Reaching for the Sun:

A refreshing dimension in agriculture

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Part 1: Harnessing the Sun

RA: How very right the ancient Egyptians were in their worship of the Sun God RA as the giver of all life! How very right the Zoroastrians are in their worship of the Sun and Fire as fundamental to existence.

Those of us with the privilege of a *pirivena* (Buddhist) grounding to our education will recall being taught the four 'elements' of life in *Ahpo, Thayjo, Vahyo, Patavi*. The Pali word *Patavi* represented the 'solid' or 'earth' state, while *Thayjo* represented the state of 'heat,' of 'energy', or 'fire'. *Ahpo* represented the 'liquid' state or 'water', while *Vahyo* represented 'air' or the 'gaseous' state.

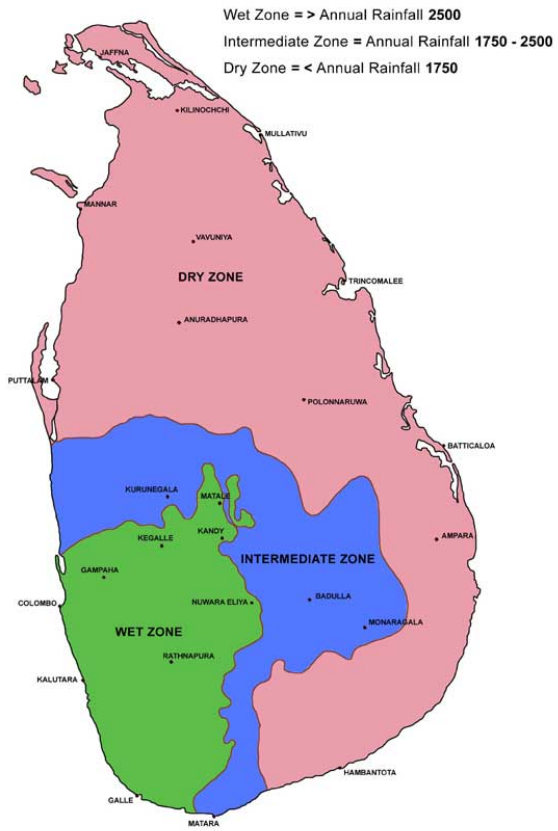
We learned the example of the solid, a cold lump of ice which, when heat is added, turns into the liquid state, and with further heat, turns into vapour or gaseous state. All

these ‘states’ or elements were reversible if heat was reduced: the vapour reverting to liquid and then to the solid state. Central to them all was heat, energy, fire – ultimately, the Sun itself.

Similarly, the Sun’s energy flows through every part of Nature. It is only comparatively recently – within the past few centuries -- that a greater appreciation has been realised of more fundamental differences between tropical agriculture (with year-round sunshine) and temperate agriculture (carried out under seasonal or ‘summer’ sunshine which may last only for a few months in the year).

The growing of rice – a temperate crop – came to us from southern China, through India. As a seasonal, 4-month crop, it has adapted well to the water-saturated valleys (or *yaya*) between the rain-fed uplands of the tropical *haena* (anglicised as chena). The big adaptation was in the use of water much of which was for control of weeds (using an average 20 tons of water to grow a kilogram of rice).

Map 1: Climatic Zones of Sri Lanka



***Vel Govithan*: The Sun in Rice Culture**

It is only recently that the importance of sunshine is again becoming fully appreciated in the growing of rice. Sunshine is specially important during the last 20 days prior to harvest when the vital starches move, through photosynthesis, from the leaves into the grain.

An essential sunshine-intensity requirement is the availability of at least 500 - 600 calories per square cm per day (or 15 - 17 MJ/square metre/day) during this ‘grain-filling-period’ to ensure a yield of at least 6 to 7 tons per hectare. Failure to achieve this level of sunshine invariably results in reduced yields of 4 to 5 tons per hectare.

We can now well appreciate the farmers’ wisdom in choosing Sri Lanka’s North Western Province (NWP or Wayamba), North Central Province (NCP) and the Eastern Provinces for rice production, and specially when the timely needs of water (supplementing rainfall) are provided to the crop through the ‘tank’ [reservoir] system, during the preceding ‘growing’ period.

***Haen Govithan*: The Sun in Coconut Culture**

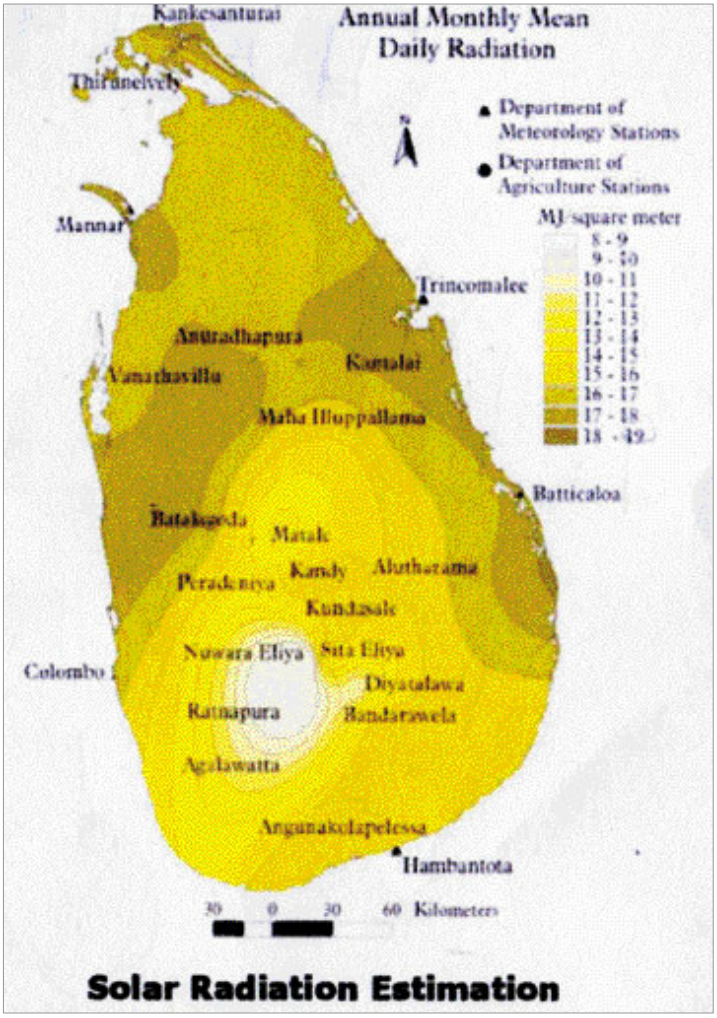
Coconut is our primary crop in the intermediate zone, as the agro-climatic region between the Wet and the Dry zones is described. The coconut palm has adapted well

to the NWP, with two periods of rainfall (April to June, and September to November) during a year of sunshine, as befits the needs of a perennial crop, with intensities of over 16 MJ/square metre/day. Such round-the-year sunshine is essential for the photosynthesis that moves the starches in the leaves and into the coconuts being formed at their axils (where they join the palm).

Thus, while the temperate crop (rice) is in particular need of sunshine during a few critical weeks of grain-filling prior to harvest, the perennial crop (coconut) needs that sunshine throughout the year that it took for the starches to flow into the nuts from the leaves.

Any period of low sunshine invariably results in a reduction of coconut crop in the following year. This has been well observed during the last few years (2006, 2007) and will sadly again be observed in the year ahead when heavy cloud cover sans rain in the first half of 2008 has blocked the sunshine from reaching the leaves.

Climate Change – or something else?



For some years, we have tried to link the fluctuation of coconut yields with variations in rainfall during the preceding year. But this co-relation was only partially correct because periods of rainfall are usually associated with cloud cover.

But exceptions in recent years have puzzled scientists. Coconut yields dropped following periods of heavy cloud cover that did not result in much or any rain. If it wasn't the reduced rain, what else was the limiting factor?

In fact, the 'climate change' we have thus experienced can be better attributed to changes caused by our own air pollution: micro particulates released into the air by partial combustion of imported petroleum fuels have formed nuclei upon which moisture in our normally humid airs have coalesced. This has resulted in an umbrella-like cover of cloud which blocks some of the sunlight from falling on to the crops and other foliage beneath.

The formation of such a haze – a man-made barrier to sunshine falling on our island – has frequently been observed by pilots flying over Colombo during the past few

decades. Sometime ago, we used to jokingly refer to it as 'Never-on-a-Sunday': reduced weekend traffic in the city provided some rapid but short-lived relief to the gradually spreading umbrella of haze (usually between 800 to 1,800 feet above ground level). Once we flew through this layer of haze, the skies were much clearer above.

With the growing human population and increased use of motorised vehicles, the area covered by this haze has gradually expanded over the country. This (imported) pollution can only increase with the coming of the coal-fired power generating stations around the country. Perhaps this is an inevitable price to pay for the pattern of 'progress' we have chosen to pursue…

When this slowly developing situation was described at meetings of prominent agricultural scientists some decades ago, their initial attitude was one of ridicule. But more recently, they have begun to take it more seriously as similar reports about the yield-effects of reduced sunshine have been reported from neighbouring countries -- and specially from lush Indonesia where increased burning (clearing?) of forests has left a pall of smoke hanging over the cities.

So what do we do?

In the past, the thinking was that there was little we could do about the lack of sunshine. The problem could not be resolved by heavier inputs of fertilisers or chemicals to correct so fundamental a problem caused by Nature – this indicated an inherent resistance to blaming ourselves for our predicament.

It was, however, realised that certain plants (known as 'C-4') contained an inherent characteristic to be more efficient in photosynthesis. This includes plants such as maize (corn), sorghum, sugarcane and bamboo, all of which can convert a greater quantity of Carbon Dioxide in the atmosphere into biomass through photo-synthesis.

Unfortunately for us, rice, wheat, coconut and other common crops do not possess this C-4 facility; they are described as 'C-3' for their ability to convert a lesser quantity of available Carbon Dioxide into biomass.

Is there something we can do to change this? The very words 'genetic modification' often result in raised eyebrows. This is with good reasons, for genetic manipulations by scientists have created or aggravated problems in both health and farming.

Already, the rice seed is known to be under genetic modification to C-4 characteristics, and the process is being strongly guarded by the internationally recognised research institutes from acquisition and exploitation by avaricious multi-nationals. That rice can be thus manipulated to become C-4 configuration is well known. And appropriate decisions need to be taken towards directing research effort also on breeding this characteristic in coconut. But that may take longer – perhaps several decades – as the breeding of perennial crops is more tedious and challenging.

Unless, of course, a fortuitous breakthrough is achieved through the dedication of our scientists. Meanwhile, improvements in certain recent cultural practises suggest fresh directions by which the photosynthetic capabilities inherent in the growing of this traditional crop may be enhanced.

Any research efforts to "breed" such characteristics into the coconut should be carefully monitored. However, the process could take decades, considering the more difficult conditions relating to the breeding of perennial crops. Meanwhile, recent changes in traditional practices in the growing of coconut suggest fresh directions by which the tree's photosynthetic capabilities may be enhanced.

Part 2: Let farming come naturally

The importance of photosynthesis in agriculture has been recently reappraised, both for its role in the cultivation of commercial or food crops, and also as an agent for promoting the well-being of soil organisms (earthworms, etc.) that feed on decaying vegetation.

These organisms convert and recycle (through their digestive systems) the minerals present in the quartzes and sands of the soil, and into "plant-available-form" as nutrition for crops cultivated on and above the soil. This is the basis of natural farming, as practised worldwide. The practice is also termed "organic farming" or "green manuring": micro-fauna consume the micro-flora in the soil and recycle this nutritional content to feed crops being cultivated.

The processes of "composting" support and maintain the warmth required by these organisms. The art of composting has evolved to help accelerate the activity of these micro-organisms by giving them more favourable conditions in which to breathe, live and multiply.

In Sri Lanka, the traditional Kandyan Forest Garden has for generations deployed the wisdom and science behind the green manuring concept: forest vegetation flourishing under year-round tropical sunshine is used for food, fertiliser, fuel and forage.

Meanwhile, vegetative nutrition falling from the forest canopies enriches the soil below.[1]

Green manuring serves in the cultivation of the various spice plants grown commercially in the region, and also fruit trees like jak and breadfruit, and a variety of the legumes that form an important part of the local diet. These supplement the rice grown in the "*vela*" or levelled-paddies of the valleys below the "*haenas*" (or undulating-rain-fed-uplands).

Sadly, this was not understood by the tea planters of old who were more used to the open-field system of farming practised in the western and temperate regions they hailed from. They dismissed *haena* (or chena) cultivation as wasteful, failing to appreciate the subtle rotational and multi-function system in this form of farming. A revised system (now known as "alley-cropping" and "SALT", which stands for sloping agricultural land technology) is gaining fresh appreciation for its unique adaptability, especially in the world's humid-tropical regions in Asia, Africa and Central America.

Once condemned as a destructive "slash-and-burn" system, *haen govithan* or chena cultivation is now considered a preferable option for the land than the practice of cutting, burning and then digging up the naked, erosion-prone soils for mono-crops, such as coffee and tea.

If you happen to visit a forest region in search of a particular villager, you may hear the following: "*Neh mahatthaya, kelay eliya karande gihillah*", which can be translated as: "He is away giving light to the land." Previously, we might have translated this thus: "He has gone to clear the forest", implying "slash and burn". The farmer's real intent is only to prune the upper growth so as to let sunlight fall on the crops he has sown in the fertile and weed-free soils.

The cultivation of the rubber plant (*Hevea*) comes closest to the natural forest, and does not involve the pernicious and erosion-prone practice of "clean weeding" as practised on farms in the temperate western regions.

"Chemical farming" bypasses all these natural processes. Chemicals are applied directly to the crop being cultured. But this

[1] See http://books.google.com/books/about/The_forest_garden_farms_of_Kandy_Sri_Lan.html?id=G3QPo7lThXsC

practice invariably results in the destruction of a vast proportion of the soil-organisms, and pollutes sub-soil water resources leading to surrounding tanks, irrigation schemes and domestic wells.

Natural farming of coconut

A systematic reversion to natural farming is being researched in a modern approach to the growing of coconut, thus returning to the wisdom behind both the Kandyan Forest Garden and the more sustainable features of the *haena* system. This is achieved through the "companion" or complementary growing of fertility-restoring crops.

In the coconut approach, the alleys or avenues between adjacent lines of coconut palm alternate between the "gaman elliya" (covering plucking, collecting and transport) and the "saru elliya" (contributing towards the fertility needs of the system). Husks, if not dry-decorticated, are buried between the palms to perform the dual function of conserving (sponging) valuable moisture and recycling the palm's valuable needs of potassium and magnesium contained in the coir pith.

Harvesting and Sunshine

The harvesting of cultured crops usually takes place during the periods of brightest sunshine. The long summer-holidays enjoyed in the west were timed so that the children returning home from school could help their parents harvest the crops.

Around the world, the harvesting of crops has proven the most labour-intensive of all farming operations. The plucking of tea, the tapping of rubber, the picking of coconuts, the harvesting of rice (which involves cutting, gathering, conveying, threshing, winnowing, drying and bagging) – all take place in the brief periods of sunshine between monsoon rains.

Tea cultivation

It is little known that the tea bush (a temperate crop adopted from China and Japan) is, in the tropics, grown throughout the year, with year-round (muted) sunshine. The tea bush is selectively-harvested about once every five days. The tea bush in Japan, however, is mainly dormant during the winter months, and grows mainly in the sunnier spring and summer months; it is harvested only two or three times a year.

The bush, however, is cleverly "pruned" at the start of spring, so that a "two-leaves-and-a-bud" yield is achieved across the table for harvesting in one sweep (manually or mechanically). This precludes the need for the far more labour-intensive operation of "selective-plucking", and cuts down harvesting costs.

The lesson for us here is that "mechanisation" does not simply mean the "mechanic-ing" of a manual operation.

In 1964, this writer was presenting “The Land Master Saga” to an agri-business class at Harvard Business School. The lecture was enthusiastically received. Buckminster Fuller, the world famous engineering designer, happened to be a visiting lecturer and our course director. He rose and asked me: “Did your tractor mechanise tropical agriculture, or did it just mechanise the buffalo?”

I was “floored”. The class eagerly awaited my response. I could give none that was appropriate. The next morning the subject was taken up again with the question: “What was the farmer really trying to achieve when ploughing his field?”

And he quoted from Robert Browning: “A man’s reach must exceed his grasp, or what’s a heaven for?”

And thus began a new phase in my life: Reaching for the Sun.

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http://sundaytimes.lk/080622/Plus/timesplus0011.html