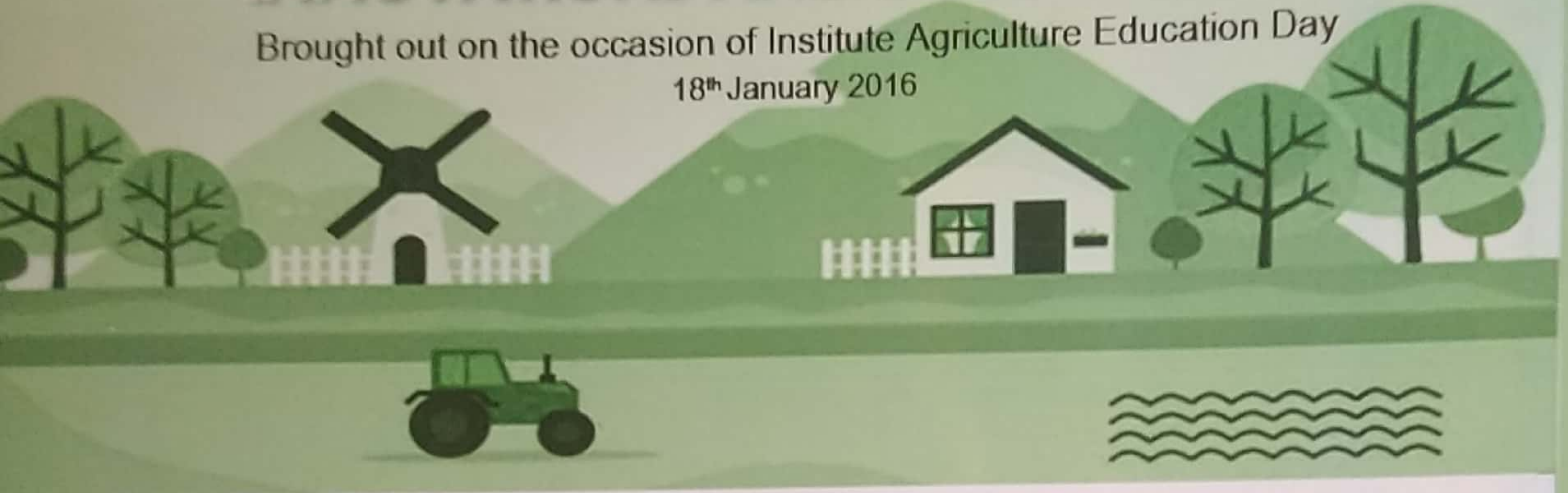




हर कदम, हर उजर  
किसानों का हमसफर  
सहज गृह आराम पालक  
*AgrEsearch with a human touch*

# AGRICULTURE : THE CUTTING EDGE OF INNOVATIONS AND DEVELOPMENT

Brought out on the occasion of Institute Agriculture Education Day  
18<sup>th</sup> January 2016



## Glowing Plants: Natural Lighting with no Electricity

Biotechnology scientists are now using genetic engineering technology to develop plants that emit their own light that could one day replace streetlights to fill with glowing leaves lining highways to light the way for drivers, or a street lined with energy-neutral trees instead of electric street lamps. Traditionally, the gene for luciferase [an enzyme from a luminescent organism] from fireflies along with a promoter [a region at the beginning of a gene that tells a cell to start transcription, the first step to producing a protein] are inserted into plant genome and then add the luciferin [a chemical that produces light when oxidized] manually.



## Nutraceutical: New thought for Good Health

The term 'nutraceutical' is derived from the words 'nutrition' and 'pharmaceutical' also known as Molecular medicine. Thus, nutraceutical is a food or a part of the food which exerts a curative or preventive effect on disease. These include various nutrients, dietary supplements, specially designed diets or herbal products. The phytochemicals present in these foods have wide range of therapeutic effects against a number of diseases like diabetes, heart disease, common cold, arthritis, cancer, hypertension, dyslipidemia, inflammatory bowel disease, depression etc. Compounds like phenylpropanoids, isoprenoids, polyphenols, anthocyanidins, flavonoids, terpenoids, carotenoids, phytoestrogens and alkaloids etc. are responsible for the beneficial effects of diet rich in fruits and vegetables (fig.1). Melatonin (N-acetyl-5-methoxytryptamine) is also found in plant diets which produce kynuramine, a biogenic amine, by oxidative metabolism. Kynuramine



Fig. 1

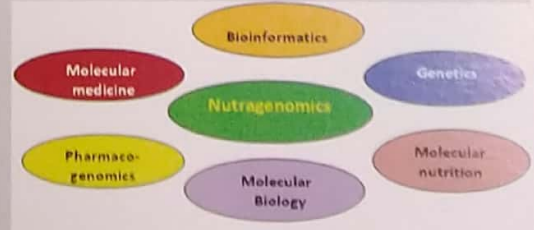


Fig. 2



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improves mitochondrial metabolism, acts as cyclooxygenase-2 inhibitor and an important antioxidant. The interface between the nutritional environment and cellular/ genetic processes is termed as 'nutrigenomics' (nourishment genome science). Nutrigenomics is newly developed methodology combined with multiple genomic techniques and molecular biology technologies (fig.2). It has been then used as a basic technology that became a driving force for the creation of Nutraceuticals.

## Development of Colored Cotton

Cotton fibers are naturally white. Industrially they are coloured by synthetic chemical dye which is potent environmental pollutant. Cotton fiber colour modification by transgenic approach will reduce the need of dyeing it chemically. The approach not only will save the cost of dyeing, but also help to develop environmentally sustainable way of lint colouration. Transgenic expression of delphinidin genes in cotton can likely change the lint colour. Expression of tyrosinase gene will greatly enhance melanin biosynthesis and as a result lint can be changed to brown. Engineering the tryptophan biosynthetic pathway by simultaneous expression of tryptophanase (tryptophan to indole) and naphthalene dioxygenase (indole to indigo) can modify the lint colour as indigo. Transgenic cotton plant with coloured lint may be proved as strikingly important both economically and environmentally.

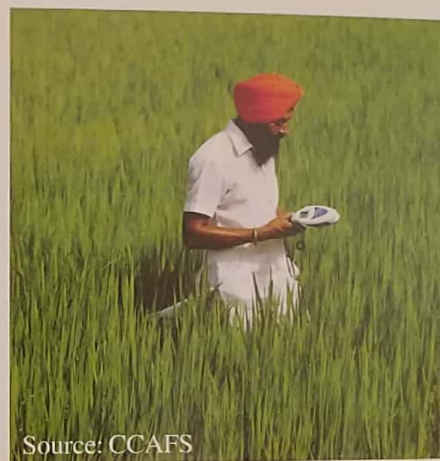


## Precise Nitrogen Management using Hand-held Crop Sensor (GreenSeeker)

The consequence of mismanaging nitrogen fertilizer application in crop plants is costly from production, economic and environmental perspectives. This is why developing effective nitrogen fertilizer decision tools have been a continuous endeavor. Soil scientists and agronomists initiated a concerted research effort to develop an optical sensor-based decision tool to assist producers in managing nitrogen fertilizer. With this approach, nitrogen recommendations are done instantly in the absence of soil and plant tissue tests. GreenSeeker N-sensor is a system for differential application of nitrogen fertilizers and drawing up of biomass maps and application norms basing on crops measuring in real time. Sensors measure plants normalized difference vegetation index (NDVI; standardized index of plant cover differences). This data can be used together with agronomical information to determine need for nitrogen.



GreenSeeker



Source: CCAFS

The GreenSeeker ensures accurate and balanced nitrogen fertilizer applications, cutting farmers' costs, reducing nitrification and nitrogen runoff into groundwater and water systems, and raising crop yields.

## Towards the Development of a C<sub>4</sub> Rice

To meet the food demand of the soaring population, rice yields should increase by at least 50% within next four decades. Despite the best efforts of plant breeders, the prospect of a second drastic increase in yield using conventional approaches is unlikely but may be possible, if we redesign rice photosynthesis into C<sub>4</sub> type. Most of our conventional crops, including rice and wheat assimilate atmospheric CO<sub>2</sub> by the C<sub>3</sub> pathway of photosynthesis, which takes place in the mesophyll cells of the leaves. In one hand these plants assimilate atmospheric CO<sub>2</sub> into sugars, but in the other hand, part of the potential for sugar production is lost by photorespiration in daylight by releasing CO<sub>2</sub> into the atmosphere. This is due to the dual function of the key photosynthetic enzyme ribulose 1, 5-biphosphate carboxylase/oxygenase (Rubisco), in which high CO<sub>2</sub> favors the carboxylase reaction and thus net photosynthesis, whereas high O<sub>2</sub> promotes the oxygenase reaction leading to photorespiration, which reduces net carbon gain and productivity of C<sub>3</sub> plants by 40%. So, the recent trend in research is to develop a C<sub>4</sub> type of photosynthesis in C<sub>3</sub> plants like wheat and rice by transferring the concerned genes which could facilitate an increase in yield potential to levels found in C<sub>4</sub> crops like sorghum and maize with their leaf structure of Kranz anatomy (mesophyll cells surrounded by bundle sheath cells). Another possibility is for cloning and transferring C<sub>4</sub> photosynthetic genes from a single cell C<sub>4</sub> photosynthetic species *Borszczowia aralocaspica* and *Bienertia cycloptera* (Chenopodiaceae) grown in desert which lacks Kranz anatomy.

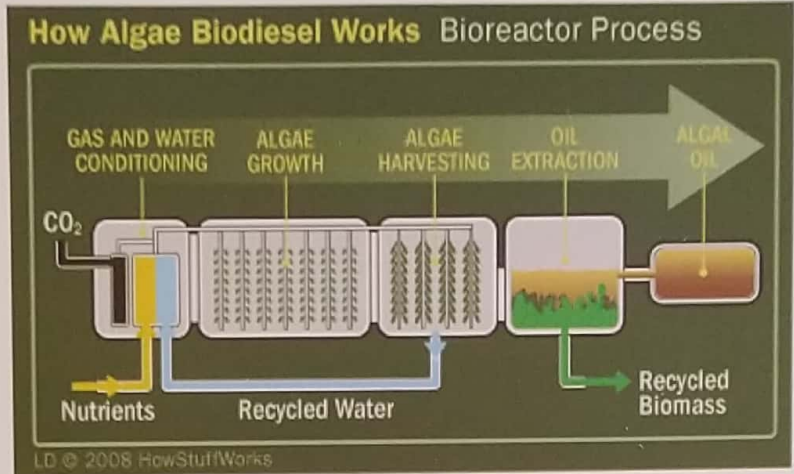


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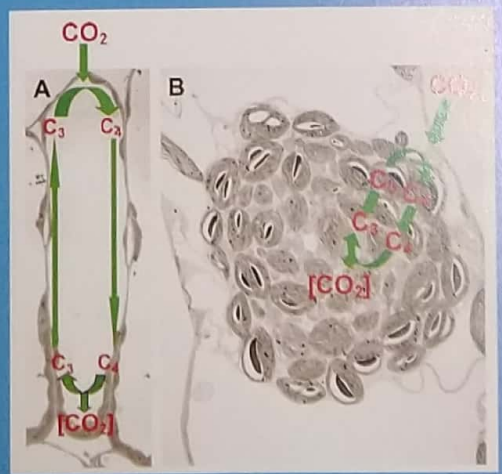
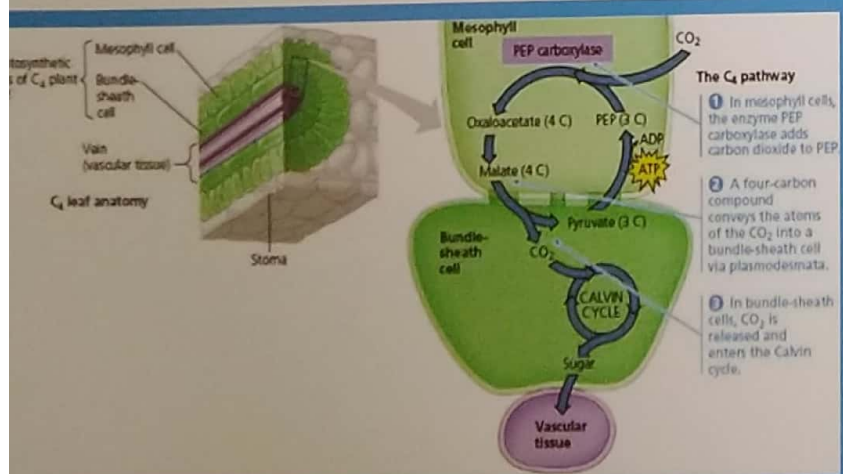
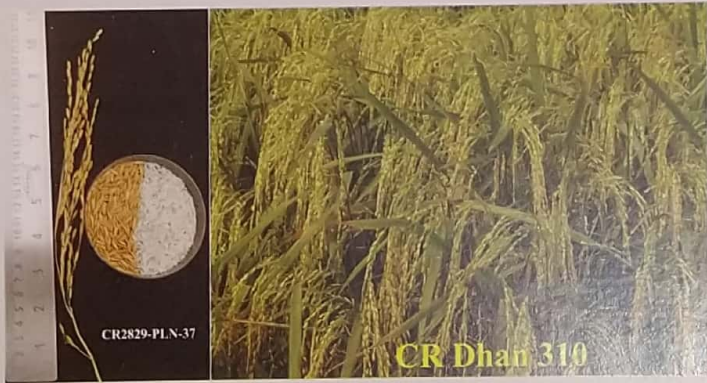
# Biodiesel from Algae

Continued use of petroleum sourced fuels is now widely recognized as unsustainable because of depleting supplies and the contribution of these fuels to the accumulation of carbon dioxide in the environment. Biodiesel derived from oil crops is a potential renewable and carbon neutral alternative to petroleum fuels, but unfortunately it is not able to satisfy even a small fraction of the existing demand for transport fuels. With the need to reduce carbon emissions, and the dwindling reserves of crude oil, liquid fuels derived from plant material – biofuels – are an attractive source of energy. Microalgae appear to be the only source of renewable biodiesel that is capable of meeting the global demand for transport fuels. Like plants, microalgae use sunlight to produce oils but they do so more efficiently than crop plants. Among algal fuels' attractive characteristics are that they can be grown with minimal impact on fresh water resources and are biodegradable and relatively harmless to the environment if spilled. Oil productivity of many microalgae greatly exceeds the oil productivity of the best producing oil crops. Microalgae offer great potential for exploitation, including the production of biodiesel, but the process is still some way from being carbon neutral or commercially viable.



# CR DHAN 310- A High Protein Rice

Rice varieties with high grain protein content can significantly contribute towards the better nourishment of millions of unprivileged children who depend mainly on rice for their nutrition. National Rice Research Institute has developed two backcross populations using high grain protein content grain protein content (GPC) donor, ARC10075, a germplasm line from Assam rice collection at NRRI gene bank. Based on average performance over the location, a backcross derived line in Naveen background, (CR Dhan 310), with average 10.2% GPC in polished rice has been identified for release at national level as Indian first high yielding variety with high GPC. It has medium slender grains with high yielding ability (national average- 4483 kg/ha) and acceptable grain and cooking qualities.



C4 Photosynthesis pathway in maize and single cell C4 pathway in *Bieneria cycloptera* a desert plant

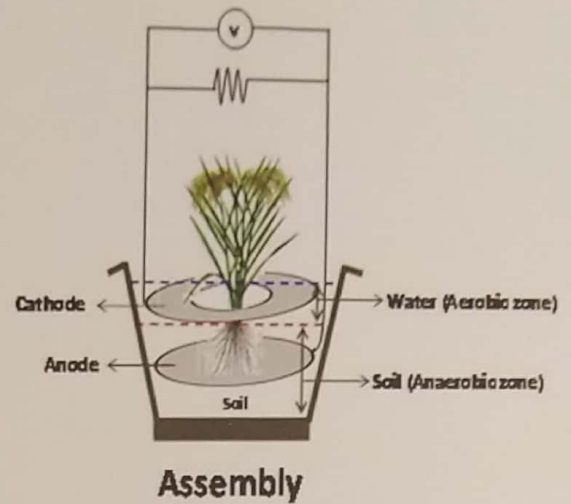


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## Electricity Generation from Rice Field for Underdeveloped Area

Paddy fields normally remain as water logged and the ecology supports the development of anaerobic microbes. Methanogenic bacteria produce methane from the field causing substantial contribution to Global warming. The excess photosynthate of rice plants are exhausted from the root as exudates which are utilized by microbes. The oxidation of the organic matter by microbes generate free electron. If this electron could be captured efficiently by putting artificial electrodes (microbial fuel cells-MFC) in the field, we could generate electricity. Methanogenesis and electrogenesis compete for organic matter in paddy field. So operation of paddy field MFC would greatly facilitate to reduce methane emission from the field. In this way, research in this area would not only help to generate local electricity for the backward areas, but also would help to mitigate the problem of methane emission from rice field.



## 2015 as the International Year of Soils

On December 20, 2013, the 68<sup>th</sup> UN General Assembly declared December 5<sup>th</sup>, 2014 as World Soil Day and 2015 as the International Year of Soils giving official recognition for the importance of soils.



## A Grain Saved is a Grain Produced: Controlling Store Grain Pests

Post harvest losses were estimated from 9% in developed countries to 20% or more in developing countries due to stored product insects. Concepts of "A grain saved is a grain produced" and "hidden harvest" are being incorporated to achieve food security. But concerns over the adverse effects of chemical fumigant residues on human health and the environment have led strict limitations on fumigant registration. In recent years, essential oils (EOs) derived from aromatic plants are becoming popular to control store grain insects. Essential oils (EOs) are belonging mostly to terpenoids and obtained from distillation of 17,500 aromatic plant species. ICAR-NRRI evaluated essential oils as grain protectant against rice weevil, *Sitophilus oryzae* and paddy moth *Sitotroga cerealella*.

Pheromone against rice storage pest management (as traps) against paddy moth *Sitotroga cerealella* is another successful option. Uniformity in effectiveness of these chemicals, shelf life and lack of proper formulation are the hindrance to make it successful.



Essential oils

Kill store grain pests



Rice store grain pests

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