the growers by supplying them with necessaries and small luxuries from time to time and recovering the value in the shape of arecanuts at harvest time, of course at reduced rates. This deprives the arecanut growers of what profit they could otherwise get and keeps them always in a state of indebtedness to the moplas. If big merchants could in their own interest be more considerate and extend their sphere of beneficial influence over the growers direct by stocking chemicals and sprayers advancing what little is required by the growers at reasonable rates, they will get nuts of better and uniform quality which will ensure stability in trade.

M. K. NAMBIAR.

The principles of crop production.*

Up to 1840 farmyard manure held undisputed sway as a fertiliser. It was known that plants contained metallic constituents, and that certain metallic compounds were useful fertilisers, but in as much as organic matter was the chief constituent of plants, it is believed that organic manures must be the best. In 1840, Liebig taught that the true function of a manure was to provide mineral matter, the nature of which wa to be deduced from the composition of the plant ashes. His prescriptions failed completely in practice; and the Rothamsted experiments showed that he had overlooked the role of nitrogen, and that the composition of the ash of the plant was no guide to the soil amendment required in any specific case. When artifical fertilisers were first introduced, it was maintained that the fertilising effect would not endure but experience disproved this, and experiments for over 60 years at Rothamsted have shown that good crops can be grown almost indefinitely by supplying sufficient nitrogen, phosphorus, and potash. Plot experiments by Wille in the sixties disclosed the nature of the fertilising elements required by a given soil, but his work was purely

*Lecture delivered before the Chemical Society by Dr. E. J. Russell.

empirical, and scientific agriculture marked time till Schloesing and Muntz discovered that the nitrification of the ammonia in sewage was due to specific bacteria. This discovery opened up the highly important hinterland of soil bacteriology. Weathered subsoil contains little plant food, but supports a certain flora which when it decomposes yields nitrates, humus, lime, etc., as endproducts; and these furnish the conditions necessary for the existence of bacterial life and for soil fertility. Scientific agriculture controls the decomposition by adjusting the air supply, water, temperature, etc., by securing the presence of beneficent organisms, and by maintaining the supply of plant residues. Fallowing and ploughing in are almost prehistoric operations; in modern practice a special crop, e. g., clover, mustard, lupines, vetches, is grown and ploughed in, or brought back to the land as farmyard manure. The loss of nitrogen due to denitrification, which occurs particularly on prairie land and in soil intensively cultivated, has been traced to the hydrolysis of proteins by bacterial agency. In well-covered manure heaps the anaerobic conditions prevent loss of nitrogen, but so soon as air is admitted the loss proceeds apace, not as ammonia, but probably as free nitrogen. In the farmyard the loss is increased by leaching, and altogether millions of pounds sterling are lost annually from these causes. Such biochemical changes are affected by minerals, e g., lime, by the physical texture of the soil, and by the crop; the growing plant apparently retards nitrification since more nitrate is formed in fallow than cropped land, even after allowing for the nitrogen assimilated by the crop. Whitney, in his studies of tobacco culture in the United States, traced the connection between good growth and "soil climate," (i.e., moisture, temperature, etc.,) by correlating these factors with the sizes of the soil particles; hence, the value of the mechanical analysis of soils. The factors which favour plant growth are so related that the good effect of any one of them ensues only when every other factor is operative. The failure of one factor affects the

growth, even when the others are present in increaseon of other
and a stage is finally reached when the superabu· Here is an
factor does direct harm. When tomatoes we·on on the organs
favourable conditions in four pots, to wh. V.
increasing doses of sodium nitrate were added,
increase in growth from pots 1 to 2 but a decreasresearch, the
2 to 4, because in 3 and 4 moisture was deficient: watrisiting the
the "limiting factor." Most soil problems are to bertant part in
from the stand-point of the limiting factor and its con the mucous
Thus dryness and acidity are counteracted by people living
organic manrediate vicinity of lepers. It is believed that the house-
experiments only a mechanical transmitter, and that it is not in any
the latter case intermediate host like the mosquito is in regard to
he limiting fagricultural News. Nov. 6, 191.
he one under.

The three main purse of cocoanut seedling:—It hasare ad a current
(1) the maintenance of that the quate supply of nutrients, chiefly
nitrogen, potash, and outer phosphorus. (2) The biochemical
compositions the s iter in the t proceed smoothly and quickly.
The occ ... e possession of th factors must be prevented by
rings adaptations for requirements of the plant are satisfied. It
is possible that the existence of plant accessories, or hormones,
as agents directing and regulating the vital activities of the plant,
may have to be included. The simple fact that phosphates
increase plant growth is very complex in practice. Laboratory
experiments on the effect of phosphates on plants in sand
cultures are vitiated by the factor of the active phosphate
inherent in the soil itself. Phosphates may be superabundant
in a soil, yet the plant may starve for lack of added phosphate.
Determinations of the "available" phosphate in soils by
extracting with 1% citric acid led to results useful in practice
but practically useless as a guide to the amount of available
phosphate present. The reaction between a dilute acid and
a phosphate in the soil is reversible, the direct solvent action

empirical, ar ompanied by the removal of dissolved phosphoric acid and Muntz dis lution by the soil. When the reverse action is sewage was due to using a diffusion method of extraction, all dilute the highly importa to exert approximately the same solvent effect. subsoil contains ct action is rendered negligible by adding sodium which when it o the soil, acids fail to remove all the added endproducts; i. e., some of it is absorbed by the soil particles. The existence of ng the distribution of added phosphate between the agriculture co solution is the ordinary absorption isotherm, similar supply, water, ned with charcoal and dilute acids. The curves for beneficent organisms, and by maintaining the supply of plant residues. Fallowing and ploughing in are almost prehistoric operations; in modern practice a special crop, e. g., clover, mustard, lupines, vetches, is grown and ploughed in, or brought back to the land as farmyard manure. The loss of nitrogen due to denitrific which occurs particularly in prairie lan fertility quick growin been trace ors the hydro yet bee and so complex that first principles well-cov ave not anure he possib and consequently accurate predict ss of nitroge not so soon a surveying, joined with chemic s apace, not as and bacteriolo studies, materially assists the exis ard the loss is incre methods. Rothamsted work on the par ion sterilizat ils revealed another limiting facto crop production, viz., the activity in the soil of orgnisms hysica nical to beneficent bacteria, and though the problem is y oung, good practical results have been achieved in the curin of "sick" green house soils by steaming.—E. H. T. (Journal of the Society of Chemical Industry. Feb. 15, 1916).

Notes.

Self sterility of cultivated fruit-trees:—Investigations show a growing tendency towards self-sterility—i. e., incapacity to be fertilized by its own pollen—in the cultivated varieties of fruit

elongates and becomes enlarged at both ends. From the outer end arise the plumule and the roots, while the internal growth results in the formation of a large bulbous mass of spongy tissue pure white in colour. This is technically the cotyledon and is responsible for the absorption and digestion of the endosperm—(the kernel and the liquid)—which is then passed on to the young plant. This beautiful arrangement is appropriately styled 'wet nurse' arrangement.

These enlarged cotyledons of the germinating cocoanut—in appearance much like a sponge-cake—are considered luxuries and food for the invalids by the Polynesians. Along the west coast of Mexico these enlarged cotyledons are dried and sold under the name 'cocoanut apples.' These are said to be very delicious. T. S. V. The Journal of Heredity. April, 1916.

The following table showing the proportion of ash and potash in various tropical plants has been extracted from the July number of the Tropical Agriculturist.

	Ash.	Potash.	Percentage on.
Castor seeds	3·2	0·5	dried sample.
Cocoanut husk (dry)	5·3	47·0	on ash.
,, shell	1·3	26·5	,,
Crotalaria juncea	4·0	14·1	,,
Neem husk	13·6	0·75	on sample.
,, Poonac	9·0	1·69	,,
Sesbania Aculeata	6·2	15·6	on ash.
Tephrosia Purpurea	5·9	24·0	,,
Tobacco	16·0	25·9	,,
Tapioca (stem)	4·7	22·1	,,
,, (leaves)	8·6	14·6	,,
Pithicolobium saman	5·0	1·27	on sample.
Vigna catiang (dried)	14·2	3·46	,,
,, (fresh)	3·03	0·73	,,

These figures are estimated on the sun dried sample.