

# DRY MATTER PRODUCTION IN PLANTATION CROPS

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## INTRODUCTION

Plantation crops provide the basic requirements of human being such as food, shelter, beverages and industrial raw material. Crop yield is defined as the weight per unit area of the harvested produce or of a specific part of it and is influenced by several internal and external factors. The partitioning of Dry Matter (DM) towards economically important part is known as Harvest Index (HI). This means that  $HI = \text{Economic yield} / \text{Total biological yield}$  or total dry matter production i.e., the proportion of total DM to the economic yield is HI. Hence understanding of dry matter production (DM) and partitioning is very important for the evaluation of the production potential of any crop. Being perennial in nature, studies on DM production have been very limited in plantation crops. DM production depends on management practices, climatic variables and soil conditions. However, yield in addition to these is influenced by several other internal and external factors.

## MEASUREMENT OF DRY MATTER PRODUCTION

Methods employed for the estimation of DM production of crop plants include (1)  $CO_2$  exchange measurements in the field. (2) Growth measurements. The former requires sophisticated equipments for the measurements and various instruments are available in the market for the same. While the latter requires only some morphological measurements of the crop plants in use such

as height, girth, leaf production etc. which do not require costly equipments. But the second one is more laborious because large number of plants have to be destructively analysed for getting accurate results. Genetic variability, management practices employed in various places, climatic conditions etc. pose other problems for getting comparable results.

These problems have been tackled to certain extent by innovating suitable methods to the specific location and crop. Non-destructive methods by employing regression equations as well as crop modelling pertaining to the situations have helped in solving the problems and the results are on par with the results obtained with other methods.

### DM production:

In coconut non-destructive methods are employed to calculate DM production in the seedlings as well as in adult palms. The DM production of the seedlings ranged between 70 and 130 g whereas in the adult palms it ranged from 70 - 100 kg. palm<sup>-1</sup> year<sup>-1</sup>. Genotypic variations are also found in the partition of total DM towards vegetative and reproductive growth. In the adult palms, variation in nut composition i.e. in the partition of the nut dry matter towards its components viz; husk, shell and copra content are also seen. The nut DM partitioning is in the range of 40 - 53% in the husk, 22 - 27% in the shell whereas in copra it ranged between 27 and 35%. Between the selected cultivars/hybrids for example in Laksha Ganga, DM partitioning towards husk is found to be

higher (53%) while in Chandra Sankara it is only 40%. However the partitioning towards shell and copra is found to be higher in the former than in latter.

Regression equations have been developed in other crops also for the non-destructive estimation of DM production. In oil palm, DM production ranged from 15 to 40 t.ha<sup>-1</sup> in well managed plantations. This has been attributed to the variation in the interception and conversion efficiency of solar radiation (Corley, 1983). In case of rubber the process of exploitation and extraction of latex limits DM production to the extend of 10 to 60%. This is mainly due to the fact that rubber production involves partitioning of assimilates and too much draining of metabolic energy. Templeton (1969) reported that Rubber trees produce 26 to 36 t.ha<sup>-1</sup>. DM in a year when untapped whereas tapping reduced the DM production to 15- 20 t.ha<sup>-1</sup>. The latex yield of rubber is observed to be 1 to 4 t.ha<sup>-1</sup>.yr<sup>-1</sup>.

In tea, the tender leaves are the economic produce and the growing buds are the strongest sinks, and the canopy maintenance foliage acts as source of carbohydrates to these growing portions. Hence only 34 - 46% of DM produced remain in a plucked tea bush and the rest are lost in respiration. Pruning alone account for more than 90% of the loss (Barua, 1987). Mugambo and Cannell (1981) reported about 35% reduction in the DM production of plucked tea bush as compared to unplucked bush.

In most of the crops the harvested product include some waste material such as husk, shell, bunch stalk, leaves, bark portion etc. along with the economic products such

as copra, oil, latex and tea leaves. These waste products are used as fuel, activated carbon, biofertilizers etc.

## **CONSTRAINTS IN THE DM PRODUCTION**

Problem encountered in DM production studies is the long life span of the tree crops. In tree crops the entire life span is divided into three stages: 1) Juvenile period, 2) reproductive period and 3) senescence. During the juvenile period a high proportion of the DM produced are diverted towards the vegetative growth. Similarly during reproductive stage for higher productivity a large portion has to be transported towards flowering and fruiting and finally during senescence there is a decline in the partition towards reproductive growth. Hence, DM production and partition in other words source-sink relationship is an important tool for understanding the productivity of the crops. There is no plasticity in DM production in these crops. This means that when assimilates are limiting, the vegetative sink has priority over reproductive sink.

In most of the perennial crops DM production refers to the tissues above ground level. In oil palm the total root biomass is estimated to be only 3 - 5% of the annual DM production.

## **FACTORS AFFECTING DM PRODUCTION**

Agro-climatic conditions, source-sink relationship, light interception efficiency, Leaf Area Index (LAI), photosynthetic efficiency, respiration rates, leaf longevity and Harvest Index influence the DM production. The wide gap observed in the yield realization can be attributed to the above factors.

In tree crops, sink is not found to be a limiting factor for productivity. In annuals such as wheat, rice, etc. where the growth is determinate, the ear is the major sink for DM. However, in perennial crops where the growth habit is indeterminate competition for assimilate between vegetative and reproductive parts even after flowering results in source limitation. Maximum crop productivity depends on the light use efficiency which is related to Leaf Area Index. In oil palm Corley (1976) reported high DM production with a LAI between 8 and 10. But an LAI of four only has been achieved due to the removal of leaves during harvest. In coconut an LAI ranging between 4 and 5 has been obtained. Genotypic differences have been observed in this parameter.

The harvested product has a much greater energy content. Westlake, (1963) reported that energy content of 40, 25, 24 and 19 kJ g<sup>-1</sup> for lipids and rubber, lignin, protein and other materials respectively. By knowing the energy content of the harvested products the photosynthetic efficiency can be calculated. For oil palm the photosynthetic efficiency i.e. the ratio of chemical energy of DM formed to the light energy absorbed is about 2.1% which is nearer to the values observed for rubber (2.8%). However, the theoretical maximum value for photosynthetic efficiency is more than 22% of the absorbed energy. But for most of the agricultural crops a value of 2 - 4% only is obtained.

In perennial crops the potential energy fixation is estimated as 1.2 T.J.ha<sup>-1</sup>.yr<sup>-1</sup>. In tropical crops it is reported that 50% of the photosynthetic production is lost through

respiration, but in perennial crops it is 75 %. This is mainly due to the long life span of the leaves which require maintenance of more supporting structures. Estimates of gross or net productivity for perennial tree crops are few because of the high respiratory loss of the DM produced. For tea, the respiratory loss is estimated to be 85% and for oilpalm it is 80% (Corley, 1976). A coconut canopy with high conversion efficiency would yield 51 t.ha<sup>-1</sup>.yr<sup>-1</sup> of DM, but the highest value realised is only 31 t.ha<sup>-1</sup>.yr<sup>-1</sup>. However at Kasaragod condition the highest value recorded is only 17 t.ha<sup>-1</sup>.yr<sup>-1</sup>. This can be attributed to the lower conversion efficiency of the intercepted radiation.

From the above, it is clear that there is a wide gap in the yield realisation thus showing the potential is not being fully exploited. The main reason for this is the field crops are rarely exposed to the ideal micro climate which would enable the plant to reach its maximum potential. A complete understanding of the crop plant at the whole plant level would only help to solve this problem. This can be achieved only by evolving plant ideotypes through breeding and biotechnological approaches.

In the days of energy shortage the worth of palms like coconut as energy source deserves consideration. The energy contained in the harvest of over 12 billion nuts is equal to 31x10<sup>12</sup> K.calories. Considering only the energy in the husk and shell this is equivalent to 3.8 billion litres of gasoline. In Phillipines, one of the most important potential source of fuel from plants is coconut oil. Efforts are being made for producing a variety of renewable energy resources such as gas, ethanol and electricity from these tree crops.

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