FERTILIZER USE AND IT'S FUTURE IMPLICATIONS

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It has been said that with the rising incidences of chronic kidney diseases in the agricultural areas of the island, the Sri Lankan government is taking measures to control the indiscriminate usage of chemical fertilizer and agrochemicals by the farmers.

According to the government the country is experiencing adverse effects of the use of chemical fertilizer and agrochemicals introduced to increase crop productivity and ensure food security.

Although Sri Lanka has become self-sufficient in rice and some other crops, the adverse effects of chemical usage such as damage to bio-diversity, contamination of water and soil due to chemical substances leading to various health problems, particularly renal diseases in agricultural areas such as North Central and Eastern Provinces, are becoming costly for the country.

According to a World Health Organization (WHO) study, in recent years, a significant increase in Chronic Kidney Disease of uncertain etiology cases has been observed in some parts of Sri Lanka, especially in North Central, North Western, Ova and Eastern provinces.

A joint research project conducted by the government and the WHO found that the high prevalence of chronic kidney disease in the country's main agricultural production regions caused by fertilizer and pesticide use.

The Health Ministry, which commissioned the WHO study, says the number of affected people in the country had grown to 450,000 although uncertainty prevails over the exact cause of the kidney disease.

The government has therefore, initiated measures to control the use of agrochemicals and fertilizer consumption and promote the use of organic fertilizer in farm lands.

Other side of the story

Fertilizer seems to have a bad name, and in some surprising circles. It is time to dispel some myths about mineral fertilizers, to appreciate the role they play in feeding the world, and to assess how best they can help agriculture meet the challenges it faces in the decades ahead.

There is a general consensus about the way agriculture is evolving in response to demographic and economic trends. World population will probably peak at some 8,000 million around 2030, when two out of every three people will live in towns and cities. Rising incomes will create a disproportionally higher demand for food, meaning that over the next three decades food production will need to increase by about 60%.

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Nearly all of the increase in production will have to come from developing countries through intensification of agriculture, i.e. more yield per unit time and per unit area. As urbanization reduces the rural workforce, agriculture will also need to adopt new forms of mechanization and shift to land use intensification, with all of its connotations. Those scenarios point to an increase in use efficiencies of all natural resources, particularly water, and to the need for greater - although not proportionally greater - use of mineral fertilizer.

FAO's study World agriculture: towards 2015/2030 says "increased use of fertilizer is becoming even more crucial in view of other factors, such as the impact on soil fertility of more intensive cultivation practices". However, increases in food production are possible with a less than proportional increase in fertilizer nutrient use. For example, the study says, maize farmers in North America have increased nutrient use efficiency by adopting improved management practices. Other research suggests that techniques such as precision agriculture could help substitute "information for fertilizer". See World agriculture: towards 2015/2030.

Yield increases. Half a century ago, farmers applied only 17 million tonnes of mineral fertilizers to their land. Today, they apply eight times as much. In northern Europe, fertilizer use has increased from about 45 kg/ha to 250kg/ha since 1950. In the same period, wheat yields in France increased every year, from about 1.8 tonnes/ha to more than 7 tonnes/ha. The growth in fertilizer use is certainly lower than the increase in yields, and confirms the overall pattern of increasing efficiency in fertilizer use.

Fertilizer application currently accounts for 43% of the nutrients that global crop production extracts each year, and the contribution may be as high as 84% in the years to come. Contrary to some public opinion, non-mineral nutrient sources are unlikely to challenge mineral fertilizer in the future: while there will be more manure available as livestock production increases, and urbanization produces more waste, especially sewage, their efficiencies are considerably lower and the current cost of using waste for crops is still quite high.

Organic agriculture, which eliminates the use of synthetic inputs, does not appear to be a feasible alternative. FAO, has done some very tentative calculations of what organic agriculture would mean on a global scale if market demand for organic produce increased substantially. The consequences are quite staggering: a large amount of land that would have to be brought under rotation with legumes or under animal production to make up for the lack of mineral fertilizer. While organic agriculture does fill a niche market, its limits - and its dangers, in terms of nutrient depletion - need thorough review.

The question is not whether but by how much fertilizer use will need to increase. At the World Food Summit in 1996, governments committed themselves to halving the number of hungry people by the year 2015. There is a direct link between that WFS goal and fertilizer use. Possibly, it means an 8% increase in fertilizer applications compared to the "business-as-usual" scenario. That does not seem very much, but in terms of its tonnage, it is considerable. Enhanced fertilizer use to meet WFS goals is particularly important in countries such as China and India, which make up a large proportion of the world population. But it may be even more important in Asia, where increases of 2.7% or more a year are needed in order to make up for nutrient losses, and in the humid tropics, where unfertilized annual cropping takes a heavy toll of soil organic matter.

Fertilizer use efficiency. Improving the efficiency of fertilizer use is the challenge of the future. One possible direction is improving fertilizer use and plant nutrient uptake efficiency through biotechnology. Hardly any current work in biotechnology addresses abiotic stresses or biological nitrogen fixation. While there may be scope for such research, we should be very careful about promising too much, too quickly. In any case, there is still a lot to gain from conventional plant breeding. For example, considerable work has been done on the so-called "staying green" characteristics of crops such as sorghum - the longer the crop stays green, the more fertilizer uptake there is over time.

Another promising area for research is soil biology. Although it remains an isolated field, we do know that soil organic matter and soil biology are important in nutrient management, and that nutrient recovery for fertilizer is much better with soil improvement. In Asia, where the recovery of nutrients is very low, more systematic work is needed on soil organic matter and on soil quality in physical, biological and chemical terms. Since biological nitrogen fixation produces mixed results, scientists need to link it to the application of more conventional fertilizers and study recovery. Results would probably show that biological nitrogen fixation is not a miracle solution by itself, but is successful under certain conditions.

Integrated management of production systems offer a proven path to greater fertilizer use efficiency. Remarkable results in rationalizing pesticide application have been achieved by making farmers more aware of integrated pest management through field schools, where they learn to observe crops closely and discuss the management of the pests and pathogens. These activities are increasingly linked to integrated nutrient management - farmers are being trained to observe the real impact of nutrient application rather than, for example, applying more and more urea simply because it is the cheapest fertilizer. Farmers also need to understand the effects of over-use of nitrogen on certain pathogens and other stress factors in crops. This may convince them of the need to buy non-nitrogen fertilizer and adopt much more balanced fertilizer applications.

Plantation tree crops

In Plantation Tree crops, plant organs particularly leaves are analyzed to determine the nutrient content in the sample and hence in the selected stand of the crop, with a view to utilizing the data to improve fertilizer use efficiency and to confirm visual symptoms.

Interpretation of soil analysis allows for assessing fertilizer needs, but it does not allow us to evaluate the efficiency or sufficiency of nutrient uptake to ensure optimal growth and productivity of the crop(s).

Private/public partnerships. The gains to be made from fertilizer use efficiency, even from a purely economic standpoint, could be significant. However, those gains depend on a broad range of factors that determine fertilizer use and fertilizer application by farmers. We need private/public partnerships, much better systems of distribution and quality control, and the array of marketing tools that goes with it. The fertilizer industry should become more creative in ensuring that the farmer actually obtains the maximum benefit from existing crop and fertilizer application techniques. This means looking systematically at ways of reducing labour demand, which is particularly important as the availability of agricultural labour declines. For example, new polymer-coated fertilizers could offer a much better recovery rate. The industry should also look at the total cycle of nutrient use and nutrient recovery, remembering that the automobile manufacturing industry heard the same plea 20 years ago and has since made considerable progress.

There is still a lot of misunderstanding and confusion about soil nutrients and, in particular, mineral fertilizers. The public needs objective, science-based information from all partners involved in nutrient management. We must, in other words, tell people what we know. We know productivity gains are necessary and possible. We know that more fertilizers are needed. We know that fertilizer use can be far more productive and efficient, if we do it in the right way and in the right context. Use organic manure alone is not the answer. Let us look at the indiscriminate use of other agro chemicals that are being very vigorously promoted by the private sector, other than the mineral fertilizers.

FACTORS GOVERNING PRODUCTIVITY WITH SPECIAL REFERENCE TO QUALITY OF PLANTS

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Introduction

Rubber tree is unique in many ways. In order to harvest the crop, the latex, a vegetative tissue, the bark which is so important for the tree should be removed. Thus not only this operation should be done very carefully but also, very methodically. Further the crop or the harvest is directly related to the size of the tree or the vegetative growth (Seneviratne etal, 1998). Yield variation among trees of the same clone is due to difference of growth owing to many factors. Accordingly, positive correlation exists between girth and yield of rubber trees within the clone. The crop or the productivity of the original trees from Brazil was about one tenth of what is harvested from improved cultivars today, yet the cost of production increases at a faster rate. This demands further increase in productivity or the crop. However, the Sri Lankan rubber growers are gifted; they can still make profits with a yield of half the potential. The potential yields of many clones recommended are in the range of 2500-3000 kg/ha/year. The average yield per hectare per year for estate sector remains around 1000 kg/ha per year, where the national productivity is around 1400 kg/ha/yr. This figure is rather unrealistic as there aren't many clearings yielding more than 1500 in the smallholder sector. The next concern is whether the growers are in a position to achieve the potential yield of new clones in the future. This needs proper analysis of the factors which have prevented the growers from achieving the potential yields of new clones.

Key Factors

One obvious factor is the usage of low yielding clones. Unless high yielding clones are used, high yields cannot be achieved. Currently, three clones having 3 different yield potentials dominate the rubber industry in equal shares. What has been recommended by the RRISL is to use any one clone only up to 10% of the total extent. Genetic diversity is more important to prevent severe losses due to sudden disease out breaks, than to achieve high yields. Clone alone cannot guarantee the potential yield unless other contributing factors are maintained at optimum levels.

The next important factor is the stand per unit land area. Productivity relates directly to the stand. Not attending to the infilling during the immature phase with suitable plants, leads to poor stands at tapping. Root diseases too play a vital role in reducing the stand. Mechanical damages and pest attacks are severe in some areas, which affect the stand significantly.

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The third, most important factor is the presence of weak or under girth trees in the field. Replacing weak plants with good quality plants is as important as infilling vacant points. The contribution of weak trees or runts to the final crop is minimal. Also identifying these trees at the time of tapping serves no purpose as introducing a new tree to the field at that age is not possible.

How to select good quality plants

We have conducted experiments on effect of plant quality on girth of the trees in the field. Plant quality correlates positively and significantly to the growth indicating that farmers can select good rubber trees at nursery stage and prevent the usage of poor quality plants in replanting programmes. When the budded plants grow up to the second whorl stage, there is a significant variation among plants for height and diameter (Seneviratne et al 1996). Both parameters distribute normally making the planters to select vigorous plants through growth parameters of girth and height. In one study, the individual plants were labeled according to the diameter of the stem and annual girth of the tree in the field was measured. Girth data positively correlated to the initial diameter of the plants in the nursery. This is a very useful tool and also can be used effectively to increase the productivity in rubber clearings. Only constraint is the involvement of private rubber nurseries in the planting material production in Sri Lanka and lack of their concern on quality of the plants. Another reason could be the farmers not been competent enough to identify the quality plants or rather, farmers given no option to select plants. But to accept the plants issued to them under the subsidy scheme. But Regional Plantation Companies can practice this to select plants, as they have their own nurseries to produce plants.

This will definitely help in establishing clearings with 100% productive trees. Therefore, when ever possible this practice should be adopted to select only good quality plants, which leads to complete stand of high quality productive plants. Vigorous and good quality plants can withstand adverse or unfavorable conditions which is also advantages.

Quality parameters of budded rubber plants

(i) **Vigour of the root stock.**

Quality of a budded plant depends on two main factors, vigor of the seedling and the juvenility of the bud.

Vigorous seedlings can only be selected by sowing the seeds on a germination bed followed by harvesting only early germinates. This method is effective if only the seed germination rate is 100%. Using 50% of the number of seeds will not serve any purpose when only 50% of the seeds sown germinated due to poor quality. Further, harvesting early germinated seeds, as they germinate is as important as using twice the quantity as otherwise all seeds will germinate making it difficult to identify early germinated seeds.

The economical return to the grower through adopting this selection can be explained as follows. One kilogram of rubber seeds holds over 200 seeds which are sold at a range from Rs.30/= to Rs.50/= per kilo. Even at Rs.50/= a kilo, a seed costs only 25 cents. Using 50% only will double the cost for seeds, yet 50 cents. The rubber tree originated using the stock plant raised from the seed (the cost of which is only 50 cents) is expected to give at least 5 kg of rubber per year during its revenue life span of 24 years. Thus the total quantity of rubber harvested would be 120 kg and at a rate of Rs.300/= per kg, Rs.36,000/= is expected. With compared to this amount, the investment on 50% selection of seeds at a rate of Rs.50/= per kilo cannot be even compared. This shows that the investment on seeds can be increased to spend even Rs.100/= per kilo to purchase good quality seeds when considering the impact of quality of the root stock on the productivity.

(ii) Juvenility of the budwood.

The second important selection required to produce high quality plants is the budwood. Apart from the clone or the cultivar, physiological growth condition of the bud patch affects the growth of the scion. The only reason to recommend annual pollarding of budwood nurseries is to maintain the juvenility of budwood. This is evident by no flowering and wintering observed in budwood nurseries. Perennial trees such as rubber undergoes a physiological phenomenon called "phase change" where trees show morphological differences as well. In rubber, flowering and wintering start only when the trees enter the mature phase. But what is most important with regard to phase change is the growth rate of the trees. Generally, the immature or the juvenile phase lasts only for 5-6 years in case of both budded and seedling rubber. During this period, all trees should maintain at least, 10 cm girth increment per year making them tappable after 5-6 years. There are instances where 15-20 cm girth increment is seen in rubber tress. Whether the trees are opened for tapping or not the growth rate becomes very slow as they enter the mature phase at 5-6 years, to 2-3 cm per years. This condition demands maintaining the budwood plants as juvenile as possible in order to have a good growth rate in budded plants. Though the life span of budwood nurseries is 10 years, flowering or wintering are not observed in budwood nurseries for the reason that the trees are pollarded annually. Every time a tree is pollarded, it reverses its phase and maintains the juvenile growth phase throughout. Accordingly, buds harvested from trees in juvenile phase has faster growth rate.

The reason to maintain a frame close to the ground level or to the root system, of budwood nursery plants is also to maintain the juvenility which is high close to the root system within the plant.When pollarding budwood trees, only 15cm distance is kept from the previous cut (Figure 1). Agromanagement practices such as weeding, manuaring and disease control are equally important.

Figure 1. Maintaining the frame close to the graft union to preserve juvenility.

When vigorous stock plants are grafted with budwood of juvenile phase having juvenile characteristics, obviously the resulting budded plants will be of high quality. When high quality plants are used and all agromanagement practices are adopted according to RRISL recommendations, then the clearings will be able to give potential yields of 2500-3000 Kg/ha/year with no difficulty. The key agromanagement practices include land preparation and cover crop establishment, weeding and manuaring and most importantly correct harvesting practices.

All these factors are interdependent. For instance even the best quality plants will become very unproductive if other agromanagement practices are not adopted. Similarly if the plants are weak or poor quality, they will not perform satisfactorily or will not give potential yields even under the best agromanagement practices.

The economical aspects of selecting plants

The government rate of a two whorl budded rubber plant is Rs.60/=. As discussed earlier also a rubber tree planted in the field is expected to give at least 5 kg of rubber per year throughout its life span after 5-6 years of immature phase and expected to give about 120 kg of dry rubber. At the rate of Rs.300/= per kg this amounts to Rs.36,000/=.

Thus even if the plant selection process is to use only 50% of the budded plants in the nursery measured by the diameter (by discarding half the number of plants as weak plants) still the cost per plant will be double i.e. Rs.120/=. Therefore, in order to expect a crop worth of Rs.36,000/= investment of an additional Rs.60/= per plant by selecting only 50% of the nursery plants would be worthwhile.

The other extreme is weak plants planted in the field which would remain as runts throughout, giving no significant yield or return for the investment. A weak plant or a runt though occupying a space in the field is similar to a vacant point as there is no yield contribution from it to the final crop of the field.

Harvesting plays the biggest roll of all the factors as it determines not only productivity but also sustainability. It is a proven fact that high intensity tapping always lead to reduce the yield and the productivity and more importantly the viability. Instead, lower intensities will increase the yield per tree per tapping which leads, to higher annual yields and no risk of sustainability.

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