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.

CH₄ efflux throughout the season varied significantly depending upon the cultivar type and mid-season drainage, alternate wetting and drying reduced the CH₄ emission as compared to continuously flooded rice soil.

The integrated CH₄ and N₂O 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 N₂O emission from flooded rice paddies.

Adoption of legume cultivation stored more carbon in soil and substantially reduced CO₂ 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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matter. But, CO₂ has a significant impact on crop photosynthesis, agricultural production and productivity. On the other hand, the increase in CH₄ concentration is predominantly due to agriculture and fossil fuel use while the increase in N₂O is primarily due to agriculture.

Rice cultivation is considered as one of the most important anthropogenic sources of CH₄ and N₂O.

Rice cultivation is considered as one of the most important anthropogenic sources of CH₄ and N₂O emissions. Rice is 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 CO₂, CH₄ and N₂O. 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 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 CH₄, N₂O and soil-plant respiration for monitoring the real time GHG emission in rice ecosystems.

- Site specific NEE of CO₂ through open path eddy covariance (OPEC) system along with high frequency chamber measurements of CH₄ and N₂O 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 CO₂ 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 CO₂ concentration as measured by a fast-response infrared gas analyzer (IRGA). A positive covariance between vertical fluctuations and the CO₂ mixing ratio indicates the net CO₂ transfer into the atmosphere from plant-soil system and a negative value indicates net CO₂ absorption by the vegetation.

- CH₄ and N₂O 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® bags at 0, 15 and 30 minute intervals. Samples are then collected by syringe for analysis of CH₄ and N₂O 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 CO₂ 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 CH₄ and N₂O and CO₂ 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 CO₂ 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 CO₂ equivalents in flooded rice-rice cropping system. This indicates that rice fields actually behave as a net sink of carbon.