of the climate variation that this region experiences, the growth of the cane is checked. The sugarcane soils of North Indian states are alluvial and more fertile than those of the residual soils
of the tropical areas of Southern India. But these extreme conditions of climate suit only the cultivation of the hardy types of cane, which give low yield in comparison to the cane planted in the tropical regions.

**Cane Cultivation in Uttar Pradesh:**

The position of Uttar Pradesh in Northern India is, that it is a land locked State lying between 23° 52' and 31° 18' N and 77° 10' and 89° 39' E. It is bounded by Tibet and Nepal in the North, Himachal Pradesh and the Punjab in the West, Rajasthan in the South west, Madhya Pradesh in the South and Bihar in the East. The Yamuna river forms part of the western boundary, the Ganges part of the Southern boundary and the Gandak part of the Eastern boundary. It has got an area of 1,13,654 sq.miles (1,92,953 kilometres) with 54 districts. According to 1961 Census, the State had 1,12,624 inhabited villages with a population of 6,42,66,056, as against its total population of 7,37,46,401. About 75 per cent of the total working population in Uttar Pradesh depends on agriculture for their livelihood as against an all India average of 69.5 per cent. It has got a density of 649 persons per sq.mile as compared to all India average of 373 persons per sq.mile. These figures indicate heavy pressure of population on agriculture, which also reflects lack of development of employment opportunities in other fields in the State.

Agriculturally speaking, it is the most unique state on the surface of the earth. It has an area which is subject to wide variations in rainfall. Secondly, it comprises the world's greatest canal systems, which are responsible for altering the character of its cropping and the distribution of population. Thirdly, the middle and the central plains exhibit the most phenomenal well

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(4) The Sugarcane, 1964, A.I.C. Bames, pages 68-70
system in the world. Lastly, agricultural research and experiments have modernized some long established crops, which have improved the general conditions of the cultivators here.

The state has a good irrigation system and over 50 per cent of the total cultivated area is covered by it, although in some districts, over 30 per cent of the rabi crop is watered. The state has a vast alluvial plain, tending to southeast, and watered by great rivers. Between the rivers are even stretches of land dotted with swamps, ponds, groves and patches of scrub jungles. The western tract, known as 'DOAB' differs materially from the country north and east of Ganges. This known as 'Gangetic Valley'. Within it the SUGARCANE DOAB is fully covered by canals. The soils of the main cane growing regions is alluvium of the gangetic plain, containing lime and potash. The loamy soils are excellent for cane and reduce expenditure on artificial manures. Cane is the cash crop of the state which is usually found around the sugar factories.

The soils of Uttar Pradesh (Diagram No.II) form a major portion of the widely known great Indo-Gangetic plain consisting of the soils mostly derived from the disintegration of Himalayan gneisses and schists. According to the epics of 'Ramayana' and 'Mahabharata', and the accounts of the Chinese travellers as far back as 600 B.C. as well as Greek emissaries, the now almost treeless tract of the Central Uttar Pradesh, was covered with thick dense forests in those days. The primeval forests were cut down by the emigrants to the Indo-Gangetic basin for providing habitation, cultivation and pasture. The fertility accumulated through the ages was thus gradually lost and the soil eroded badly, forming the famous ravines of Jamuna and Ganga. These ravines have increased rapidly and have engulfed thousands of acres of fertile land.

The cane growing area of Uttar Pradesh lies mainly within the Gangetic plain. The sugarcane belt extends from west to east to a length of 600 miles and by a width of about 200 miles. Such an extensive area presents wide diversity of climate and soil. The western part of the belt consists of medium and heavy soils, rich in humus, with moderate rainfall but with ample irrigation facilities through a network of hydro-electric tube wells and canals. The eastern part consists of poorer soils, with little resources for irrigation in hot weather, and often beset with floods during the rainy season. The central part possesses somewhat rated soil and climatic conditions for sugarcane cultivation. The northern strip along the Sub-Himalayan range from Dehra Dun in the west to Deoria in the east, and the newly reclaimed Tarai tract in the Sainital district, have their own peculiar soil and climatic conditions. The soils are calcareous and generally rich in humus, built mostly on the washings of the Hill soils. The climate is moderately hot with excess of atmospheric humidity.

In such a vast area with diverse topographical conditions, every tract has its own difficulties of cane cultivation. Here the cane varieties have to be somewhat drought resistant in order to overcome the dry spells or conditions on account of insufficient irrigation, and red rot resistant due to flood conditions. Similarly, in tarai areas, the late maturity of cane on account of the peculiar soil and climatic conditions, has to be overcome by the introduction of early maturing varieties. Another problem in this area is the presence of weeds, which compete freely with the cultivated crops. Again, the climate of western Uttar Pradesh favours the growth of some -- the most destructive pests like pyrilla and hygacid bug and the notorious disease of smut. The 'Dhoon valley' and riverine areas exposed to floods have their own problems of pests and diseases.
All these factors have to be controlled, to raise the yields of crops in the fields and the recovery of sugar in the mills.

Again, sugarcane is a very heavy feeding crop, depleting the soil of large amounts of nutrients up to the depth of 4-5 feet and tapering the resources of the soil up to 10-12 feet. A crop of 30 tonnes (600 maunds) cane stalks per acre, weighing about 40 tonnes (1100 maunds) including leaves and tops, removes from the soil approximately 105 lbs of Nitrogen, 63 lbs of Phosphoric acid, 315 lbs of Potash, 75 lbs of Lime, 22 lbs of Sulphuric acid, etc. The ingredients that need constant replacement are chiefly Nitrogen, Phosphoric acid and potash/lime, the rest being present in the soil and needing replenishment only in special cases. This confirms the fact that sugarcane is a highly exhaustive crop and needs an ample supply of different nutrients for its successful growth and development. In cane plant, nitrogen, phosphorus and potassium are considered to be important elements required by it. Although, the Indian soils are generally deficient, the fertility status of the soils of Uttar Pradesh has been found to be particularly low. It has got a supply of 600 to 4000 lbs nitrogen per acre with an average of 1000 lbs. It has got potassium contents of about 800 to 10,000 lbs per acre. Because of the depletion of nitrogen in quantities which have not been replaced in the proper doses, the yield and the quality of cane in this State has been found to be very poor as compared to other States.

Although Uttar Pradesh lies outside the Tropics, the acreage under cane here has been more than half of the total acreage of Indi

The original home of sugarcane is believed to be the rich alluvial plain watered by the Ganges and the Jamuna in the Rohilkhand Division of this State. The State did not have regular sugar factories in the 19th Century, but it had got the largest acreage under cane, being 11 lakh acres (North West Provinces and Oudh) closely followed by Punjab, Bengal and Bombay - having 3.75 lakh acres, 2.87 lakh acres and 1.25 lakh acres respectively, in 1888. In 1893-94, the area increased to 29 lakh acres. The area planted with sugarcane in the Madras State (Tropical region) was only 54,000 acres in 1899-1900. In the North of Ganges, and as far as west of Gorakhpur, the dominant canes belonged to the Mungo group. In the North East of Bihar and near the Eastern Uttar Pradesh, especially in areas adjacent to the Nepal frontier, large areas were laid down in canes belonging to the Nagori group. New varieties of cane were introduced from time to time but none established on an extensive scale except Coimbatore varieties, like Co.210, Co.213, Co.214. An average yield of 10.3 tonnes cane per acre was only obtained in 1922-23, from varieties like Mungo, Caretha, Pansahi and Nagori. As compared to them, Coimbatore varieties gave an average of 35 tonnes cane per acre on an extensive scale. It had been estimated that with systematic irrigation combined with proper manuring and cultivation, the desi varieties could give an average of 25 tonnes cane per acre. Although, the yield of cane was not as high as that in the tropical regions, the State possessed 50 per cent of the total Indian acreage, on the eve of the grant of protection to the Sugar Industry, in 1931.

As compared to Uttar Pradesh, the Bombay (Maharashtra and Gujarat) and the Madras States, which lie entirely within the tropical climate.

have got much less acreage under cane. It is due to the fact that there has been scarcity of water for irrigation and not much suitable land was available for cane cultivation. The cultivator in these States has got many alternative crops for sowing, for example, cotton, tea, rice etc., which paid him equal returns. The tropical soils are most suited for cane cultivation, but these require heavy doses of manures and fertilizers to bring high yields, which are very expensive. The soil of Bombay is capable of producing a higher yield of cane per acre than any part of India, but the chief drawback here is the high cost of cultivation, coupled with less and costly irrigation facilities. Most of the factories, therefore, have maintained their own farms so that these get proper returns for the high costs incurred by them on the cultivation of cane. It has, therefore, been possible to obtain an average of 40 tonnes cane per acre. The cane grown there is of thick type (Noble) and the main varieties are POJ 2679 and Co.419.

In Madras, the rainfall is precarious and often badly distributed. Irrigation is dependent upon tanks and channels. The Southern tract comprising of East Coast districts, south of Madras, has an average rainfall of 36 inches a year, and part of the land is irrigated by the Cauvery, Mittur and Periyar irrigation projects. The preparation of ground and the manuring of the field raises very high the cost of cultivation. The cost of cultivation is low in the coastal districts, but the chief difficulty faced by these districts is their liability to violent cyclonic storms during the period of the growth of the cane. About 5,000 bamboos per acre are required for propping, wrapping the cane, which is an additional expenditure on the crop. Inspite of its being situated in tropics, Madras offers limited prospects for cane
cultivation, due largely to the widespread preference for rice, wherever supplies of water are available. Although cane yield is twice as compared to that of Uttar Pradesh, its costs too is much higher, which offsets the premium of the yields.

Taking all these aspects into consideration, it has been maintained that the Uttar Pradesh offers better opportunities for the growth of cane at cheap rates. Although sugarcane is cultivated in the whole of Uttar Pradesh, still some parts of the State have got more of it as compared to the rest of the State. The Sharda canal was opened in 1939 and its influence is marked in the areas of Bareilly, Shahjahanpur and Pilibhit. The increase in cane cultivation in the Meerut Division was due to the establishment of factories there. It is also due to the introduction of tube wells. The increase in areas in Agra and Hathura is due to better water supplies in the Agra canal and 'Hut' branches of the Ganges canal. We can, therefore, safely divide the State into the following tracts with regard to the cane production.

EASTERN TRACT: This is the main sugarcane tract and includes the districts of Meerut, Saharanpur, Meerut, Mainpuri, Agra, Aligarh, Firozabad, and Pilibhit etc. It comprises two divisions viz., Meerut and Rohilkhand. The climate in this tract is hot and dry in summer and cold in winter, with occasional frosts. The lower temperature which occurs in the Rohilkhand between December and February, proves unsuitable to cane cultivation. Cane is irrigated mainly from the Ganges and Jamuna canal system, and partly from tube wells also. It had an acreage of 5,49,981 acres in 1901, which increased to 7,04,175 in 1931-32. The area increased by 90 per cent by 1943-44. By 1951-52, that is, on the eve of the First Five Year Plan, it had an acreage
of 14,95,406 acres which is 3 times that of 1901 acreage.

CENTRAL TRACT: This tract consists of the districts of Lucknow, Unnao, Rae Bareilly, Sitapur etc. The extremes of climate are somewhat less here. Before the grant of protection to the sugar industry, cane crop did not play an important role in the economy of this tract. The opening of the Sharda canal increased the cane acreage in this tract. In 1901, it had an acreage of 2,41,467 acres. This area increased by more than 100 per cent in 1935-36, but the slump in that year contracted the cane cultivation. By 1951-52, it had an acreage of 5,73 lakh acres.

EASTERN TRACT: This tract consists of the districts of Gorakhpur, Basti, Azamgarh, and Deoria. The climate is hot in summer but comparatively mild in winter. The tract is traversed by the rivers Rapti, Ghagra and Chota Sarju. It is always faced with floodwater threats from them. Although flood waters damage the kharif crops, they also bring with them thin silt which they leave on the ground while receding. This silt makes the soil fertile and clayey. Two third of the sugar cane crop is classified as un-irrigated and the remaining irrigated. This tract had an acreage of 1,92 lakh acres in 1901, which increased to 3,15 lakh acres in 1938-39. It kept a constant area under cane till 1951-52.

TARA AREA: This tract consists of the districts of Almora, Garwhal and Nainital. The only area capable of growing cane lies in the tehsil of Kashipur in Nainital. Clearing of forests at foothill has increased cultivation of the cane crop. It had an area of 3,921 acres under cane in 1901 which increased to 19,911 acres in 1951-52.

The position of the cane acreage in different Divisions has
been included in the following table. It is found that Meerut Division tops in cane acreage. Even in this Division, Meerut district contributed a big crop every time. Gorakhpur and Lucknow districts have also gained position in cane cultivation:

Table No. III - I

Statement showing the position of cane cultivation in different Divisions of Uttar Pradesh.

<table>
<thead>
<tr>
<th>Division</th>
<th>1901</th>
<th>1938-39</th>
<th>1951-52</th>
<th>1965-66</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acres</td>
<td>Position</td>
<td>Acres</td>
<td>Position</td>
</tr>
<tr>
<td>Rohilkhand</td>
<td>293</td>
<td>I</td>
<td>465 I</td>
<td>II</td>
</tr>
<tr>
<td>Meerut</td>
<td>257</td>
<td>II</td>
<td>450 II</td>
<td>I</td>
</tr>
<tr>
<td>Gorakhpur</td>
<td>192</td>
<td>III</td>
<td>373 III</td>
<td>IV</td>
</tr>
<tr>
<td>Lucknow</td>
<td>113</td>
<td>VI</td>
<td>246 IV</td>
<td>III</td>
</tr>
<tr>
<td>Faizabad</td>
<td>128</td>
<td>V</td>
<td>174 V</td>
<td>V</td>
</tr>
<tr>
<td>Varanasi</td>
<td>140</td>
<td>IV</td>
<td>164 VI</td>
<td>VII</td>
</tr>
<tr>
<td>Agra</td>
<td>36</td>
<td>VIII</td>
<td>86 VII</td>
<td>VI</td>
</tr>
<tr>
<td>Allahabad</td>
<td>47</td>
<td>VII</td>
<td>81 VIII</td>
<td>VIII</td>
</tr>
<tr>
<td>Nainital</td>
<td>4</td>
<td>IX</td>
<td>11 IX</td>
<td>IX</td>
</tr>
<tr>
<td>Jhansi</td>
<td>2</td>
<td>X</td>
<td>8 X</td>
<td>X</td>
</tr>
</tbody>
</table>


Total area under cane in Uttar Pradesh in 1901 was 12,12,594 acres as against the all India average of 25,22,442 acres and represented a percentage of 50.4. The area went down to 11.20 lakh acres in 1908-09, but the percentage remained the same, as the total Indian acreage also went down in that year. In 1921, the cane area of this State was 12.85 lakh acres, which represented 46.4 per cent of the all India acreage of 27.47 lakh acres. The first condition laid down by the Fiscal Commission for the grant of protection was, that the industry must possess natural advantage such as abundant
AREA UNDER SUGARCANE.

MILLION ACRES

supply of raw material, cheap power and a sufficient supply of labour. The Indian Tariff Board, 1931, found that cane areas were sufficiently concentrated for the manufacture of white sugar on an economic scale in Punjab, Uttar Pradesh and Bihar etc., where the working season of the mills could be extended to 120 days, a period which permitted of economic working at that time. The assessment of the Board proved true as by 1935-36, the cane acreage increased to 22.49 lakh acres, representing a percentage of 55.95, against the total Indian acreage of 40.20 lakhs. In 1936-37, that is, a year before the appointment of the next Tariff Board for the Sugar Industry, it was found that the area of this State and the Indian Union had increased to 25.15 lakh and 45.62 lakh acres, respectively. By 1940-41, the cane area in Uttar Pradesh had touched the figure of 25.59 lakhs against the all India figure of 45.59 lakh acres. The following table shows that with regard to cane cultivation, the State has always maintained its position of contributing 50 per cent and more to the total cane acreage of the Indian Union.

Table No. III - 2
Statement showing the cane acreage of Uttar Pradesh and the Indian Union.

<table>
<thead>
<tr>
<th>Year</th>
<th>Indian cane acreage (000 acres)</th>
<th>Uttar Pradesh cane acreage (000 acres)</th>
<th>Percentage of Uttar Pradesh acreage to Indian acreage.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1943-44</td>
<td>2517</td>
<td>2239</td>
<td>61.9</td>
</tr>
<tr>
<td>1948-49</td>
<td>3745</td>
<td>2116</td>
<td>56.5</td>
</tr>
<tr>
<td>1953-54</td>
<td>3498</td>
<td>1973</td>
<td>56.4</td>
</tr>
<tr>
<td>1964-65</td>
<td>6285</td>
<td>3432</td>
<td>54.5</td>
</tr>
</tbody>
</table>

( Diagrams also at No. III and IV )


How far the cultivators had welcomed the grant of protection
PRODUCTION OF SUGARCANE.

IN TERMS OF CANE.

MILLION TONNES

1950-51 54-55 56-57 58-59 60-61 62-63 64-65

ALL INDIA

SUB-TROPICAL REGION

TROPICAL REGION

UTTAR PRADESH

BIHAR

MAHARASHTRA

ANDHRA PRADESH
and the establishment of sugar factories in Uttar Pradesh is evident from the fact that majority of then left cotton cultivation which was the major crop in this State. The cotton crop had an area of 10.46 lakh acres in 1900-01, which represented 3 per cent of the total cropped area of the State in that year. The sugarcane also represented about 3.51 per cent of the cropped area at that time. By 1935-36, that is, on the eve of the formation of the second Tariff Board for the sugar industry, area under the cotton crop shrank to 1.65 per cent or 6.87 lakh acres, while area under the cane crop increased to 6.19 per cent of the total cropped area in the State.

By 1951-52, that is, on the eve of the First Five Year Plan, the cotton area in the State went down to 1.93 lakh acres or 0.47 per cent of the total cropped area, whereas the sugarcane area rose to 7.53 per cent of the cropped area. This position still exists in the State.

Within the State, Bareilly Division in the western Uttar Pradesh has topped in regard to cane cultivation. Statistics show that in 1901, only 54 acres were being cultivated per 1000 persons in this Division, but by 1918-19, this figure rose to 77. Immediately after the grant of protection to the sugar industry, the cane area available per 1000 persons touched 93 acres. By 1951, the area again rose to 122 acres per 1000 persons. During the 1961 census, it had a cane acreage of about 140 acres per 1000 persons. The majority of the sugar mills in this Division, therefore, had a longer crushing period, as the yield and the quality of cane cultivated in this tract proved better than that grown in other regions of the State. The main reason for the increased cane cultivation in this tract has been the facilities for irrigation from the canals, tube wells and wells. Sugarcane is cultivated with the help of irrigation mainly in Jaunsi, Varanasi, Allahabad and Agra Divisions. In the Kolkhband Division,

cane cultivation is carried through mainly on rainfall, as other
artificial irrigation facilities are not available in plenty for its
cultivation. As compared to Uttar Pradesh, the Bombay and Madras
canes are cultivated mainly through irrigation, the percentage being
93.4 and 95.4 respectively. The irrigation facilities are dearer
in both these States.

Cane Varieties of Uttar Pradesh:

The varieties of cane in Uttar Pradesh were classified into
3 broad categories before the introduction of improved varieties of
Coimbatore canes. These were (i) Uch canes, (ii) Ganna races and
(iii) Paunda canes. Uch canes were cultivated for the manufacture of
sugar exclusively, while ganna races were usually cropped for chewing
purposes. These were, however, utilised for the manufacture of sugar
in Cawnpore, Rohilkhand, Gorakhpur and Banaras Divisions. These canes
were found later on, as susceptible to fungus diseases like 'Red rot',
Saut etc. The Paunda canes had been imported in this State and were
usually cultivated in the vicinity of the towns for other commercial
purposes only, but not for the manufacture of white sugar.

In addition, other types of canes for example, Dhauli, Matna,
Kuswar, and Red ukh, were also cultivated. Of these, the Kuswar canes
gave juice rich in crystalline sugar, and were highly prized on that
account, by the owners of the refineries. This group consisted of
canes like Mango, Bharanga, Reora, Dhaora, Hemja, etc. Reora, Kew hi
and Hemja canes were considered to be the juicy canes and yielded 50
to 60 per cent juice. The red canes, Saratha, Jandarria, Gajala and
Tewari compared favourably with these canes in juice, but the gur
obtained from them was of inferior quality and of dark colour. These
canes gave yields as follows:

(12) Sugar Industry in Uttar Pradesh, 1902 - S.M. Hadi.
Table No. III-5
Statement showing the yields obtained from different kinds of Deshi cane.

<table>
<thead>
<tr>
<th>Cane</th>
<th>Quantity obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemja</td>
<td>71 maunds gur per acre - cultivated in Gorakhpur Div.</td>
</tr>
<tr>
<td>Pansari</td>
<td>49 to 60 maunds gur per acre - cultivated in Ballia and Chasipur.</td>
</tr>
<tr>
<td>Kinara</td>
<td>39 to 40 maunds gur per acre - cultivated in Meerut and Rohilkhand.</td>
</tr>
<tr>
<td>Saretha</td>
<td>38 to 42 maunds gur per acre - cultivated in Meerut Div.</td>
</tr>
<tr>
<td>Kuswar</td>
<td>35 to 44 maunds gur per acre - cultivated in Sultanpur and Partapur.</td>
</tr>
<tr>
<td>Sarauti</td>
<td>35 to 40 maunds gur per acre - cultivated in Banaras and Gorakhpur.</td>
</tr>
<tr>
<td>Phaur</td>
<td>35 to 55 maunds gur per acre - cultivated in Agra, Meerut and Rohilkhand.</td>
</tr>
<tr>
<td>Chin</td>
<td>26 to 35 maunds gur per acre - cultivated in Eastern Doab.</td>
</tr>
<tr>
<td>Satna</td>
<td>30 to 40 maunds gur per acre - cultivated in Oudh and eastern part of Doab.</td>
</tr>
</tbody>
</table>

The highest juice yielded was by the Saharanpuri paumad, which gave 77.39 per cent juice.

Side by side, improved cane released by the Cane breeding stations at Coimbatore and Shahjahanpur, were also being cultivated in factory farms, and by the local farmers. While giving evidence before the Indian Sugar Committee, 1920, Mr. S.C. Burt, the then Deputy Director (Cane Culture) Central Circle, Uttar Pradesh, informed that in Sitapur and Kheri, an improved variety of cane, Jaw-35, was being cultivated along with the thick paumad canes. In the Bundelkhand Division, Jaw-35, and Asny Mauritius, canes were also being cultivated. In Shahjahanpur, mixture like Satna-Rakhra, Bikshin-Barakhan, Dhauli-Agnali and Kator-Ghami, were isolated for cultivation for cotton canes. The Dhauli-ghami mixture was the favourite and gave higher yields of cane. The Indian Tariff Board, 1931, observed that area under improved varieties of cane was largest in Uttar Pradesh, and in the State it was highest in Rohilkhand Division, amounting to 73
per cent in the Pilibhit district. The State had 20.6 per cent of the cane crop under improved varieties in 1929-30, and this percentage rose to 99.2 by 1938-39. The improved varieties grown were mainly Co.213, Co.312, Co.313, Co.385, Co.331, and Co.356 etc. These varieties gave between 500 to 800 mounds of cane per acre. After a series of trials, the following varieties of improved cane were released for general cultivation in Uttar Pradesh:

1. Western Range: Co.313 (early), Co.385, Co.421, Co.453 and Co.245
2. Rohilkhand Range - Co.313(early), Co.76, Co.527 and Co.421
3. Central Range - Co.313 (early), Co.385, Co.527, Co.421, Co.109 (including Bannarai) and Co.453
4. Id-Eastern and Eastern Ranges: Co.313(early), Co.385, Co.527, Co.421, Co.453, Co.370, and Co.455.

Co.76 was one of the most remarkable varieties which gave good yield with a high juice quality, and was found most suited for the Tarai areas. Co.3 245, had proved an excellent substitute for Co.312, in the Western Range. Co.421 did well in almost all the areas and gained favour with the cultivators. The burden of the main season's factory crushing was carried largely by Co.421.

Co.453 and Co.513, were occupying large areas in the Gorakhpur and Moradabad districts of Eastern Uttar Pradesh, respectively. They succumbed to 'Red rot' and were replaced by Co.3 443 and Co.416 in 1953 and 1955, respectively. Co. S. 443, was a solid, mid season cane, with a heavy juice yielding capacity. Co.5 416 was a thin, early maturing variety with good tonnage and high sucrose contents. Similarly, Co.453, was replaced by Co.951 in 1959-60, in the Western Uttar Pradesh. Again Co.975, which is a cross of Co.527 X Co.617, was released in 1960-61 for cultivation in the West Uttar Pradesh.

comprising the districts of Dehra Dun, Saharanpur, Kasauli, Meerut and Bulandshahr. It was found to give an average of 800 maunds yield per acre. Further, trials made at the Indian Agricultural Research Institute, New Delhi, which has a sub-tropical climate, proved that 2 new varieties, Co.647 and Co.797, were the most outstanding canes and had out-yielded Co.312, not only in quantity but in juice also. Co.797 gave 92.39 per cent and Co.647 gave better results. The list of improved varieties was further supplemented and more additional varieties were added. Co.510, Co.527 and Co.859, were released for general cultivation for the whole of Uttar Pradesh, as early varieties. Co.3.416 was found more useful for the soils of the Eastern Uttar Pradesh, and was released as an additional variety for districts of Gorakhpur, Deoria, Saharan and Basti. For Bareilly, Lucknow, and Fyzabad districts, Co.3.443, Co.356 and Co.17 were accepted as 'Midseason and late varieties' for the whole of the State. Co.3.109 was released for the eastern districts and Co.3.245 and Co.356/Co.975 etc. for the Western districts of this State as 'midseason and late varieties'.

The above details show that the domestic production of cane was sought to be increased by two methods (i) by the adoption of improved varieties and production techniques, which result in higher output per acre, and (ii) by development of additional land. The first method holds immediate promise in most areas, but in this case the cultivators have to be given considerable technical assistance to enable them to know the behaviour of the seed, the fertilizer and the pesticides etc., and thus to adopt a combination of improved practices. At the same time, the cultivators have also to be convinced.

that every new technique is an economic proposition. (18)

Now we revert to the question of the practicability of effecting a rise in the cane crop. The low crop-producing capacity of cultivated lands in Uttar Pradesh, in fact, constitutes a major practical problem in this respect, and this fact has repeatedly been stressed in various plans and programmes for stepping up the production. The crop yields have stabilised at a very low level in this State, with the removal from soils of plant food nutrients, by growing of crops from year to year. The soils have not been replenished in the required quantities and the weak soil does not yield the optimum crop. One of the most excellent methods of improving fertility status of the soils is that manures and fertilisers should be added to it, as required by the crops. These fertilisers will add to the soils essential plant nutrients, that have been exhausted as a result of cropping. This brings forth the examination of the capabilities of various nutrient components, which help in increasing the cane yields.

Nitrogen is one of these elements of plant food, which is essential for growth. If it is present in insufficient quantity for normal growth, then the deficiency manifests itself in the stunted appearance of the plant. Other essential substances such as potash, phosphate and Lime occur in the mineral form, and are freed by the chemical and physical action of natural solvents. Nitrogen, however, must be obtained by its conversion, either as a gas from the atmosphere into a state of solid combination or by the oxidation of humus by agents in soil. Nitrogen is of special importance because it is an essential plant nutrient, expensive to supply and it is easily lost.

Vol. 8 page 180
(18) Practical Contribution of Agriculture to Economic Growth in Less Developed Countries, 1960 - Sherman R. Johnson - page 52
from the soil. Most of the nitrogen fertilisers applied at present are in inorganic form, but there are also some important organic sources such as Urea and Calcium and Calcium cyanamide, which have been found to give better results for the plants. Of all these types, such of the nutrients which are cheap and otherwise more efficient, have to be selected, so that the cost of these fertilisers does not go up, in relation to the yield that has to be obtained with their use.

The application of fertilisers for raising the growth of plant is not a new scientific invention. From times immemorial, the practice of applying organic manure such as PARI YARD MANURE (PUM) for crop production has been recognised and it has become one of the routine methods of agronomic practices. The 'AGHIPURANA' contains the following directions in this respect:

"A tree becomes laden with flowers and fruits by manuring the soil with powdered barley, sesame, and apal matter of a goat mixed together and soaked in washings of beef for 7 consecutive nights. A good growth of tree is secured by sprinkling them with the washings of fish."

Again there are directions for manuring the fields in the ARTHASHASTRA as well as follows:

"The seeds of grain are to be exposed to mist and heat (tumurpayyanas Janamam) for seven nights; the seeds of kadi such as munga, maza etc., are treated similarly for three nights; the shoots of sugarcane and the like (kandabija) are plastered at the cut end with a mixture of honey, clarified butter, the fat of hogs and cow dung; the bulbous root (kanda) with honey and butter; cotton seeds with cow dung and water pits at the roots of the trees are to be burnt and manured with bones and cow dung at proper seasons. The sprouts of seeds when grown are to be manured with a fresh haul of very small fish and irrigated with the milk of SHUHI (Euphorbia antiquorum)."

(20) The Journal of Agricultural Science - 201 page
(21) AGHIPURANA - Translation by M.N. Butt Vol. II page 1058
(22) Dr. Bhavan Shastri's Translation - 2nd Edition page 141 (adopted from the 'Agriculture in Ancient India', 1964 - an I.C.A.I. publication.)
Research work on nitrogen manuring of sugarcane in India was started as early as 1945, the first experiment having been conducted in Bengal. Since then, much work on fertiliser application to various soils has been done. The consensus of opinion of sugarcane agronomists and soil chemists even now is, that one half of the total nitrogen requirements of sugarcane should be given in organic form such as FYM, oil cakes and green manures, so that the fertility of the soil remains intact and it gives better yields of cane. HARRISON, estimating the crop of cane at 25 tonnes stripped cane and 15 tonnes tops per acre estimated, that the crop took away 44 lbs Nitrogen, 44 lbs Potash and 25 lbs Phosphates per acre. In this estimate, the bagasse, the ashes and the filter cakes were not counted, as they were supposed to have returned to the soil, and allowance was made for these (23) constituents. According to BARNES, the cane crop of 50 tonnes removes from the soil 75 lbs Nitrogen, 50 lbs Phosphates and 150 lbs Potash and if succeeding crops are to be obtained in full quantities, these nutrients must be returned to the root zone of the cane. In Uttar Pradesh, it was estimated that a crop of 20 tonnes of sugarcane removed from the soil, 94 lbs nitrogen, 30 lbs phosphates and 42 lbs of potash. At this rate, a total of 16,030 tonnes nitrogen, 5116 tonnes phosphoric acid and 7,653 tonnes of potash was depleted from the soil every year. In terms of fertilization, this will be equivalent to 30,152 tonnes of ammonium sulphate, 31,975 tonnes of superphosphate and 11,941 tonnes of muriate of potash. But the figures show that the overall consumption (for all the crops that is, wheat, rice, cane etc.) of fertilisers in Uttar Pradesh in 1956-57 was 97,317 tonnes of ammonium sulphate, and 3,762 tonnes of superphosphates only. With these

(23) Sugar Cane., page 154
(24) Agriculture of the Sugar Cane, 1953, F.C. Barnes, page 154
inadequate supplies of nutrients, the average cane production stood at about 15 tonnes per acre only.

Phosphorus is another major plant nutrient and is next to nitrogen in the Indian agriculture. Its need has been recognised in manuring practices along with nitrogen under intensive practices aiming high production. It does not leach out or leak but sometimes gets fixed with soil, thus rendering it unavailable to the crop. In the comparative studies of Indian soils about phosphate fixing capacity, it has been found that clayey soils have high fixing capacity and that free lime in soil (calcariou soils) tremendously increases the fixing capacity. It was further observed that in Uttar Pradesh, there has been no response of phosphate and the trend of yields did not show any sign of depletion even after 15 years of cropping. It was also found that in the North Eastern districts of Uttar Pradesh, continued application of nitrogenous and phosphatic fertilizer indicated beneficial response, while in the rest of Uttar Pradesh, Punjab etc., phosphate showed no effect on the yields of cane. The results of long term N.P.K. trials conducted at Shahjahanpur failed to bring out the utility of superphosphates to cane crop, either applied alone or in combination with a monam sulphate or potassium sulphate or both.

The evidence that has accumulated during the last century has revealed that the relation of the plant to the soil is highly complex. It has also been confirmed that as the soil fertility is influenced by its mineral make up, the use of chemical fertilizers or organic manures for crop response, will be economically wrong, till these have been found with the help of soil experiments. It, therefore, follows that the future salvation of Uttar Pradesh's nitrogen economy lies in nitrogen fixing of the soils, with regard to their various

requirements.

SOILS OF UTTAR PRADESH

From the above paragraphs it is evident that soil is the most important natural resource of the country for the production of the raw material and in ample quantities, and that its intimate knowledge is a pre-requisite in any national development plan. A survey of the soils of Uttar Pradesh was, therefore, undertaken to find out its mineral capacities. It was found that except Jamnagar, Amarnath and Dehra Dun, the rest of the State was not deficient in Potash. A phosphate deficient belt existed in the North Western parts of the State comprising the districts of Sillahit, Bareilly, Moradabad, Meerut, Rozaffarnagar, Saharanpur, Bijnor. Further north, the soils of the districts of Dehradun and Haridwar were moderately rich in phosphoric acid. It was also found that the soils of the districts of Bijnor, Lucknow, Sitapur and Kanpur districts were comparatively poorer in phosphates, but those of Hardoi and Baramati possessed good phosphoric quantities. Jajnapur, Gonda and Gorakhpur are generally deficient in phosphate while Azamgarh and Basti are fairly rich in this matter. It was further found that the soils of Uttar Pradesh as those of other India States, were particularly deficient in Nitrogen. On an average, the N content of the soil varied from 0.03 to 0.15 per cent.

The optimum dose of Nitrogen for sugarcane in Uttar Pradesh soils has been found to be about 120 lbs N/acre. The most suitable combination is organic nitrogen (green manure plus FYM or Press cake) to supply 80 lbs N and light organics (oil cakes) and inorganic fertilizer (ammonium sulphate) to supply 40 lbs N per acre. The minimum
requirements of N per acre have been suggested to be 80 lbs. The requirements of soils of each district are detailed in the statement at Appendix IV. The best time of application for FYM, compost, press mud and molasses is about 1 and 1/2 to 2 months before planting cane, and inorganic fertilizer at planting time or soon after germination. Late application of N at the break of rains or later has been found to delay maturity of canes. It was confirmed that response to nitrogen on sugarcane was quite high in North India, and the optimum dose was 125 lbs N per acre. For South India, the dose was taken to be twice that of Northern Indian soils. Further, response to the optimum dose of N in North Indian States has been found to yield 21.32 tonnes cane per acre which was found to give a net profit of Rs. 221.1 (27) paisa per acre to the cultivator. In fact, 120 lbs N per acre gave significant results on the height of cane with good yield.

The two fold effects of increasing doses of nitrogen, firstly in increasing the cane yields and secondly in decreasing the sucrose per cent juice, has been experimented and accepted. A point was, therefore, required to be reached where the out-turn of sugar per acre was the maximum and beyond which any application of nitrogen was found to be unproductive and uneconomic. This economic level of N application has to be worked out for individual soil types. An attempt was made to determine the optimum dose of N for the respective tracts by employing graded doses of N at Shahjahanpur, Musaffarnagar and Gorakhpur, and the results achieved are as follows:

Table No. III-4
Statement showing the results of Manurial trials in Uttar Pradesh.

<table>
<thead>
<tr>
<th>PARTICULARS</th>
<th>SHOAIB ANPUR</th>
<th>Gopalpur</th>
<th>Muzaffarnagar</th>
<th>Gorakhpur</th>
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<tr>
<td><strong>SHOAIB ANPUR</strong></td>
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<td></td>
<td></td>
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<tr>
<td>0</td>
<td>60</td>
<td>70</td>
<td>80</td>
<td>90</td>
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<tr>
<td>Average cane yields in mds/acre</td>
<td>426</td>
<td>541</td>
<td>553</td>
<td>605</td>
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<td>Average sucrose per cent cane</td>
<td>15.6</td>
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<td>Sugar outturn in maunds/acre</td>
<td>45.9</td>
<td>56.3</td>
<td>66.0</td>
<td>63.0</td>
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<tr>
<td><strong>MUZAFFARNAGAR</strong></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>0</td>
<td>60</td>
<td>80</td>
<td>100</td>
<td>120</td>
</tr>
<tr>
<td>Average cane yields in mds/acre</td>
<td>749</td>
<td>853</td>
<td>833</td>
<td>913</td>
</tr>
<tr>
<td>Average sucrose per cent cane</td>
<td>13.29</td>
<td>12.98</td>
<td>12.69</td>
<td>12.66</td>
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<tr>
<td>Sugar outturn in maunds/acre</td>
<td>65.6</td>
<td>73.2</td>
<td>69.6</td>
<td>76.5</td>
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<tr>
<td><strong>GORAKHPUR</strong></td>
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<td></td>
</tr>
<tr>
<td>0</td>
<td>40</td>
<td>80</td>
<td>100</td>
<td>120</td>
</tr>
<tr>
<td>Average cane yields in mds/acre</td>
<td>478</td>
<td>525</td>
<td>543</td>
<td>603</td>
</tr>
<tr>
<td>Average sucrose per cent juice</td>
<td>15.77</td>
<td>15.93</td>
<td>16.22</td>
<td>15.32</td>
</tr>
<tr>
<td>Sugar outturn in maunds/acre</td>
<td>51.61</td>
<td>57.3</td>
<td>60.5</td>
<td>63.2</td>
</tr>
</tbody>
</table>

Sources: Manuring of sugarcane - A Critical Review, 1950
B.K. Mukerjee and Gajendraksh Verma: Pages 46-49

**MANURIAL TRIALS FOR RAISING CANE YIELDS:**

Experiments with different kinds of manures and fertilizers have been conducted in the past in Uttar Pradesh, for testing their suitability for cane under diverse soil and climatic conditions. Some
of the earlier experiments on sugarcane in Uttar Pradesh were carried out at Kanpur, between 1897 and 1903 with salt petre, castor cake, cow dung, powdirette etc (in doses 125 lbs N to 500 lbs N per acre) and in 1910 with calcium cyanamide, calcium nitrate and farmyard manures. Apart from general indication, no definite conclusions were reached with those experiments. Later experiments conducted at Kanpur (1926-31) with bonemeal, cowdung and different kinds of oilcakes, had shown some effect (about 14 to 30 per cent) in the cane yield by the application of mustard cake and castor cake.

Experiments on sugarcane with different manures were also conducted between 1923-31, at Aligarh, Musaffarnagar, Shahjahanpur, Sorakhpur and Pratapgarh. Ammonium sulphate, potassium sulphate, nitro chalk and bonemeal were found good for sugarcane at Aligarh, castor cake and neem cake at Pratapgarh, green rotted water bycynth and drywater bycynth at Sorakhpur and ammonium chloride, bonemeal and nitrophoska (28) at Musaffarnagar. Experiments conducted at Shahjahanpur with SANAI increased cane yield by 33 per cent. A number of experiments were carried out with Bulky organic manures like FYM, farm compost, molasses, press mud, cattle urine earth, etc., during all these years. It was found that FYM when applied alone in equal N basis, was inferior to sulphate of ammonia or its mixture with sulphate of ammonia. Experiences gained at Shahjahanpur and Musaffarnagar show that even the lower dose of sulphate of ammonia (60 lbs N) gave better cane yields than the higher N dose (100 to 120 lbs) as FYM, molasses applied 6 to 8 weeks before planting at the rate of 100 lbs N, gave consistently better results than that of ammonium sulphate or cakes. Roughly, the response was about one

\[ \text{of cane for 2 mounds of molasses applied. Sulphatation press} \]

Mud applied at Shahjanpur increased yield by 28 per cent as compared to 70 per cent by ammonium sulphate. At Gorakhpur also, press mud (150 lbs N per acre) gave as good results as ammonium sulphate or ammonium nitrate during 1947-49. In general, bulky organic manures do not delay maturity of cane to the extent the inorganics do.

Further, Uttar Pradesh has got about 30 to 50 per cent of its cane under ratoons. It was established that every lb of N applied to ratoon crops at Shahjanpur gave 2 maunds increase in yield of cane, while at KALAI, the increase obtained was 3 maunds a lb. Ratoons mature earlier than plant cane and give better juice quality in the earlier seasons as compared to the plant cane. Amongst the Coimbatore cane Co3.245 and Co3.321 were found most suitable ratoons for different soil centres in Western Uttar Pradesh, and they yielded over 1000 and 900 maunds cane per acre, respectively. The data collected shows that 140 lbs N per acre applied in the form of cakes and ammonium sulphate on 50:50 basis, appears to be the optimum economic dose for the first year ratoon.

Experiments have shown that under drier conditions of the Central and Western tracts of Uttar Pradesh, flat planting proved better than trench planting under normal standards of cultivation, while reverse was the case under intensive cultivation. In more humid tracts of Uttar Pradesh, trench planting proved better even under cultivation standards.

The preceding paragraphs show that in Uttar Pradesh every effort has been made to increase the yield of cane by various methods.

(29) Use of Organic Manures in Uttar Pradesh, Leaftet No. 41 - Department of Agriculture, Uttar Pradesh

means that is, by the use of different types of manures and fertilizers, by the change of irrigation methods and by the change of cultivation programmes. But with all these efforts, cane yield has not gone up except in few individual cases, where the cultivators have successfully obtained the yields with their personal efforts. The reason being, that the general cultivator does not replenish the soil with manures, seeds and the irrigation that the soils require. In addition, diseases, pests, etc., tell upon this crop and further reduce the yield to some extent as mentioned in the following paragraphs:

**Loss of Cane due to Pests and Diseases**

Pests and diseases of sugarcane are responsible for the losses in various segments of the world's sugar industry, and the services of the Pathologists and Entomologists that have protected or saved the sugar cane from extinction, are commendable. SCERA reports the earliest mention of diseases in Buddhist writings. A disease is manifested by a deviation from the normal functions or structures in the plant. It is usually recognized by structural changes, depressed growth, development of abnormalities, the presence of spots, stripes, blotches etc., of the plant. These affect not only the quality of the plant but its yield also. Attempts to clarify the cane diseases on the basis of the part affected are not successful with sugarcane, since many diseases affect several parts of the plant at the same time. However, these have been grouped as follows, according to casual agents:

1. **Virus or probable virus diseases.**
   - Chlorotic streak, ratan stunting, mosaic, Fiji and dwarf etc.

2. **Fungal diseases.**
   - Pineapple, yellow spot, pokkah boeung, stem rot, downy mildew etc.

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3. Bacterial diseases
   Leaf scald, red stripes or top rot etc.

4. Cane killing weed.
   About 25 types of cane diseases are common in Uttar Pradesh, but mosaic, red rot, wilt, smut, stinking rot etc., cause appreciable damage to the crops of susceptible varieties. Details of some of them are given below:

MOSAIC: The disease has been known for many years in Java in the name of 'COLE STRIPTÈRI FTE'. It was first mentioned in print by Van Han Cheesbrough in 1892. In Hawaii, it was known as 'Yellow stripe' in 1908, and all the cane varieties were found susceptible to it. The cane mosaic is not inherited through true seed, but is carried around in infected material. It is highly infectious. This disease reduced cane yield by 40 per cent in Porto Rico in 1917 and in a well fortified farm by 20 per cent in that country. The control of mosaic has outstripped the scientific knowledge and more than 1900 commercial varieties fell prey to it. In 1925, this disease attacked the following varieties in Uttar Pradesh:

- Aligarh Agricultural Farm: Co.213, Co.232
- Bulundshahr: Co.213, Co.232 and Co.281
- Kalai Demonstration Farm: Co.213, Co.48, B.6308, Mauritius 16 etc.

It was first noticed at Pusa in 1921 by Bastur and was subsequently recorded authentically by M.C. Rae. It was also recorded on P.O.J. 2876, Co.354, Co.427, Co.3. 17 and Co.119 and on 'Shakar Chiniya' and 'Bashiri' canes. At Shahjahanpur alone, a loss of yield of cane by 10 per cent was recorded on Co.213 and Co.313. Turka Saharanpuri registered a reduction of 18 per cent in weight, as a result of the attack of this disease.

Red rot is a serious disease of sugarcane. It causes a rot of seed cuttings that commonly result in weak stand of plant cane. This disease causes loss of sucrose in the mill canes, as the diseased canes usually get further attacks from sugarcane moth borers. The diseased canes fell an easy prey to the pests which devour the sucrose contents and leave the cane entirely blank from inside the stalks. As a seed rotting disease, red rot is hard to control. Red rot develops within the cane stalks but under certain conditions or in later stages of the disease, the fungus breaks out to the surface and feeds on the sunken cankers of the stalk. In India, it is of principal importance as a disease of standing crop in the field. In Louisiana, it is primarily a disease of seed cutting. While in Florida, it is for both seed and crop. In Tropical countries, it is of minor importance, but it attains severity in subtropical areas, particularly in India, Louisiana and Australia. In these countries, it is one of the most important diseases and often the limiting factor in cane cultivation.

Epidemics of red rot are not novel in India. In 1902, cane in Godavari delta was attacked. In 1906, the disease occurred in a severe form in Chamaran and at saffarpur. Later at Ferosepur in the Punjab, cultivation of thick canes had to be abandoned due to its presence. In 1932, this disease damaged the crop of Co.210 at Fusa in Bihar. According to 'Chona and Padwick', the disease caused an "almost complete devastation of thousands of cane fields of the predominant commercial variety of Co.213 in the affected parts", reducing the cane yield by about one third to one half.

(35) Sugarcane and its Diseases, 1959. Edgerton page 69
During 1938-59, a red rot epidemic of unprecedented severity occurred in sugarcane in Uttar Pradesh and Bihar, resulting in the failure of the most predominant commercial variety, Co.213. This epidemic completely routed out this variety from this tract. It was replaced by other Coimbatore varieties like Co.299 and Co.331, but these too became heavily infested with red rot and went out of cultivation in the later years. During 1946-47, red rot epidemic flared up again in Uttar Pradesh, chiefly affecting Co.312, and an indigenous variety Manehuh. The epidemic this time did not confine itself to Eastern Uttar Pradesh only, but engulfed the Central and the Western tracts of the State, where Co.312 was the chief commercial cane variety. In 1957, red rot again broke out and in this flare up, the top cane variety of Uttar Pradesh, that is, Co.453 which had carried the sugar industry in this State for 10 years through worst post-war periods of commodity shortage in Northern India, was seriously damaged. B.0.11, another cane was also badly damaged. To overcome the shortage of cane for the sugar industry in Uttar Pradesh, and to fill the vacuum created by the loss of the popular varieties, the best available varieties like Co.443, Co.514, B.0.17 and Co.L.29, pressed into service. There is no other alternative now but to depend upon the new cane and to improve them further, as the State cannot afford to lose its long established industry.

In addition to red rot, other similar disease like top rot and stinking rot have also attacked canes in Uttar Pradesh at various intervals. Stinking rot appeared in 1933 on Co.300 and Co.313 at the Musherri Sugarcane Station. In Uttar Pradesh, it has盛es on The Diseases of Sugarcane in India, a monograph Resistance of Sugarcane Varieties to Red rot - B.K. Chauta, M.Sc., Ph.D. - Ed. Jour. of Agri. Science, Vol. XXIV, 1954 page 301 (38) Position of Uttar Pradesh in Cane Cultivation - Indian Sugar-Mill, 1961, pages 127-131
been found on Co.419, Co.311 and Co.325 also.

Top rot causes torn leaves, rots the young internodes, makes the older internodes hollow and often makes the stem look shrunken to nothing. According to the reports of the Agricultural Department Uttar Pradesh, this disease is commonly found in the western tracts of the State. Since 1947, more than 10 per cent loss in weight has been observed in Co.312, Co.464, Co.245, Co.222 and Co.370. In 1955, it was observed in these cases, but the damage was not appreciable in any tract on account of the recovery of the crop after the monsoon.

**SUGARCANE WILT.** It is caused by the fungus 'Cephalosporium Sacchari', which causes the rotting up of the stalks and the wilting of the cane. It was first recorded in India, in 1906. In Uttar Pradesh, it was commonly found in association with red rot in Roa, Shahganj, Gola, Biswan and Ghugli in 1950-51. At Bargaon alone, the wilt caused appreciable damage to Co.453 and Co.421. The infection here was widespread and in the highly affected fields, it was about 10 per cent. Co.356 suffered severe damage from it in Sardarnagar, where it was aided by the stem borer.

Today in the Gangetic States, red rot is not the only problem. Wilt has attained importance as a prevalent major disease. It is not as spectacular in its outbreaks and effects as red rot is, but it is more insidious. These two diseases are not merely destroying the varieties sent out for cultivation, but are also instrumental in holding back good varieties from being released.

**SUGARCANE SMUT.** The common smut of sugarcane (also called carbon) is a disease of major importance in many countries including India. AhamPortrait, sugarcane Research Scheme, Uttar Pradesh, 1955 page 135.

India, China, Taiwan, Java, Mauritius etc. Smut is characterised by the production of a long whiplike structure from the terminal bud of the stalk. India has suffered severe losses on account of this disease.

After red rot and wilt, this is another serious disease of sugarcane in Uttar Pradesh. The varieties like Co.513, Co.313, Co.301, Co.290 and desi varieties have been badly affected by it. The affected ones become thin and assume abnormal height. The juice becomes dry and the weight of the cane is reduced. The recovery of sugar becomes low. In 1948, losses due to this disease were as follows:

1. Gauribazar, Bulsipur, Co.513 20 per cent
2. Shahsajan ur Co.312, Co.421 5 per cent
3. Varamasi (Bamars) Co.300 60 per cent
4. Piyzabad Co.301 40 per cent.

In 1954, it was found that the disease was widespread in the western range of the State. In the affected fields of the plant cane, it ranged upto 5 per cent. In the ratoon, the usual intensity of 2 to 10 per cent was common although in the worst affected fields the intensity of diseased clumps was from 5 to 25 per cent. Co.321 particularly its ratoon, suffered heavily although Co.524, Co.453 (41) and Co.393 etc were also affected with this disease.

Co.313, Co.393, and Co.321 have shown the highest infection and Co.527 and Co.K.30 the lowest. Wind plays an important part in carrying over the infection. 'Albino' disease also attacked Co.5245 along with the smut and it is losing ground. In the circumstances, another variety Co.1007, has been released in Uttar Pradesh to take place of Co.5.245.

The disease is in severe form in western Uttar Pradesh mainly in Meerut and Muzaffarnagar districts. Here the intensity of infection has been found to be up to 15 per cent in plant and about 50 per cent in the ratoon cane crops.

In addition to the above mentioned diseases, there are many more diseases like leaf scald, eark, fiji, ratoon stunting, eye spot, etc., which also cause losses. Leaf scald is found with an elongated narrow, white to yellow stripes on the leaf blades. It makes the cane juice poor in its sucrose contents. Ratoon stunting was first reported in 'Australia' from where it travelled to India. It discolours the vascular bundles and affects severely in successive ratoon crops. Harvest results from the plant crop trials show that varieties such as Pindor, K-Co.310, F.O.J. 2878, etc. suffered between 4.5 to 7 tonnes cane per acre.

Weeds: Cane yields have also been reduced by the weeds present in the cane fields. A weed can be defined as a plant that is growing where it is not wanted. These obnoxious plants interfere with the agricultural operations, increase operational costs and reduce yields. Nematodes and insects live and multiply on weeds. Under most condition, the greatest loss caused by weeds is in the reduced yields of crop plants, as these compete with them for soil moisture, nutrients and light. Some weeds have the capacity of obtaining their water and food directly from the crop plants rather than from the soil. It is here that the weeds not only take away these foods from the sugarcane, but also make the stalk weak by the insects it harbours and the stalk loses its strength and the sugar content by and by. This is a great economic loss to the cultivator and the

and the industry in the State. In India, a weed known as STRIGALUTEA and resembling the 'broom ree' is known as a frequent inhabitant of the cane lands.

**ECONOMIC LOSS DUE TO THE WEEDS:** The losses due to the weeds are far greater than actually realised. For instance, U.S. Chamber of Commerce listed 30 items of waste in the United States Agriculture of which 'as a problem' was second to the soil erosion. They put the losses caused by weeds to 3,000 million dollars which was more than the combined losses (2375 million dollars) caused by insect pests and diseases. In India, weeds have reduced crop yields by about 30 per cent in general. These losses are probably of much higher order in Kharif crops than that in rabi crops, because the warm humid weather favours the growth of weeds. As the most critical period of growth of sugarcane falls in Kharif season, effective control of weeds is most necessary for attaining high yields and economic production of the crop. VAN OVERBICK found that when weeding was neglected during the first 6 weeks of the sugarcane planting, even followed later by complete control, a reduction in yield of 45 per cent was experienced at harvest time. It was also found that complete neglect of weed control might result in 70 per cent of even more loss in the yield.

It was further confirmed by SHANNA and PADWICK that string weed reduced the yields of cane from 8 to 36 per cent. Another estimate placed it between 20 to 25 per cent. In unchecked weed competitions, the damage recorded was about 63 per cent in the cane crop.

**CANE PESTS:** Sugar producing countries are infested with a number of pests which have their feeding on the cane. Cane 'Mealybugs', cane grubs, sugarcane fly, leaf hopper (pyrilla) white ants or termites...
and moth borers are a few important pests that cause heavy damage to the cane crops. Cane grub plays havoc on the cane crop in Queensland. The names white ants or termites are usually associated with wooden buildings or standing timber, to which these pests cause a great amount of damage. When white ants succeed in establishing themselves in timber, they frequently leave nothing but a shell as evidence of their activities there. Sugarcane meets the same fate. The ants and termites make tunnels right up to the centre of mature sticks of standing cane, devouring the interior portion both above and below the ground. The most destructive insect pest of sugarcane throughout the sugarcane world is the 'Sugarcane borer'. Earlier, it was found that it had 18 species including the 5 varieties operating in Mexico and the Central America. GUPTA AND AVASTHY estimated that 14 to 40 tonnes cane per acre was lost due to the attack of these borers.

**LEAF HOPPERS:** These hopper attack the underside of the cane leaves and make minute punctures with their piercing mouth parts with which they suck the sap from the tissues. Their attack was so severe in Hawaii in 1905 that one plantation closed down and others faced closure due to it. It has become a serious pest of the cane in the districts of Musafirnagar, Meerut, Bulundshahr, Sitapur, Kheri and Gorakhpur in Uttar Pradesh. It has been found, that late ripening oats, early maize and jawar and shoots of retoom and October planted crops of cane are the main carriers of the pest from the preceding years crops. The juice has been reduced by 2 to 5 per cent and purity by 5 to 12 per cent. It has also reduced the sugar recoveries from 0.2 to 0.5 per cent below the normal recoveries, in the Western Uttar Pradesh.


(46) Comparative Efficiency of Various Insecticides against 'Sugarcane Leaf Hopper', 1957- D.K. Bhutani and K.L. Shanna
TERMITES: Termite or white ant damage on sugarcane is severe in India. Their damage starts with the planting of the seed cane in the soil and later in the season, they attack the cane shoots. As high as 60 per cent of the eye buds of sugarcane have been found killed by the termites. Two species viz. ODONTOTRICES OBESUS Ramb and O. ASSAMICA Hilgr occur commonly in Uttar Pradesh. In Western and the Central Uttar Pradesh, infestation of 15 to 20 per cent are commonly observed at any time. The weight of the termite infested cane is decreased by about 35 per cent in comparison with the healthy canes. A reduction of 1 to 4 units in sucrose contents was also observed in juice from termite damaged stalks of the canes. The average incidence of termite was found to be 15.8 per cent at Shahjahanpur, 4.9 per cent at Buzafarmagar and 20.7 per cent at Gorakhpur. It was also found that a reduction in sucrose per cent juice was 1.5 units at Shahjahanpur and 2.8 units at Buzafarmagar. This is a great economic loss both in weight and sucrose contents.

SUGARCANE BORERS: Sugarcane borers are a major problem to the sugar industry. They are widely distributed wherever sugarcane is grown, and having 4-5 broods a year, continue their depredation right from the germination till the harvest of the crop. Judging from the extent of loss caused by each of the three types of borers that is, Top Borer, Stem Borer and the Root borer, it was found that the loss in crop to mace was caused by the top borer, and heaviest loss in sucrose by the stem borer, while root borer, was middling in either respect. Annually, these borers reduce the crop yield to 8.17 per cent and sugar by 2.25 per cent per acre and these losses are on the increase.

(Uttar Pradesh and Bihar) were tested in 1937-38 and it was found that while there was a slight decrease in infestation in cane delivered to the Bihar factories (38.75 in 1938 against 41.32 in 1937), there was an increase in the Uttar Pradesh factories (31.10 in 1938 against 29.09 in 1937). The big rise in infestation which occurred between 1936-37 had been checked. The major loss to the factories lay in the reduction in the recoverable sugar in infected sugarcane. The percentage of sugar in the cane fell from 12.98 to 10.13 in 1937 and from 13.51 to 10.38 in 1938.

In Uttar Pradesh, there are at least 8 species of the cane borers, which attack sugarcane. Some of them as detailed below are active during hot weather on cane shoots while others come into prominence during monsoon and post monsoon period, when the growth of the cane is in full swing.

**TOP BORERS**: These are found in a caterpillar form and are destructive to young canes. During the first 5 months of the cane crop, young shoots are killed by this borer and the plant becomes weak. It was observed that this borer took a heavy toll of young sugarcane plants during the pre-monsoon period in Uttar Pradesh. Most of the damage was caused in the shoot stage of the crops.

**TOP BORER**: It is found principally at the apex of the cane boring through the growing joint and down the upper joint. Top borer kills the vegetative cane of the young as well as of old stalks. Young shoots always die, old stalks may die but often survive by producing one or more lateral shoots. In the last case, the loss of available sucrose is small as compared to the loss of sucrose in stalks dying without producing lateral shoots. Upto 1952-53, none of the insecticides tried proved effective against this pest. Preliminary

**Infestation and Disease Infection — A Cawse and J.H. Haldane — Agricultural Livestock in India, 1938 Vol.VIII page 503.**
trials carried out with malathion in August, 1953, gave hopeful indications as incidence of this pest was only 15 to 19.2 per cent in the treated crops as against 73 per cent in control and 49 to 60 per cent in the case of other treatments.

Another type of borer named PROCERAS INDICUS KAPUR was found in Uttar Pradesh. In 1954, it attacked the factory farm at Rosa at Shajahanpur. This resulted in a loss of 7.4 and 3.2 per cent in cane yield for autumn and spring planted canes respectively. Co.3.321 and Co.421 had very bad incidence - being to the tune of 64.8 and 69.2 per cent with a loss of cane yield of 15.8 and 14.7 per cent respectively.

STEM BORER: This is the most widely occurring and destructive species. It is abundant in all parts of the tropical and sub-tropical countries, feeding and breeding freely on cane, but also attacking corn, sorghum etc. It is one of the most destructive pests of India. In the year of serial multiplication, as many as 20 per cent of the internodes in the attacked canes are destroyed by this pest resulting in a loss of about 33 per cent in yield and 12 per cent in sucrose contents. An estimated loss of 156 mounds of sugar per day in the mills at its average crushing of about 20,000 mounds cane per day was calculated in Uttar Pradesh. It was found in Barabanki in 1945, Gola and Kargaon in 1946, and it damaged a full crop in Jarwal Road zone in 1949.

In general, it was found that the extent of the borer infestation varied from 50 to 75 per cent in different years and it was responsible for decreasing the sugarcane yield by about 20 percent.

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(51) An Estimate of Damage Caused to Sugarcane by the 'Stalk Borer', 1957, G. Kularshetra and P.N. Avasthi.
and also adversely affecting the quality of cane by about 2 units in the sucrose in the juice. This infestation was found to be reduced under heavy application of nitrogen manures say 120 lbs in an acre in the western Uttar Pradesh. Co.5.298, 320,332,334,335,337,346,348, 356, 385, 411, Co.421, Co.513, Co.549, Co.617, Co.618, Co.621, Co.622 Co.643 and B.1. 3 were found highly resistant to this pest. It was also found that watering/waterlogging increased the borer attack 2 to 5 times more in comparison to that in a normal year. In brief, the average incidence of borer to millable cane in Uttar Pradesh during 1950-51 to 1960-61 was found to be 23.9 per cent and this still is so.

Position of Cane in General: There is a growing demand for the high yielding and disease resistant cane for the sugar industry in Uttar Pradesh. The yield of sugarcane per acre in Uttar Pradesh in 1930-31, that is, on the eve of the grant of protection to the sugar industry was 10.6 tonnes an acre. This yield increased to 14.5 tonnes per acre in 1935-36 and declined to 11.7 tonnes per acre in 1948-49. As compared to this figure, yield of cane per acre increased from 25 tonnes in 1935-36 to 31.9 tonnes an acre in Maharashtra in 1948-49. Similarly, Mysore and Hyderabad States also gained an increase from 10.4 tonnes and 16.8 tonnes per acre to 18.2 and 19 tonnes per acre respectively. Not only in cane yields but in sucrose also, Uttar Pradesh lagged behind the southern States. Yield of sugar per acre in Uttar Pradesh in 1932-33, was 3,263 lbs per acre. It went down to 2,643 lbs per acre in 1950-51. As compared to it 'Maharashtra' had 5,935 lbs sugar per acre in 1932-33, which increased to 6,653 lbs per acre in 1950-51. Similarly, Madras produced 6,276 lbs sugar per acre in 1950-51.

During the First Five Year Plan, some improvement in the
(52) Losses Caused by 'Bunt Borer' to Sugarcane in Uttar Pradesh by K. C. Gupta, Basant Singh and Sanje Sugar - Sugarcane Research Station, Sahajaulapur, Indian Sugar - June, 1966, page 273
quality and the yield of cane was achieved by Uttar Pradesh in the
development zones. In 1954-55, the cane yield in the developed zones
was 18.85 tonnes per acre. Target was fixed in 1960-61, for raising
this yield to 22 tonnes per acre and the Central Government
allocated Rs. 5 crores for cane development in the Indian Union
including the State of Uttar Pradesh.

Indian Council of Agricultural Research conducted experiments
on the various aspects of the crops on an all India basis during the
period 1948-53. They found that the following cane yields could be
raised in different parts of Uttar Pradesh:

1. **AGRICULTURAL INSTITUTE ALLAHABAD**
   
   11.48 tonnes cane was obtained from an acre. It could
   be increased to 12.51 tonnes an acre.

2. **TOKIYA HIRD AGRICULTURAL FARM, JABALPUR**
   
   Experiments were conducted with Co.453, (medium) type cane. A
   tonnage of 17.76 cane per acre was obtained without
   manure. It was found that this yield could be raised to
   20.09 tonnes with the addition of 60 lbs/acre of phosphorus
   and to 30-35 tonnes with the addition of 150 lbs/acre
   under varying conditions.

3. **GURJAR HIRD AGRICULTURAL FARM, PYZABAD**
   
   Experiments were conducted with Co.511(b). A cane crop of
   14.43 tonnes/acre was obtained without the application
   of any manure. It could be raised to 15.45 tonnes per acre
   with 60 lbs/acre of phosphorus.

4. **SUGARCANE SUB-STATION, MIZAPUR(NAGAR)**
   
   Experiment was conducted on Co.451, a mid season cane. A
   cane crop of 33.20 tonnes per acre was obtained without
   manure with follow-sugarcane-basal conditions. It was
   found that Co.421 could give 33.75 tonnes cane per acre
   with 100 lbs/acre as super broadcast.

5. **SUGARCANE RESEARCH STATION, SHAHJAHANUR**
   
   Experiment was conducted on Co.453, a late ripening
   variety. A cane crop of 23.09 tonnes per acre was
   obtained with green manure, sunai tops and roots. A yield
   of 32 tonnes per acre could be obtained with 120 lbs/acre
   N.A.S.

* AGRICULTURAL EXPERIMENTAL WORKS IN UTTAR PRADESH, 1948-53, PAGES 759 - 1078.*
As against it, the experiments conducted in Maharashtra State showed that it was possible to get an average of 60.34 tonnes per acre with various combinations of compost and basal dressings. This yield, however, went up to 78.26 tonnes per acre with a placement of phosphoric acid together with N, P, K, and manures. The above experiments do not mean that it is not possible to raise the cane yields in Uttar Pradesh above the experimented level.

In the crop competition scheme, 1956-57, of the Indian Central Sugarcane Committee, Shri Jagdeo Choudhri of district Basti, obtained a yield of 61.096 tonnes sugarcane per acre and was awarded the First prize. In the same year, Shri Prithvi Nath of District Rebet raised a cane yield of 56.473 tonnes per acre and was given the second prize in the competition. However, these were the solitary instances where the cane cultivators made timid to raise the yields with the desired quantities of manures, irrigations, etc. The latest figures show that the average cane yield in Uttar Pradesh has reached only 15.7 tonnes per acre against the anticipated yield of 22 tonnes per acre fixed for 1966. As compared to it, Maharashtra and Mysore raised the average cane yield to 34.3 and 34.7 tonnes per acre respectively, in that year. Yield of sugar per acre in Uttar Pradesh was 1,487 tonnes as compared to 4,416 and 3,744 tonnes per acre in Maharashtra and Mysore respectively, in that year. The sugar recovery per cent cane of Uttar Pradesh was 9.47 as compared to 11.97 and 10.79 per cent for Maharashtra and Mysore respectively in that year. The sugarcane production in the Western Uttar Pradesh, which was 14.5 tonnes in 1955-56, went down to 13.70 tonnes per acre in 1964-65, showing a decline in the production capacity of lands in the state. The cane

(54) National Index of Agricultural Field Experiments Vol.2 Pt.I Maharashtra, 1948-55- page 574
(56) Indian Sugar - November, 1966 - pages 49-50
yield has been low due to the diseases and insects devouring the good quality canes, which have been replaced one after the other in this state. The other point for this low average is the little attention paid by the cultivators in effecting the required improvements in the manures and the seeds.

The sugar industry in Uttar Pradesh has been recovering less sugar from the canes as compared to other States in the Southern India. Leaving aside the quality and the yield of the cane in this state, the industry has been transporting cane from an average distance of 45 miles. The time taken by the cultivators in delivering the harvested canes to the mills, also adversely affects the sucrose contents. While making strenuous efforts to improve the quality and the quantity of the cane, it will economize the extraction of the juice, if the cut canes are brought to the sugar mills, within the shortest possible time after harvesting of the cane in the fields.