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# Serial Guesstimates, Cereal Grasses, Statistical Guidance and Surreal Genetics

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## Climate Change: No longer entirely the tip of an Iceberg

Climate change, which necessitates no formal introduction, is a juggernaut that requires a holistic universal response to mitigate, and local solutions to adapt. Climate change is provoked by the greenhouse effect, the retention of heat in the atmosphere (global warming) due to a handful of gases, namely carbon dioxide, methane, and nitrous oxide, but not limited to the above three. Sri Lanka, which houses as its highest elevation the Pidurutalagala Mountain at 2524m, is largely a nation with a flat terrain with the exception of the central highlands. Being an island nation surrounded by the Arabian Sea on one side and the Bay of Bengal on the other, can lead to unprecedented catastrophic events, although the knowledge base on such phenomena remain poorly understood. Climate change can be the root cause of drought, prolonged heat, cyclones and saltwater intrusions that can impact agriculture in Sri Lanka, and to limit the damage from cascading climate events should be a priority on the drawing boards, as we look to limit the detrimental effects of climate-magnified events in the country.

## Drought: Interaction of Weather with Cultivation

The community of climate scientists have come up with a five-themed classification of droughts, namely, 1) meteorological drought, 2) hydrological drought, 3) agricultural drought, 4) socio-economic drought and 5) ecological drought. While meteorological drought is a prolonged period of dry weather, hydrological drought encompasses water bodies facing shortages of water, agricultural drought is a period where crop growth is handicapped by the lack of water resources, socio-economic drought is supply shortages in the commodities markets propelled by the paucity of water, and the final, ecological drought, is widespread ecological impacts set in motion by poor moisture content in the soil.

The dry zone of Sri Lanka faces the most significant impacts of drought, while experiencing the strongest rainfall from the North East Monsoon and Second Inter Monsoon. In the intermediate zone, the monsoonal behavior closely resembles the dry zone, while in the semiarid zone, there are similar events of precipitation comparable to the dry zone. A reduction in droughts in Sri Lanka appear to be due to the increases in Light (2-10 mm) and Moderate (10-30 mm) rainfall in all four climatic zones. The Rainfall Anomalies Index showcases a stronger tendency for the Yala season to face droughts than the Maha season during the time bracket 1989-2012, but this trend appears to be shifting to the Maha season since 2012. The meteorological drought contributes to the

agricultural drought by exacerbating crop stresses, but there is no perfect correlation as to the basis of agricultural drought originating strictly from anomalies in rainfall patterns.

A tangible solution is provided by remote sensing and GIS [Geographic Information Systems] technology, in the surveillance and prediction of droughts. The ability of GIS to demarcate at district level, meteorological and agricultural droughts, provides the context for better disaster reduction & management, while also assisting in planning for the immediate future.

Drought tolerant crop varieties are now in the research pipeline and will fashion the next wave of cultivars that have superior capabilities to withstand acute water stresses. Root features such as root angle, root biomass, root anatomy, root length and root distribution are all significant factors for water uptake under drought conditions. A handful of drought tolerant QTLs [Quantitative Trait Loci] have been identified that are correlated with traits such as superior leaf water potential, deep root mass and root hair lengths.

A QTL is a local stretch of DNA that is correlated with traits (phenotypes) that vary in a population. The surrealism of plant breeding is in the mapping of a QTL - that affects the trait of interest - through statistical analyses of a linked genetic (molecular) marker. It should be noted that most agronomically-important traits are controlled by QTLs, where a gene or nearby collection of loci, confer a relatively minor effect to a discernable phenotypic trait. In an era of rapid DNA sequencing and precision bioinformatics (BLAST tools etc), zooming in on candidate genes determining a noticeable trait, is now easier than 50 years ago, i.e. the heyday of the Green Revolution. Epistasis though is a strong consideration since a single gene by itself is unlikely to be the sole criterion to a trait of interest, but the interactivity of mutations in a subset of genes that confers the total effect or "additivity" engineering a sought after trait. In summary, statistics and genetics can be termed as a marriage made in heaven for designer yields in the name of food security.

**Heat and Temperature: Two Peas in a Pod**

A rise in temperature can have disastrous effects on a crop. Such inhospitable effects include, poor grain filling, leaf abscission, limited shoot and root growth, pollen sterility and pollen tube anomalies, showcasing that both vegetative and reproductive stages of a crop are affected by rising temperatures. The changes in a plant emanating from high temperature can be divided along anatomical (leaf abscission), physiological (pollen sterility) and biochemical (poor transfer of carbon from source to sink) effects. In rice, the main staple of Sri Lanka, anthesis, fertilization and booting are mostly affected due to heightened temperatures, showcasing that reproductive stages are impacted more than their vegetative counterparts. Heat and temperature resistant cultivars are now strategically designed in research labs, as solutions to the scorching conditions brought on by a ruthless climate change.

**Flooding: Submerged Windfalls**

Flooding is a recurrent event in Sri Lanka. For example, in May 2017, heightened rainfall continuing for a 12 hour period in South Western regions led to the spillover of the Kalu, Nilwala and Gin rivers, impacting small scale crop vegetation in the wet zone.

The data from the year 2011 is symbolic as to the extent of damage flooding causes paddy cultivation; 1. 700,000 hectares of land cultivated in the Maha season out of which 200,000 hectares were destroyed by seasonal floods; 2. A target of 2.75 million MTs of rice which fell well below 1.75 million MTs; 3. Worst hit districts were Ampara, Batticaloa, Polonnaruwa, Trincomalee and Anuradhapura in the dry zone of the country. The effects of floods on a rice plant is manifold: 1. Nodes of rice plants can easily break; 2. Poor plant health can result from diminished photosynthesis due to poor penetration of sunlight; 3. Higher propensity of opportunistic pests can harm crop yields. QTLs that provide submergence tolerance to rice are now in the works elsewhere in the world and such QTLs (example *Sub1)* should now be introgressed to local cultivars to fashion the next generation of climate resistant rice varieties.

**Coastal Erosion and Saline Soils: Tolerating Saltwater**

The mean global rise in seawater levels approximates to 210-240 mm since 1800s, with a mean rise of 3mm per year, but this phenomenon remains variable depending on the wind patterns and ocean currents. The rise in seawater levels has repercussions not just on the coastline but also the ecosystems in the vicinity, as well as internal aquifers that can be contaminated by the rising intrusive sea levels. Paddy cultivation can be impacted by the rising sea levels due to the high

levels of entrenched salinity that can have negative reverberations on the productivity of the paddy fields. Salt-tolerant cultivars are the way ahead to resist the salinization of soils, and QTLs such as *Saltol* have given a fresh lease of hope for paddy cultivation to not be impacted significantly by rises in sea levels. To adopt – introgress – such QTLs to high yielding local varieties should be the ideal path ahead.

**Epilogue: From Yesteryear to Tomorrow**

Famed visitors to Sri Lanka included, Ibn Battuta, Marco Polo and armadas from colonial powers, but in today's world the uninvited visitors come in the form of cyclones and hurricanes. While Ibn Battuta and Marco Polo were readily welcomed to our shores, the effects of climate change are unwelcomed visitors to our teardrop-shaped isle. Climate change amplifies a bevy of dramatic events into magnified, ad hoc and constantly-evolving phenomena that can threaten the fabric of grassroots life. In such a landscape, we need to embark on early warning systems, to be able to tell when and where – preferably at the district level - a climate event will hit, and to be able to scope the probable damage that the event can cause.

Marco Polo once said of Sri Lanka, "*They have no grain other than rice. They have sesame, from which they make oil. They live on milk, flesh and rice and have wine made from trees*". Yes, we have no grain but rice to feed us, and no threat like climate change to pulverize paddy fields and waste millions of tons of golden harvests. Marco Polo visited Sri Lanka in the 1200s, and this may have coincided with the ensuing period following the demise of the Polonnaruwa Kingdom (1070 to 1232), when Sri Lanka was renowned as the granary of the orient. This was the most prosperous of epochs, especially during the reign of king Parakramabahu I (1123 to 1186), who literally built a reservoir that rivaled the size of an ocean (*Parakrama Samudraya* translating into Parakrama Ocean) to nurture paddy cultivation.

Fates woven into meteorology can befall our country. Keeping "meteorologically" vigilant and prophetic are musts under such fickle circumstances. Serendipity means we are the lucky ones, but luck too is the residue of design as quoted by one of the greatest baseball managers (Branch Rickey of Brooklyn Dodgers) the world has ever seen, and echoed by the IRRI scientist, Peter Jennings, who played a pivotal role in the design of the high-yielding semi-dwarf cultivar, IR8. Climate Smart Agriculture in Sri Lanka, should demand a red carpet, a blank check book and a green light, to outsmart the meteoric rise of a "Franken" climate change. The clock is ticking as we speak, while the perils are alarmingly closer than we think. There is no place for wishful thinking, only harvests of evidence-laden science triumphing over a behemoth climate change.

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