- CRRI, for the first time in India, has installed OPEC system in lowland (flooded) rice paddy ecosystem for continuous monitoring of NEE between rice paddies and the atmosphere for characterization of ecosystem carbon budget.
- The integrated season-long NEE value measured by OPEC in lowland (flooded) rice paddies was -3.78 t C ha^{-1} and the derived GPP and RE values were in the order of 7.05 and 3.27 t C ha^{-1}, respectively.
- The integrated one year-long NEE values in flooded rice paddy ecology (rice-fallow-sequence) monitored and estimated by the OPEC was - 10.25 t C ha^{-1} yr^{-1}.
- Ch_4 efflux throughout the season varied significantly depending upon the cultivar type and mid-season drainage, alternate wetting and drying reduced the CH_4 emission as compared to continuously flooded rice soil.
- The integrated CH_4 and N_2O emissions measured by high frequency chamber measurement were 128 and 0.67 kg ha^{-1} yr^{-1}, respectively.
- Application of N-fertilizer found to be the most important factor controlling N_2O emission from flooded rice paddies.
- Adoption of legume cultivation stored more carbon in soil and substantially reduced CO_2 efflux from soil as compared to maize cultivation following rice in a rice-maize-legume cropping system.
- HRD programmes for demonstration of this technology were done to develop trained manpower in this new frontier of agro-environmental science.

Points to remember

- The open path eddy covariance system must be installed in the centre of a rice paddy ecosystem and should be surrounded by similar ecology.
- The fetch area of the system for monitoring of the flux of scalars of interest must be properly calculated which must be proportionate with the sensor height and depends on the wind direction, velocity and turbulence.
- There should not be any hindrance or obstacles between the sensors and the targeted fetch area from where flux of scalar of interest is coming to the system.

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Advance Technology for Greenhouse Gas Monitoring in Rice & Rice-based Cropping Systems

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The global atmospheric concentrations of greenhouse gases like (GHGs) carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) have increased markedly as a result of human activities since 1750 and now far exceed the pre-industrial values. The global atmospheric concentration of CO_2, CH_4 and N_2O increased from a preindustrial value of about 280 ppm to 387 ppm, 715 ppb to 1774 ppb and 270 ppb to 319 ppb at present, respectively. The natural as well as anthropogenic activities have serious effects on the GHG emissions. GHGs differ in their warming influence (radiative forcing) on the global climate system due to their different radiative properties and lifetimes in the atmosphere. Changes in the atmospheric concentrations of GHGs alter the energy balance of the climate system which leads to subsequent climate change. Atmospheric concentrations of GHGs increase when emissions are larger than removal processes.

These GHGs have profound impact on global climatic changes resulting into increase in ambient temperature which is likely to affect agriculture. Agriculture is considered to be one of the major anthropogenic sources of atmospheric GHGs. CO_2 is the most important anthropogenic GHG and is mostly originated from industrial activities, deforestation, burning of fossil fuels, land use changes and microbial decomposition of soil organic matter. But, CO_2 has a significant impact on crop photosynthesis, agricultural production and productivity. On the other hand, the increase in CH_4 concentration is predominantly due to agriculture and fossil fuel use while the increase in N_2O is primarily due to agriculture.

Rice cultivation is considered as one of the most important anthropogenic sources of CH_4 and N_2O

Rice cultivation is considered as one of the most important anthropogenic sources of CH_4 and N_2O emissions. Rice is the one of the important cereals consumed by the majority of Indian population and rice-based cropping systems are the mainstay of Indian agriculture. However, by providing food to rapidly increasing population it is anticipated to cause damage to the environment by becoming a source of GHGs like CO_2, CH_4 and N_2O. Flooded rice fields can act both as source or sink of GHGs depending on the cultivation processes, agricultural operation and management practices. Thus technologies should be aimed at monitoring, budgeting and mitigating of GHGs emissions from rice and rice-based cropping systems keeping in mind the sustained agricultural productivity and better soil health.

GHGs monitoring technology

- An advanced technology by simulating net ecosystem exchange (NEE), high frequency chamber measurements of CH_4, N_2O and soil-plant respiration for monitoring the real time GHG emission in rice ecosystems.
- Site specific NEE of CO_2 through open path eddy covariance (OPEC) system along with high frequency chamber measurements of CH_4 and N_2O and soil respiration by soil respiration chamber in rice and rice based cropping system, real time GHGs monitoring could be done very precisely and accurately.
- Merging of net ecosystem production (estimated through OPEC technique) with measurable net gains and losses of carbon, net ecosystem carbon budgeting could be quantified.
- NEE is measured continuously by OPEC applying Webb-Pearman-Leuning (WPL) correction terms and gap-filling with the computer simulation programmes. NEE is further partitioned into gross primary production (GPP) and ecosystem respiration (RE). RE is extrapolated from night time fluxes to daytime by using temperature response functions and afterwards GPP is calculated by subtracting RE from NEE.
- The eddy covariance (EC), a micrometeorological technique, is the most important method for measuring the trace gas exchange between the terrestrial ecosystems and the atmosphere. It can be employed to measure net ecosystem CO_2 exchange (NEE) or net ecosystem production (NEP).
- Technique uses the covariance between rapid fluctuations in vertical wind speed measured with a three-dimensional ultrasonic anemometer and simultaneous measurements of the rapid fluctuations in the CO_2 concentration as measured by a fast-response infrared gas analyzer (IRGA). A positive covariance between vertical fluctuations and the CO_2 mixing ratio indicates the net CO_2 transfer into the atmosphere from plant-soil system and a negative value indicates net CO_2 absorption by the vegetation.

- CH_4 and N_2O emissions are measured through chamber measurements. High frequency chamber measurements are very user friendly to quantify GHGs emission through out the cropping period. From the chambers (equipped with pulse pump for homogeneous mixing of air sample inside the chamber over specific time period) air samples are collected in tedlar(R) bags at 0, 15 and 30 minute intervals. Samples are then collected by syringe for analysis of CH_4 and N_2O by gas chromatography using flame ionisation and electron capture detectors, respectively.

- Soil respiration is quantified by infrared gas analyzer (IRGA) which measures the increase of CO_2 concentration in enclosed chamber over a specified time.
- All the real time GHG monitoring data recorded by OPEC technique could be validated any time with the datasets of high frequency chamber measurement of CH_4 and N_2O and Co_2 measurement through the infrared gas analyzers with the help of soil and canopy respiration chambers.
- The another advantage of this technique is that OPEC system continuously monitors and stores half-hourly and hourly CO_2 flux data using which carbon footprint analysis of specific ecosystem can be characterized precisely.

Achievements

- Using the advanced GHGs monitoring technology the annual GHGs emission was found -36.88 t ha^{-1} yr^{-1} CO_2 equivalents in flooded rice-rice cropping system. This indicates that rice fields actually behave as a net sink of carbon.