Advanced Research Facilities developed under National Initiative on Climate Resilient Agriculture (NICRA)

D.J. Rajkhowa, R. Krishnappa, S. Hazarika, Anup Das, U.S. Saikia and S.V. Ngachan

ICAR RESEARCH COMPLEX FOR NEH REGION

Umiam, Meghalaya 793 103

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Compiled and Edited by

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Introduction

Climate change has become an important area of concern for India to ensure food and nutritional security for growing population. The impacts of climate change are global, but countries like India are more vulnerable in view of the high population depending on agriculture. In India, significant negative impacts have been implied with medium-term (2010-2039) climate change, predicted to reduce yields by 4.5 to 9 percent, depending on the magnitude and distribution of warming. The Government of India has accorded high priority on research and development to cope with climate change in agriculture sector. The Prime Minister's National Action Plan on climate change has identified Agriculture as one of the eight national missions. With this background, the ICAR has launched a major Project entitled, **National Initiative on Climate Resilient Agriculture (NICRA)** during 2010-11 with the following objectives:

- To enhance the resilience of Indian agriculture covering crops, livestock and fisheries to climatic variability and climate change through development and application of improved production and risk management technologies
- To demonstrate site specific technology packages on farmers' fields for adapting to current climate risks
- To enhance the capacity building of scientists and other stakeholders in climate resilient agricultural research and its application.

India is expected to face severe impacts of climate change and the country's north eastern region is highly vulnerable. Agriculture in north east is heavily dependent on climate and therefore, a slight shift in climate could severely affect the agriculture and hence food and livelihood security of the people. The signs of climate change in NEH are becoming increasingly evident in terms of rising temperature and changing rainfall pattern. The annual maximum and minimum temperature during 1901-2003 have increased by 1.02 °C and 0.6 ^{0}C/100 years. Temperature is projected to rise by another 3-5 °C during the latter half of this century. Frequent occurrence of droughts, floods and even flash floods further substantiate the impact of climate change in the region. These changes are expected to intensify further in the near future which are likely to reduce the agricultural productivity. The perceptible changes in climate and current scientific evidences warrants an urgent need for development and application of improved production and risk management technologies in the field of agriculture for north eastern region of the country. With this background in view, NICRA project was launched in ICAR Research Complex for NEH Region, Umiam, Meghalaya and its six (6) regional centres viz. Basar (Arunachal Pradesh), Lamphelpat (Manipur), Jharnapani (Nagaland), Tadong (Sikkim), Lembucherra (Tripura) and Kolasib (Mizoram) during 2011 with the following major objectives:

- Identification of temperature tolerant rice and maize varieties for north eastern hill ecosystem.
- Assessment of mitigation potential through SWM practices for enhancing climatic resilience.
- Understanding the unique traits in indigenous pig and poultry which make them resilient to climate change and development of data base.

Social Division along with other Divisions and some Krishi Vignan Kendras (KVKs) under the Institute are involved in Technology Demonstration Component (TDC) in identified villages and disseminating technology to the climate sensitive hill farmers.

State of the art facilities have been developed in ICAR Research Complex for NEH Region, Umiam and its regional centres under NICRA to carry out advance scientific research for strengthening the climate resilient agriculture in the region. Glimpses of the advance research facilities developed under NICRA along with their features and applications are described in this publication.

Carbon dioxide Enrichment Technologies

A number of technologies have been developed in the recent years to study the impact of climate change on agriculture. Earlier techniques were based on controlled environment such as closed chambers, cuvettes, phytotrons etc. which are far from the natural environment, in which plant naturally grow. However, technologies such as FACE (Free Air CO_2 Enrichment), FATE (Free Air Temperature Enrichment), OTCs (Open Top Chambers), SPAR (Soil Plant Atmosphere Research), CTGC (Carbon Temperature Gradient Chamber) with holistic approach have been developed and are being currently used for crop response studies. The data base generated using these facilities seems to be more realistic for impact assessment analysis of rising atmospheric CO_2 and temperature on crop plants for developing models to predict responses for future climatic conditions.

Carbon dioxide- Temperature Gradient Chamber (CTGC)

CTGCs (2.5m x 3m x 30m) are made of framework of semi circular pipe coated with zinc. These are covered with UV-transparent polyvinyl films (0.15 mm thick) which has a transparency of 65–85% at wavelengths of 250–700 nm and is manufactured with dew-

Carbon dioxide- Temperature Gradient Chamber (CTGC)

preventing treatment on its inner surface. The cooling wall in the chamber is covered with porous polypropylene screen (8x8 clear strands per cm). Air in the chamber is heated by solar radiation. However, at low radiations, oil heaters are used. Set of oil heater and ventilators are used to maintain temperature gradient inside the chamber.

The gradient of temperature can be increased to the extent of 5°C warmed conditions at the air outlet, rising at a rate of 1°C at 5m intervals across the chamber despite great daily and seasonal changes in ambient air temperature. Also, CO_2 concentrations were linearly increased from the air inlet to the outlet from 370 ppm and 750 ppm (doubled the concentration) respectively.

In order to achieve the target temperature and CO_2 concentration gradient in the chamber, the CTGC has a control on ventilation rate according to the fluctuation of ambient air temperature and regulation on electronic mass flow controller, flow direction changer and pressure regulator. The injection system includes a blower, injection pipes, CO_2 and temperature measuring system. CO_2 (conc. 370, 530 and 750 µmol $mol^{-1,}$ respectively at 0, 10 and 25 m away from the air inlet) is supplied through longitudinal pipe installed at 10 cm height along inside wall of CTGC. Environmental variables such as soil temperature, relative humidity, incident solar radiation etc. can be recorded.

Specifications

The Carbon dioxide and Temperature Gradient Chamber (CTGC) facility consists eight 30x6x4m chambers with

1. Two chambers with temperature gradient of 5°C above ambient
2. Two chambers with temperature gradient of 5°C above ambient + uniform concentration of elevated CO_2 (550 ppm)
3. Two chambers with uniform concentration of elevated CO_2 (550 ppm)
4. Two chambers with ambient temperature and CO_2 with all structural fittings of S.No.2
5. All the chambers are covered with high quality, light weight, rigid, corrugated polycarbonate sheet of Lexan and BIS grade, with excellent impact and weather resistance, superior clarity, versatility with >90% light diffusion and with >85% PAR transmission. The thickness of the sheet is 4mm.
6. Each chamber is provided with 12 no's of sensors for temperature and relative humidity appropriately located and controlled by RTD/Thyristers to maintain the temperature gradient of 7.0±0.5°C with reference to ambient temperature. Temperature sensors have provision for measuring range 0-100°C, with an accuracy of ±0.2°C and a resolution of 0.02%. The RH sensors range of 0-100% with accuracy of 0.5% and a resolution of 0.02%.
8. The chambers with elevated CO_2 are provided with provision for proper monitoring and control system to maintain uniform CO_2 concentration vertically and horizontally even in combination with gradient temperature condition.

9. Control panel consists of temperature, humidity and CO_2 controller attached with software PLC (Programmable Logic Controller) and SCADA (Supervisory Control and Data Acquisition) control system
10. Air circulating unit has the provision for maintaining set humidity and temperature with at least 90% efficiency and aerosol disinfector humidifier to attain a maximum of 80% RH.
11. IRGA along with pump pack considering as a set CO_2 monitoring by microprocessor based CO_2 analyzer with non-dispersive infrared absorption (NDIR) measuring method. The repeatability of the CO_2 analyzer within ±0.5% of full scale and response time of 1-3 seconds; within ±1% of linearity; ±0.5% of noise of full scale with in-built temperature and relative humidity measurement facility. Before air sample enters the analyzer, it should pass from the moisture removal device to safe guard the analyzer from excess humidity. The provision for measuring CO_2 concentration should be made through 6 sampling points in each chamber by a dedicated CO_2 analyzer with pump pack and should be interfaced with SCADA and PLC.
12. Heating system for four chambers (2 only temperature; 2 with both temperature and CO_2): The gradient of 5±0.5°C above ambient increase in temperature within

CTGC facility at Agro-forestry field of ICAR Research Complex, Umiam

each chamber with 1±0.5°C increase at regular interval are set with proper control and regulation. The temperature settings have a cut off for above 50±0.5°C under any circumstances. The provision to program variable temperatures for different durations and an in-built alarm system for different trouble shooting events need are provided.

Applications

1. To evaluate the physiological, bio-chemical and phenological responses of crop genotypes to the interactive effects of elevated temperature and CO_2
2. To assess the interactive effect of elevated temperature and CO_2 on Carbon metabolism (photosynthetic rate, chlorophyll fluorescence etc.).

Free Air Temperature Enrichment (FATE)

FATE facility comprises of ring like structure of 8m diameter with steel pole erections around the ring to support infra red (IR) lamps (1500 – watt) positioned at an angle of 40° and about 1.2 m above ground which can homogeneously irradiate 40-50 cm path of vegetation. These lamps are regulated by proportional action controller, which modulates IR flux density (frequency, 10 Hz) to obtain a preset target temperature differential (T) between heated and a corresponding unheated plot. IR lamps, used in simulating temperature, are made of tungsten filament and can irradiate at 2000 °C. Filter is used selectively to cut off visible light so that light can be continued in night. It also removes wavelength to which phytochrome is sensitive so that photo morphogenesis can be avoided.

Specifications

1. Nine FATE rings with 8m diameter at elevated surface air temperature (ambient 30° C) and CO_2 (550 ppm) level with detachable arrangement and height adjustment (up to 2m) with respect to crop height.
2. Three rings each for maintaining the conditions of
   i) Ambient crop canopy temperature +3°C±0.5°C
   ii) Ambient crop canopy temperature +3°C±0.5°C and 550 ppm ±50 ppm CO_2
   iii) Ambient control with all structural fittings for temperature and CO_2 elevation
3. Heating system for maintaining elevated crop canopy temperature of +3°C±0.5°C is achieved through infra red heaters of 230V at one meter above canopy. The number of heaters to maintain set elevated temperature is fixed appropriately. Warming by heating system does not have any effect on photo-morphogenesis and no significant radiation emission shorter than 850 nm from IR heaters.
4. CO_2 supply system consists of pressurized and refrigerated CO_2 tank of min 20 kilo liters with all necessary accessories to maintain required pressure and temperature and with safety certificates. Gaseous CO_2 is supplied to each FATE ring through CO_2 supply lines.

FATE facility developed at ICAR Research Complex, Umiam under NICRA

5. Temperature, CO_2 controlling and monitoring system along with data storage and back up facility are installed. CO_2 monitoring by NDIR micro processor controlled CO_2 analyser with 0-2000 ppm range compensate the signal offsets caused by water vapour, temperature and barometric pressure. The heating system sense canopy temperature (with corrections for reflected infrared radiation from heaters) and use a proportional-internal-derivative (PID) feedback system to maintain the heating treatment.
6. Automatic Weather Station (AWS) including solar radiation, air temperature, relative humidity, rain gauge, wind speed and wind direction.
7. Soil moisture and soil temperature monitoring at depths of 15cm, 30cm, 45cm and 60cm preferably at four points in each FATE rings.
8. UPS system support all control and monitoring units with 2hrs back up.

Applications

1. To investigate the dynamics of carbon and nutrients in soil and plants under elevated CO_2 and temperature.
2. Generating data base on micro meteorological observations in the crop canopy under elevated temperature and CO_2 conditions.
3. Pest and disease incidence/dynamics under elevated temperature and CO_2 conditions.

Rain Out Shelter (ROS)

Rainout shelters (ROS) are the facilities designed to protect a certain area of land against receiving precipitations so that an experimentally controlled drought stress can be imposed on that area. There are two different types of rainout shelters *viz.* (1) static and (2) movable. Within the moveable design there are automatic/motorized and manual versions. The automatic version is signaled to move over the protected plot by a rain sensor and an electric drive system. Rain sensors activate electric motors to move the shelters along the tracks to cover the crop during a rainfall event. Once the rain stops, the shelter moves off the crop automatically. The manual version is moved either by manually switching the drive on ("manually driven") or by manually pushing it ("manually pushed") over the protected plot.

Many versions of motorized moveable shelters are available. The "classical" design used in many of these shelters consists of the same principle. A roof /walls structure is mounted on wheels on a track. The structure can be driven by electric motors. The drive can

Automatic rain out shelter facility at ICAR RC NEH Region

be switched on and off manually or via an electronic signal from a rain sensor. The structure is relatively heavy and often not allowing sufficient light inside. Besides covering a very large area this installation also includes an elaborate soil drainage system and control which allows growing crop plants and draining the water at will in order to impose soil moisture stress.

Specifications

Total area: 25´x30´ (750 Sqft) Height at center: 12´, Height at sides: 8´

Super Structure: Made of anti corrosive humidity resistant GI Sq. Pipe "B" Class of 2mm thickness, Structure with absolute strength to withstand maximum Indian wind load.

Covering: Top covered with 8mm thick triple walled U.V. stabilized polycarbonate sheet fixed with polycarbonate H & U profile, aluminum strip with gasket/silicon sealant, all edges/ joints to block and to avoid leakages, The sheet is fixed in manner escape the rains form sides.

Moving Device: Conveyer wheels on railing fitted with ball bearing system for easy movement of the shed, operated by motorized mechanism to move the rain out shelter to and fro.

Protection Wall: 45cm above and 30cm below ground level made 230mm thick of 1st class bricks of class designation 75cm in 1:6 CM (1: cement, 6: coarse sand) exposed wall duly plastered in cement sand mortar and painted with exterior grade paint mixed with silicon additives.

Applications

- To conduct experiments on water use efficiency of crops.
- To conduct experiments for better understanding of soil-plant-water continuum relationship.
- For large scale screening of genetic and breeding material.

Plant Growth Chamber

A plant growth chamber is a kind of arrangement, which is developed to create artificial environmental conditions whilst eliminating the variability found in nature. In this chamber or cabinet, temperature, light and humidity are controlled in such a way that one can create desired environment essential for research and testing for a particular seed or plant.

Product features for plant growth chambers may include touch-screen controls, observation windows, additional lighting, humidity control, spray nozzle packages, air-cooled condensing, remote-controlled condensing, dry alarms, cabinets and shelving, dimmable lighting, extended temperature ranges, and heated or glass doors. Most plant growth chambers are made of metal and covered in a white enamel finish. There are two basic models: reach-in and walk-in type. Reach-in plant growth chambers or incubators are often used in research applications. These provide lighting for vascular plants, and are used in plant pathology research, seed development, and many other applications. Reach-in plant growth chambers can have swinging, flip-open, or sliding doors. Some models have more than one chamber with the option of individual controls. These plant growth chambers are available in a variety of sizes to accommodate many different types of plants.

Plant growth chamber installed at ICAR Research Complex under NICRA

Lighting: The chambers use a combination of fluorescent and incandescent lamps to provide balanced daylight spectrum with 100% to 10% light intensity which is desirable plant growth. 'Dawn/dusk' conditions are simulated by the addition of a high proportion of red light. Light fixture is counter-balanced and heat from the lamps is removed by the refrigeration system. As an additional option, the height of the lamps can be adjusted using an external motor. This ensures that the growing conditions remain constant and the plants are not disturbed.

Refrigeration system: Cooling is provided using self-contained water cooled condensing unit with hot gas bypass for continuous compressor operation.

Airflow: horizontal or vertical airflow.

The plenum wall and floor design ensures a low air velocity guaranteeing a high degree of temperature/humidity.

Specifications

Lighting modules	:	Three (Low, Medium and High)
Lighting intensity	:	200 to 1000 mmol $m^{-2}s^{-1}$
Lighting type	:	Fluorescent and incandescent
Temperature range	:	+5°C to +40°C - lights off +10°C to +45°C- lights on
Humidity range	:	40%RH to 95%rh lights off 40%RH to 85%rh lights on
Airflow	:	Horizontal or vertical
Dimension	:	

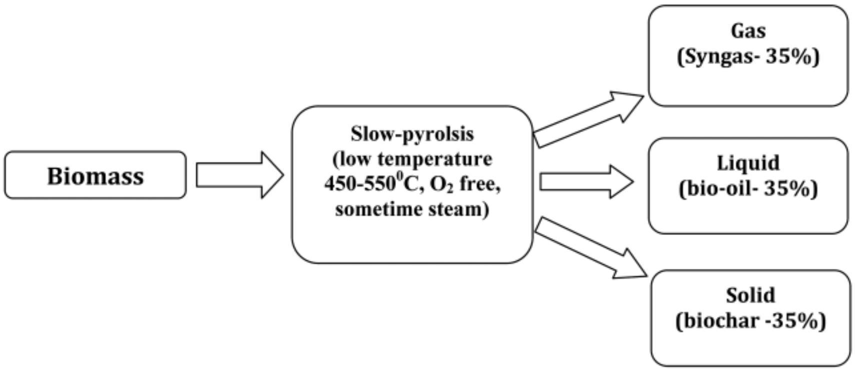
Applications

Plant growth chambers are extensively employed for agricultural and life science research applications including plant production, bio-engineering, pharmaceuticals and plant pathology research.

Biochar Production Unit

Biochar is a name for charcoal when it is used for particular purposes, especially as a soil amendment to sequester carbon and improve soil properties. It is a porous carbon rich solid produced by thermo-chemical conversion of biomass in an oxygen depleted atmosphere called pyrolysis. The only difference between biochar and charcoal is in its utilitarian intention. Biochar is produced for soil application whereas charcoal is produced for other uses such as heating, barbeque, etc.

Pyrolysis of biomass produces biochar, liquids, and gases. The relative yield of products from pyrolysis varies depending on process conditions and feedstock used. Temperatures of 400–500 °C (752–932 °F) produce more char, while temperatures above 700 °C (1,292 °F) favour the yield of liquid and gas fuel components. Pyrolysis occurs more quickly at the higher temperatures, typically requiring seconds instead of hours. High temperature pyrolysis is also known as gasification, and produces primarily syngas. Typical yields are 60% bio-oil, 20% biochar, and 20% syngas. By comparison, slow pyrolysis can produce substantially more char (~50%).



Process of Biochar production from organic residues

Specifications

Feedstock type: moist biomass
Feedstock volume: 1.5 cubic meters
Batch time: from 3 to 10 hours
Moisture content: up to 60%
Feedstock size: Wood chips (Upto 30 cm length), Crop residues, Weed biomass
Char yield: up to 100 kg per batch
Infrastructure use*d*: 3 electric fans and a generator (provided with the kiln)

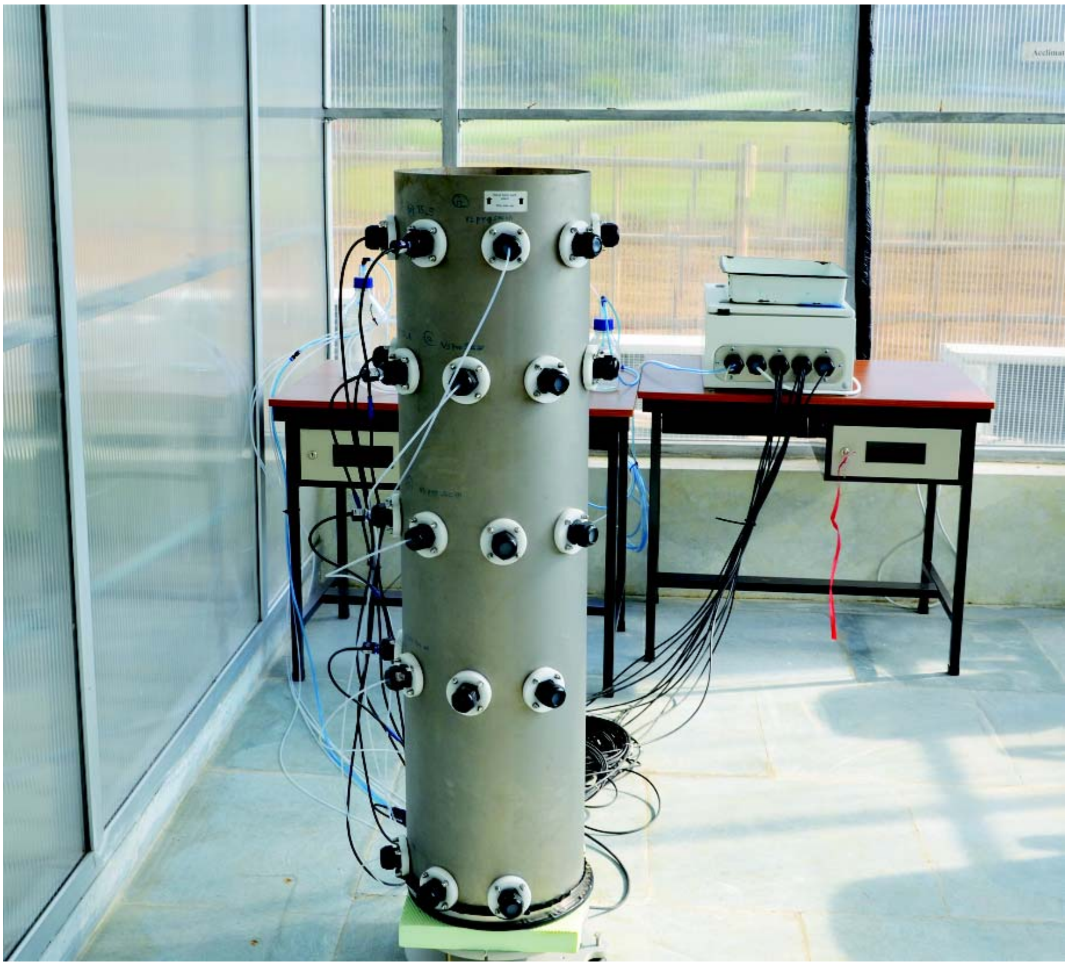
Biochar production unit commissioned under NICRA project at ICAR Barapani

Applications

1. Biochar production unit is used to produce biochar from biowaste like Crop residues, Weed biomass, wood chips which are available in plenty in NEH Region. By converting this agricultural waste into a powerful soil enhancer like biochar that holds carbon and makes soils more fertile, discourage deforestation and preserve cropland diversity.
2. Biochar application improves soil organic carbon, physical as well as chemical properties of soil.
3. Biochar can improve almost any soil. Areas with low rainfall or nutrient-poor soils of NEH Region will benefit most likely from addition of biochar.
4. Research areas that confirming benefits of biochar application include:
   - Reduced leaching of nitrogen into ground water
   - Possible reduced emissions of nitrous oxide
   - Increased cation-exchange capacity resulting in improved soil fertility
   - Moderating of soil acidity
   - Increased water retention
   - Increased number of beneficial soil microbes

Lysimeter

The term *lysimeter* is a combination of the Greek words "lusis" meaning solution and "metron" meaning measure. A lysimeter is a multifaceted instrument widely used in measuring percolation of water beneath root zone of vegetation and water use through evaporative processes. It is one of the most accurate ways to measure water use by crops estimating water loss from plant and soil. Lysimeter is also used for collecting water from the pore spaces of soils and for determining the soluble constituents removed in the drainage.



Lysimeter demonstrated and installed is used for evapo-transpiration studies

Lysimeters are of two types: Weighing and non-weighing. Weighting type of lysimeter represents field conditions well since it is done outside the laboratory. Weighing lysimeters have been used to quantify precipitation (P) not only in the form of rain or snow, but also dew, fog and rime and also to determine actual evapo-transpiration (ET).

With the advent of modern computers and data loggers, continuous monitoring of weighing lysimeter is readily possible. The most representative units typically have monolithic cores where soil structure and associated parameters remain unchanged, as disturbed soil cores may affect plant growth conditions significantly. Similarly, laboratory lysimeter is used to measure the amount of water crops use under controlled condition, It can also be used for leaching loss of nutrients study, lime movement along the soil depth etc.

Specifications

- The Lysimeter is equipped with:
  - Six TS1 tensiometers in the depths of 0.2, 0.4, 0.6, 0.8 and 1.4 m and with a field tensiometer at the depth of 1.4 m.
  - Eight 30 cm long 3-rod TDR probes in the depth of 0.1, 0.2, 0.3, 0.4, 0.6, 0.8, 1.0 and 1.4 m.
- A climate station consisting of a air temperature, a humidity, a wind speed, a net-radiation and a global radiation sensor
- The weighable lysimeter has a surface of 1 m² and a monolith depth of 1.5 m
- To receive the congruent field drainage the lysimeter's suction cup rake at 1.40 m is evacuated according to the field water tension which is measured in 1.40 m depth with an external tensiometer.

Applications

1. Evapotranspiration Studies- it is used in direct measurement of the water balance of crop plants. By weighing both the lysimeter and the drainage barrel, increase in stored water due to rain or irrigation and losses of water due to evapotransiration and deep drainage are directly measured and easly computed mathematically
2. It helps in determination of stage-wise crop co-efficient for irrigation scheduleing
3. It helps in studying leakage/percolation of contaminants

Root Imager

Root development and function are vitally important for plant adaptation to an environment. Root imaging *in-situ* helps to examine root health and activity which are critical indicators of plant performance and economic yield.

Root Imager (CI-600^{R}) is used for imaging of plant roots *in situ* and to study its distribtution and density in the rhizosphere

Specifications

- Scanner Resolution: Maximum 600dpi - up to 23.5 million pixels
- Image Size: 21.6W × 19.6L cm (8.5W × 7.7L in)
- Scan Speed: 5 to 15 seconds - depending on scanning resolutions

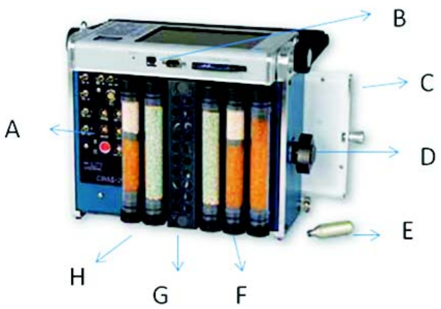
- Interface: USB port
- Power Supply: Computer USB port
- Scan Head Dimensions: 34.3cm long × 6.4cm diameter
- Standard Clear Tube Dimensions: 6.4cm inner diameter × 105cm length (2.5 inches × 41 inches); custom lengths available upon request
- Scanner Unit Weight: 750g

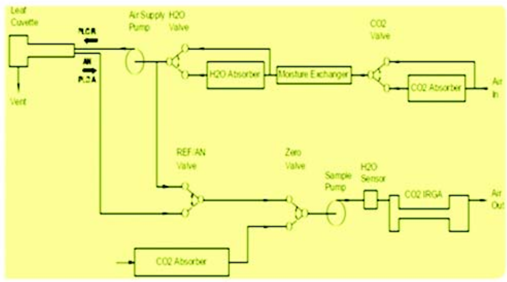
Applications

- ➢ It provides an underground, high resolution, color image of the living roots in the soil.
- ➢ This enables the observation of root growth and behavior over time-one or multiple growing seasons
- ➢ It can be easily operated using a laptop or tablet and user friendly software provided with the system.
- ➢ Portable and field ready for fast accurate root and soil images

Portable Photosynthetic System (PPS)

Photosynthesis systems or Infra Red Gas Analyser (IRGA) are electronic instruments designed for non-destructive measurement of photosynthetic rates in the field. Photosynthesis systems are commonly used in agronomy and environmental research, as well as studies of the global carbon cycle. IRGA is one such system commonly measures fluxes of CO_2 in an airstream moving through a transparent chamber enclosing a leaf. In addition to permitting the researchers to quickly assay small CO_2 fluxes, this technique avoids the logistic problems associated with radioactive substances and can be employed in the field. The basic components of a photosynthetic system are the leaf chamber, infrared gas analyzer (IRGA), batteries and a console with keyboard, display and memory.





A. Electrical and gas analysis connectors (for leaf cuvette)
B. User Interface
C. Rechargeable 12V NiMH battery pack
D. CO2 regulator and cartridge holder
E. CO2 cartridge (8g)
F. Conditioning desiccants for CO2 and H2O control
G. Water vapor equilibrator
H. Auto-zero desiccants

Parameters measured

- a) Leaf temperature, b) Chamber air temperature, c) PAR (photo-synthetically active radiation), d) Atmospheric pressure. These systems may used to calculate a) water use efficiency of agro ecosystem (A/E), b) Stomatal conductance (gs), c) Intrinsic water use efficiency (A/gs), d) Sub-stomatal CO_2 concentration (Ci).

Specifications

Main Console

Analysis Method (Gas Analyzers)

Non-dispersive infrared, configured as an absolute absorptiometer with microprocessor control of linearization.The analyzers simultaneously measure absolute CO_2 and H_2O of the reference and analysis gas streams.

Measurement Range

CO_2: 0-2,000 µmol mol-1 (Optimal Range), 0-9,999 µmol mol-1 (Maximum Range)

H_2O: 0-75 mb Corrections are made for temperature, pressure and foreign gas broadening.

Precision (Absolute)

CO_2: 0.2 µmol mol-1 at 300 ppm,
0.5 µmol mol-1 at 1,750 ppm
3.0 µmol mol-1 at 9,999 ppm

H_2O: 0.015 mb at 0 mb
0.020 mb at 10 mb
0.030 mb at 50 mb

Linearity

Better than 1.0% throughout the range, with calibration at 2,000 ppm CO_2 or 40 mb H_2O.

Stability (CO_2 Analysis)

Automatic zero at regular intervals corrects for sample cell contamination, source and detector ageing and pre-amplifier gain changes.

Response Time

Electrical: 0.5 seconds
Display/Analog Output: 1.6 seconds
Pneumatic: < 5 seconds

Air Sampling

Adjustable up to 100 cm^3 min^{-1} using integral DC pumps. Both analysis and reference pumps fitted with mass flow controllers. The analyzer may be used in open and closed systems.

Environmental Sensor Inputs

3 input channels are available for use with PP Systems' environmental sensors.

Accuracy: Better than 1 min/month at 25°C.
Operating Temperature: 0-70°C.

Recording Options

By PC or by the instrument. Automatic logging at user selectable intervals between 10 seconds and 1 hour, controlled by internal real-time clock.

Instrument Status Detection

Indication of instrument malfunction, including low battery voltage (< 10.5V) through the blinking light signals.

Power Supply

Internal, rechargeable 12V NiMH batteries providing up to 8 hours continuous use. Batteries can easily be changed without shutting down the system.

Integral Cuvette Air Supply Unit

0-470 cm^3 min^{-1} measured and controlled by a mass flow meter.

PPS procured under NICRA is used to measure photosynthetic parameters of various field crops under climate change

Automatic Control Range

CO_2: 0-2,000 µmol mol^{-1}, H_2O: 0- Dewpoint

Operating Environment

0-50°C, Non-condensing.. In dirty environments, external air filtration is required.

Applications

1. To understand the effect of CO_2 enrichment on the photosynthetic behavior of plants in terms of photosynthetic rate (A), Transpiration rate (E) and stomata conductance (gs)
2. To study the effect of biotic (pest and disease) and abiotic stress (drought resistance, salt tolerance and heavy metal tolerance) on staple crop plants transgenic plants.
3. To measure isoprene emission rates from plantation trees (oil palm tree) and to understand volatile substance emission from trees which are under circadian control of plants.
4. To evaluate the eco-physiological diversity, behavior and the breeding potential of wild germplasm
5. To investigate the relative effects of tree age and tree size on the physiological attributes of two broadleaf species.

Controlled Environmental Laboratory Shaker

Environmental chamber is an enclosure used to test the effects of specified environmental conditions on biological items, industrial materials and electronic devices. These chambers can simulate any type of environmental condition such as temperature, humidity, vibration, light intensity etc. with versatile programming. Temperature control by microprocessor plus shaking ensures a constant and even temperature within the chamber. Equipped with direct drive shaking system for reliable, long-term operation needed for cell growth. It is simple to programme time, temperature and shaking speed using electronic display.

Controlled Environmental laboratory shaker at ICAR Research Complex, Umiam

Features: Digital control of time, temperature and shaking speed for accuracy and repeatability, Variable speed: 50 to 250 rpm.

Specifications

Temperature setting range	:	10 to 70°C ,
Maximum load	:	8kg
Overall dimesions	:	590 × 525 × 510 mm
Dimensions(inner chamber)	:	460 × 350 × 400 mm
Digital time setting	:	0-96 hrs (nonstop)

Load up to 2.5 kg, Interchangeable platforms for shaking/incubating different vessels,

Option of four easily interchangeable platforms for a wide range of different, robust, compact construction with clear small window panel for easy visibility of chamber contents.

Applications

The bench-top shaker-incubators can be used for mixing/shaking and incubating biological fluids samples, cell cultures and tissues for required period of time.

Controlled Environmental laboratory shaker used for incubation and shaking of biological samples under desired temperature and light conditions

Ultrasound with Color Dapple

This system uses echoes as the basis of sonar (sound navigation and ranging). The sounds used for sonar are well within the ultrasonic range, with frequencies of 1 - 20 mega Hertz (MHz). The vibration is largest when the electric field stimulates a natural frequency of a crystal (an example of resonance). The vibrations are then passed through any adjacent materials, or into the air as a longitudinal wave i.e. a sound wave is produced. Normally the transmitting and receiving crystals are built into the same hand-held unit, which is a called, an ultrasonic transducer (generally, a transducer is any device to convert energy from one form to another). Because of the impedance difference between air and skin, a coupling medium helps to match the impedance of the crystal in the probe more closely to the impedance of the skin of the patient. The most common coupling medium is a film of oil smeared on the patient's skin. The operator requires needs to ensure that the probe is kept in continuous contact with the oil, preventing air bubbles coming between the probe and skin. On the other hand, different body layers such as fat, muscle and many body organs have very similar impedances, so that most of the beam will pass from one layer into the next, and only a small fraction is reflected. In practice, this is not a problem, in fact the imaging

Ultra sound facility used in detection of various reproductive disorders in animals and pets

technique relies on it. To obtain a reasonable image with good resolution of an interface between two layers, around 1% of a beam must be reflected, leaving a substantial portion to continue on to further reflections.

Specifications

The Color Doppler Ultrasound System is provided with the advanced ultrasonic Doppler technologies, including the Full Digital Super-wide Band Beam Former, Digital Dynamic Focusing, Variable Aperture and Dynamic Tracing, Wide Band Dynamic Range, Multi-Beam Parallel Processing, etc.

The ultrasound diagnostic software system, ultrasound system imaging, multi-languages operation interfaces and touch screen with human-computer interaction technology are customized easily in accordance with the design of human engineering.

This system has been designed to comply with applicable international standards and regulations, ensuring the safety and availability. This system is based on the computer technology and Linux operation system, which make the system more flexible and stable.

Applications

- Imaging inner body parts especially soft tissues noninvasively
- Follicular dynamic, follicular wave in different season, pregnancy diagnosis and abnormal condition in the reproductive tract.

Radio Telemetry

Biotelemetry is the measurement of biological parameters over a distance. The means of transmitting the data from the point of generation to the point of reception can take many forms.- It is defined as a means of transmitting body physiological data from a remote location to a location that has the capability to interpret the data and affect decision making. Biotelemetry is a vital constituent in the field of medical/veterinary sciences. It entails remote measurement of biological parameters. Use of wires to transmit data may be eliminated by wireless technology. Biotelemetry, using wireless diagnosis, can monitor electronically the symptoms and movements of animals.

Specifications

Instrument Type: Industrial RF Transceiver

Telemetry instrument procured under NICRA project at ICAR NEH HQ, Umiam

Transceiver Performance:

Output Power: 1000mW
Transmission Range: Up to 15 miles (32 km) line-of-sight
Receiver Sensitivity: -100dBm typical @ 76.8kbps RF Data Rate

Networking:

Frequency Band, RF Technology: 902 - 928, FHSS (USA)
Supported Network Topologies: Point-to-Point, Point-to-Multipoint Channels: 32

Electrical:

Power Consumption: 40mA receive, 400mA transmit (@ 12 Vdc)
Power Requirement: 7-18 VDC

Environmental:

Operating Conditions: Temp -40° to +176°F (-40° to +80°C);
10% to 90% humidity (non-condensing)

Physical:

Dimensions: 4-3/4x2-3/4x1-1/8 inch (12x7x2.9 cm)
Weight: 7 oz (170 g)

Applications

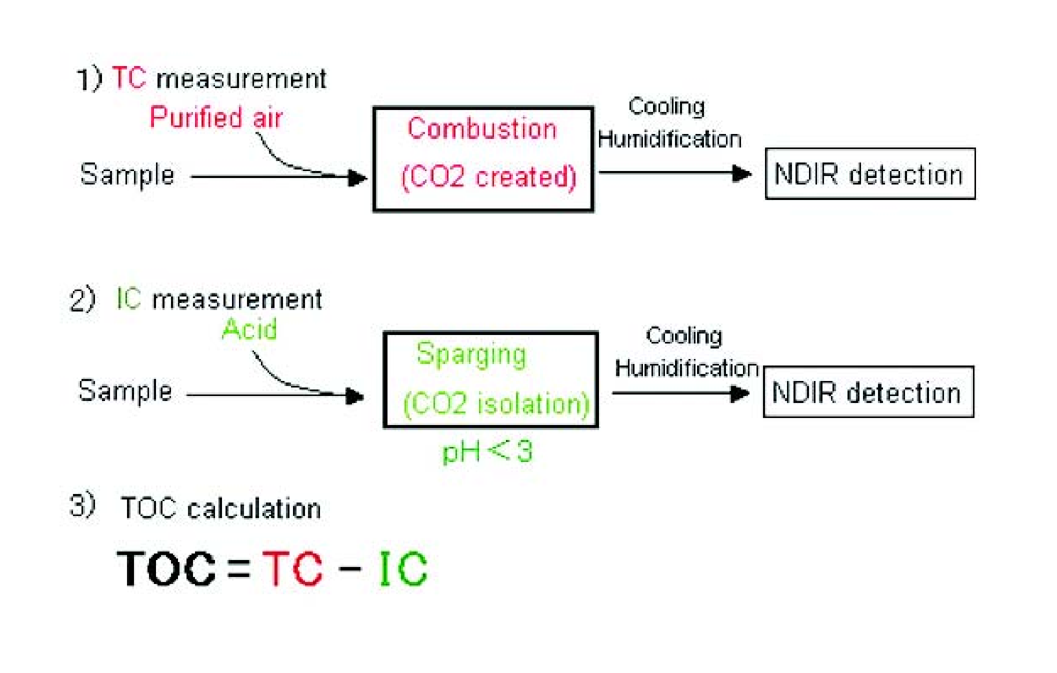
- ➢ Modern telemetry is widely used to send signals from a living organism over some distance to a receiver without use of wires. Usually, biotelemetry is used for gathering data about the physiology, behavior, or location of the organism.
- ➢ Biotelemetry is extensively used in medical/veterinary fields to monitor animals and research subjects. Sensors and transmitters placed on or implanted in animals are used to study physiology and behavior in the laboratory and to study the movements, behavior, and physiology of wildlife species in their natural environments.
- ➢ Different physiological parameters like Blood pressure, electrocardiogram, body temperature and heart rate and some stress parameters and behavior of pigs can be assessed under different climatic condition.
- ➢ It is advantageous due to its non-invasiveness, real picture based and can be assessed without handling animals.

TOC Analyzer

Total organic carbon (TOC) analyzers are devices used to analyze the organic carbon content in liquid as well as solid samples. They provide highly sensitive, non-specific readouts of all TOC through two-stage processes involving oxidation and detection. Apart from measuring organic carbon, it can also detect Total Carbon (TC) and Total Inorganic Carbon (TIC) in solid and liquid samples. In the instrument, the sample is delivered to the combustion furnace, which is supplied with purified air. There, it undergoes combustion through heating

General view of TOC Analyzer connected with TIC Module

to a high temperature (usually 680°C) with a platinum catalyst. It decomposes and is converted to carbon dioxide. The carbon dioxide generated is cooled and dehumidified, and then detected by NDIR (Non Dispersive Infrared) detector.



Operational diagram of TOC Analyzer connected with TIC Module

Specifications

Item	Description
Measurement items	TC, NPOC Optional: IC, POC, TOC (= TC-IC, = NPOC + POC), TN
Measurement principle	680° combustion catalytic oxidation - NDIR detection method
Measurement range	From 0 – 5 to 0 – 1,000 mgC/L f.s. (0 to 20,000 mgC/L f.s. with dilution function)
Repeatability	Within ±2 % f.s. *1
Span stability	Within ±2 % f.s. /day (temperature variation within 5 °C)*1
Measurement cycle	4 minutes min. (NPOC, residual IC 2 % max.) *2
Sample injection method	Syringe pump/sliding injection port
Sample dilution function	Dilution within syringe; dilution factor 2 to 50 Dilution accuracy: Within ±2 % (×2 to ×20); within ±5 % (×21 to ×50)

Automatic calibration function	Automatic calibration using standard solution (Dilution water is used as the zero standard solution for zero-calibration.) Options can be attached to use up to eight standard solutions and to permit automatic calibration with up to a 5-point multi-point calibration curve.
Display, operation	Color LCD with touch screen
EPA TOC removal rate calculation function	TOC removal rate calculation according to the United States EPA regulations (Part IV 40 CFR Part 9, 141 and 142, 1998) (when a 2- or more-stream switching option is provided)
Data storage function	Store 20,000 past on-line measured values (equivalent to one year's data at 30-minute measuring cycle). Offers trend graph displays.
Data storage device	Store measured values or measurement conditions to USB memory *3. (USB 1.1 or 2.0 USB memory; FAT16 or FAT32; no encryption)
Analog output	Selectable between 4 – 20 mA DC or 0 – 16 mA DC (isolated outputs) With attached option: Up to 12 outputs (load resistance: 500Ù max.)
Contact output signal	Alarm signals Major failure, instrument alarm, power cut, CPU alarm, concentration alarm (upper limit/lower limit/upper upper limit/lower lower limit), measurement halted event signals. Maintenance, measurement ready, on-line operation, measuring sample, calibrating, regenerating catalyst, measuring control sample, interrupt sample measurement,analog output trigger, analog output flow line recognition signal, measured flow line recognition signal, sampling pump control output
Contact input	Start calibration, stop measurement, start on-line measurement, reset alarm, measurement start flow line 1 to 6, halt measurement (output contact capacity: 1.4 V DC min., 10 mA min.)
Carrier gas	Pressurized air, high-purity air, oxygen *4; supply pressure: 250 to 300 kPa. Optional: High-purity nitrogen *4
Power supply	AC 100 ~ 240 V ±10%, 10 A, 50/60 Hz
Ambient temperature	Within 1 to 40° (34 to 104°)
Dimensions	W550 × D383 × H1240 mm (excluding protrusions) (W22 x D15 x H49 inches)
Weight	Approx. 70 kg (154 lbs.)

Applications

- ➢ Total organic carbon (TOC) analyzers are used to evaluate the total amount of organic matter in water from the amount of carbon it contains.
- ➢ TOC analyzers are used in diverse fields, including the management of tap water, effluent, and ultrapure water, management of pharmaceutical water used in drug manufacturing processes, evaluation of cleaning efficiency (cleaning validation), and environmental investigations of river water and soils, for example.
- ➢ Total organic carbon sensors and analyzers provide fast, continuous measurement of ppb-level organic contamination so that it will help to monitor organic contamination.

Gas Chromatography

Gas chromatography (GC) is a common type of chromatography used in analytical chemistry for separating and analyzing compounds that can be vaporized without decomposition. Typical uses of GC include testing the purity of a particular substance, or separating the different components of a mixture (the relative amounts of such components can also be determined). In some situations, GC may help in identifying a compound. In preparative chromatography, GC can be used to prepare pure compounds from a mixture.

In GC, the mobile phase (or “moving phase”) is a carrier gas, usually an inert gas such as helium or an un-reactive gas such as nitrogen. The stationary phase is a microscopic layer of liquid or polymer on an inert solid support, inside a piece of glass or metal tubing called a column (a homage to the fractionating column used in distillation). The instrument used to perform gas chromatography is called a gas chromatograph (or “aerograph”, “gas separator”).

In general, substances that vaporize below 300 °C (and therefore are stable up to that temperature) can be measured quantitatively. The samples are also required to be -free; they

Gas chromatography installed in central lab of ICAR RC NEH, Umiam, Meghalaya

Scientists working with Gas chromatography system, installed in central lab of ICAR RC NEH, Umiam, Meghalaya

should not contain ions. Very minute amounts of a substance can be measured but it is often required that the sample must be measured in comparison to a sample containing the pure, suspected substance known as a reference standard.

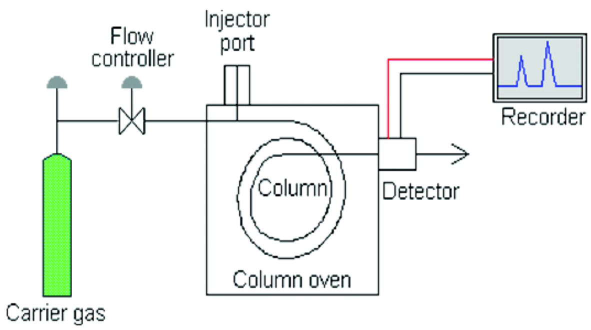
Specifications

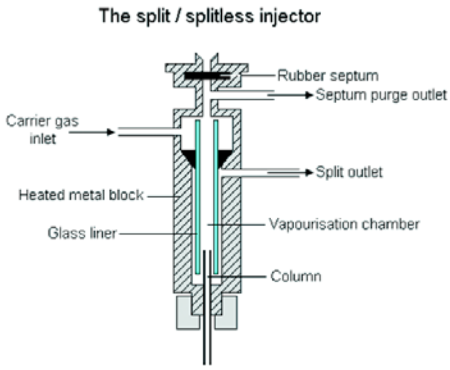
Operation Parameters

Ambient temp.	:	-10°C to 55°C (Optional enclosure: -40°C to 60°C)
Humidity	:	0-95% non-condensing
Power Consumption	:	24 watts @ 24 VDC (Nominal Operation), 36 watts @ 24 VDC (startup), 110 VAC operation (optional)
Carrier Gas	:	Helium @ 10 cc/min @ 60 PSI. Approximately 4-5 months using of 300 ft3 bottle. Hydrogen carrier option available,
Sample Flow Rate:		10 – 100 PSI clean, dry gas @ 50 cc/min

Performance parameters

Range	:	0-1000 ppm to 100% for individual components
Response	:	4 minutes for C1 to C6+, N_2, CO_2 5 minutes for C1 to C7+, N_2, CO_2 3 minutes for H2S and CO2, depending on background composition For other measurements / times please consult factory
Linearity:		1% for individual components
Repeatability:		±0.5 BTU per 1000 BTU





Instrument Specifications

Size	:	14"H x 12"W x 8"D
Weight	:	35 lbs
Columns	:	1-4 – 1/16" stainless steel packed column (application dependent)
Valves	:	1-4 valves – Uses Valco Model DV22 10-port / Model DV22 6-port
Detector	:	Low Temperature TCD
Oven	:	Stainless steel oven using airless heat sink. Designed to maintain consistent temperature
Electronics	:	Galvanic DIMAC dual processor platform utilizing 32 bit ARM7 CPU, advanced I/O processor and 6MB flash memory. Real time clock with battery backup.
Software	:	Galvanic DIMAC software. DIMAC is a Windows-based, graphical user interface (GUI) software used for analyser configuration and monitoring.
Data Logging & Archiving	:	Stores up to 10,000 items. User can setparameters such as time (hourly, daily, weekly, monthly, each analysis)

		and averages (hourly, daily, weekly, monthly and yearly, each analysis).
Reports	:	Can generate report of calculated values including BTU value, relative density, GPM, vapour pressure, specific gravity and liquid volume % for each component, plus other totalized readings.

Applications

- ➢ Gas chromatography used to determine the identity of Natural products containing mixtures of similar compounds. Ex: Crude oil analysis (Hydrocarbons (C_2-C_{40+})/ Contents of Lavender oil/Measuring the ethylene that is secreted by plants
- ➢ Determination of Pesticide residues in Agriculture/Aquaculture products
- ➢ Qualitative and Quantative analysis of Phytosterol content in Food products
- ➢ GC is used to quantify GHG emissions under climate change
- ➢ Gas Chromatography is used extensively in forensic science to identify and quantify various biological specimens and crime-scene evidence.

Phase Contrast Microscope

Phase contrast microscopy is an optical microscope technique that converts phase shifts in light passing through a transparent specimen to brightness changes in the image. Phase shifts themselves are invisible but become visible when shown as brightness variations. When light waves travels through a medium other than vacuum, interaction with the medium causes the wave amplitude and phase to change in a manner dependent on properties of the medium. Changes in amplitude (brightness) arise from the scattering and absorption of light, which is often wavelength dependent and may give rise to colours. Photographic equipment and the human eye are only sensitive to amplitude variations. Without special arrangements, phase changes are therefore invisible. Yet, phase changes often carry important information.

Phase Contrast Microscope

Phase contrast microscopy is particularly important in biology. It reveals many cellular structures that are not visible with a simpler bright field microscope. These structures were made visible to earlier microscopists by staining, but this required additional preparation killed the cells. The phase contrast microscope made it possible for biologists to study living cells and how they proliferate through cell division. After its invention in the early 1930s, phase contrast microscopy proved to be such advancement in microscopy, that its inventor Frits Zernike was awarded the Nobel Prize (physics) in 1953.

Specifications

High-contrast observation of internal structure of live cells/fungus • UPLFLN-PH series objectives have high transmission factors, producing well balanced images with high contrast even at low magnifications. They are suitable for simultaneous fluorescence, bright field and dark field observations.

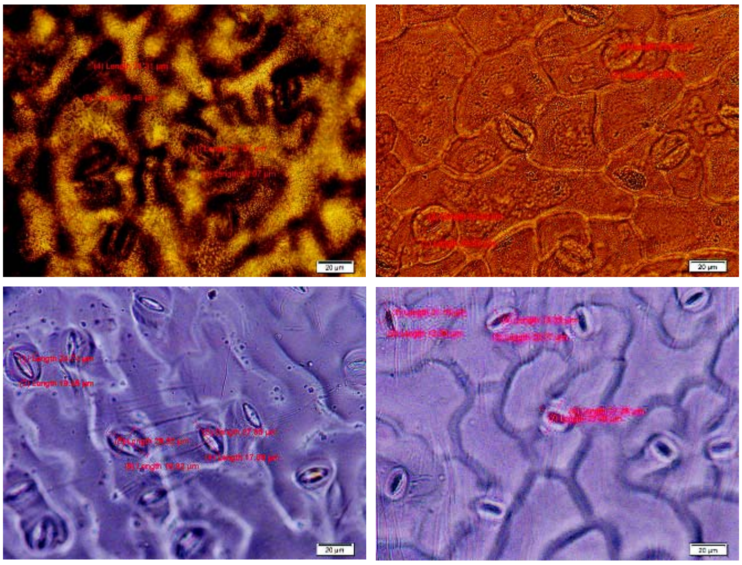
Compound microscope installed is used for various pathological and cellular studies in plants and animal tissues

Applications

Phase contrast microscopy is especially useful for studying microbial motility, determining the shape of living cells and detecting bacterial structures such as endospores and inclusion bodies. It also widely used to study the eukaryotic cells.

Turnip

Radish



Stomatal structure and distribution of turnip and radish crop plants in abaxial and adaxial surface of the leaves viewed through compound microscope (Olympus-BX-5)

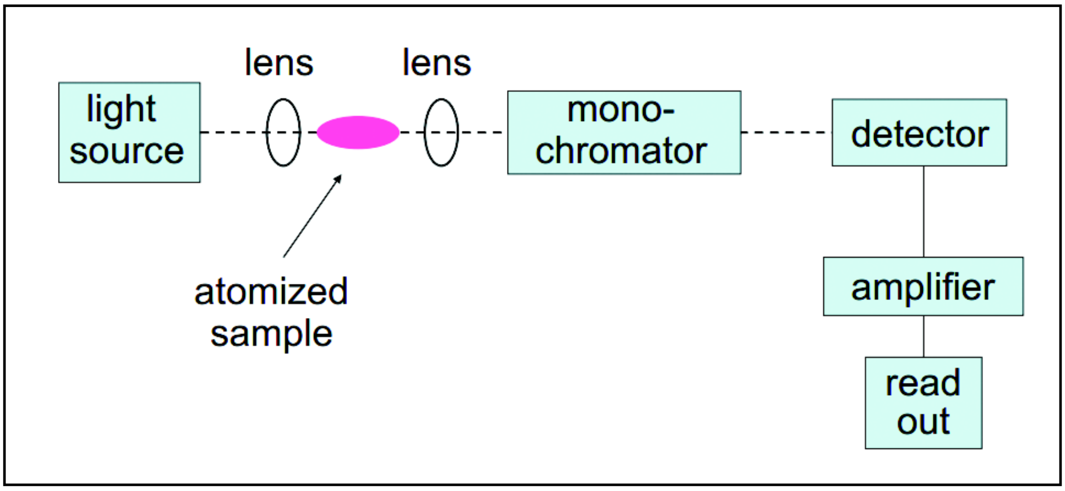
Atomic Absorption Spectrophotometer (AAS)

AAS is a laboratory instrument that measures the concentration of elements in soil, fertilizer and plant sample solutions. AAS can be used to determine over 70 different elements in solution or directly in solid samples used in pharmacology, biophysics and research. Atomic absorption is so sensitive that it can measure down the concentration of elements to parts per billion ($\mu g\ dm^{-3}$) in any sample.

Every element has a specific number of electrons associated with its nucleus. The normal and most stable orbital configuration of an atom is known as the "ground state." If energy is applied to an atom, the energy will be absorbed and an outer electron will be promoted to a less stable configuration known as the "excited state." Since this state is unstable, the atom will immediately return to the "ground state," releasing light energy. The "ground state" atom of elements absorbs light energy of a specific wavelength as it enters the "excited state." As the number of atoms in the light path increases, the amount of light

AAS installed at ICAR Barapani under NICRA

absorbed also increases. By measuring the amount of light absorbed, a quantitative determination of the amount of analyte can be made. The use of special light sources and careful selection of wavelengths allow the specific determination of individual elements.



Schematic diagram of an atomic absorption spectrometer

There are five basic components of an atomic absorption instrument:

1. The light source that emits the spectrum of the element of interest.
2. An "absorption cell" in which atoms of the sample are produced (flame, graphite furnace, MHS cell, FIAS cell, FIMS cell)
3. A monochromator for light dispersion
4. A detector, which measures the light intensity and amplifies the signal
5. A display that shows the reading after it has been processed by the instrument electronics

Specifications

Fully automated PC controlled true double beam multi element Atomic Absorption Spectrophotometer

1) **Optics**: Double beam. Optics mounted on a reinforced flat plate with a fitted cover for protection from dust and vapor. Mirror surfaces are quartz over coated for enhanced protection.) 2) **Monochromator**: Czerny turner mount, diffraction grating of atleast 1200 lines/mm, blazed at 200nm.
3) **Wavelength range**: 185-900nm.
4) **Focal Length**: 400mm
5) **Reciprocal Linear dispersion**: 1.3 nm/mm
6) **Slits Automated slit selection**. Settings: 0.2, 0.5, 1.0 nm or more.

7) **Detector**: Photomultiplier (2 nos)
8) **Background correction**: High intensity deuterium background corrector covering wavelength range 185–425 nm and Corrects up to 2.5 background absorbance.
9) **Lamp support**: At least 4 lamps mounted in fixed positions with fast lamp selection using mirror and automated lamp selection. Lamps automatically switched off at the end of analysis.
10) **Burner**: air acetylene burner and nitrous–oxide acetylene burner with Teflon coating must be quoted.
11) **Safety monitoring functions**: are available for both flame as well as furnace
12) **Gas control**: Instrument should have fully automatic programmable gas control, and automatic change over between Air Acetylene and Nitrous oxide flame.
13) **Sensitivity:** >0.9 Absorbance with precision of < 0.5% RSD from ten 5 s integrations for 5 mg/L Cu standard
14) **Coded hollow cathode lamps**: coded hollow cathode lamps should be quoted with the system for following elements Na- K-Cl-S-Cr-Cu-Fe-Mn-Ni- Ag - Cd - Pb – Zn- Ca - Mg – Al- Co- Mo-phosphorous.
15) **Software & computer/printer**: compatible and latest configuration computer, and HP Laser jet color printer
16) **GRAPHITE FURNACE**:
    A. Fully automated constant temperature zone graphite furnace, dynamic feedback temp. Control, cooling water temp compensation, Temperature programmable from 40 to 3000 C with maximum heating rate up to 2000 C/se, Choice of two inert gases with programmable flow rate, Solid titanium work-head for maximum corrosion resistance, Quartz and windows for high light energy. Comprehensive safety interlocks for gases, water flow and temp, tube and transformer temperatures.
    B. Tube Camera: Graphite furnace viewing camera for real time viewing inside graphite tube.
    C. Recirculating water chiller: with flow rates of 1.5-2L/min at 175- 200 kPa for cooling of graphite furnace must be quoted from manufacturer and will be of imported origin.
    D. Auto sampler for graphite furnace: Automatic programmable samples dispenser for GTA atleast 50 samples in 1.5-2 ml vials, five 25 ml vessels for bulk solutions, Automatic preparation up to 10 points calibration, Automatic additions of modifiers, Pre or co-injections, Automatic over range volume reduction, Hot injection Automatic flow through rinsing.
17) **Accessories**: Air compressor, Chiller Nitrous Oxide gas regulator with pre heater, Acetylene, Argon Gas cylinders with Double stage regulator, fume hood, 8 KVA online UPS with 30 minutes back up must be quoted to run the system

Applications

- water analysis
- food analysis
- analysis of animal feedstuffs
- analysis of additives in lubricating oils and greases
- analysis of soils for nutrient content
- clinical analysis (blood samples: whole blood, plasma, serum)

Automatic Weather Station (AWS)

An Automatic weather station (AWS) is an automated version of traditional weather station, either to enable measurements from remote areas or to save human labour. An AWS will typically consist of a weather-proof enclosure containing the data logger, rechargeable battery, telemetry (optional) and the meteorological sensors with an attached solar panel or wind turbine and mounted upon a mast. The basic suite of sensors typically measures wind, pressure, temperature, relative humidity, and precipitation. In addition, measurements can be taken of e.g. multi-level soil temperature, soil moisture, global and net solar radiation, water level, and temperature. The specific configuration may vary due to the purpose of the system. The system may report in several different ways. It may be in real -time via a local link to a computer system or via telecommunications or satellite systems. GSM mobile phone technology has also been known to be used. An alternative is the storage of the information in local data storage such as flash memory for retrieval at a later stage. Most automatic weather stations have Thermometer for measuring temperature, Anemometer for measuring wind speed, Hygrometer for measuring humidity, Barometer for measuring atmospheric pressure. Some of them even have rain gauge for measuring rainfall, ceilometers for measuring cloud height, present weather sensor or visibility sensor.

Automatic Weather Station

Specifications

The sensors along with the accessories and facilities shall be fully compatible with the data logger and transmission system specified below. All sensors should be NIST (National Institute for Standards and Technology, USA) traceable.

Air Temperature: a) Range: -40°C to +60°C b) Accuracy: 0.2 °C or better (with radiation shield) c) Resolution: 0.1°C d) Sensor Type: Resistance type e) Response Time: 10 sec or better

Wind Speed: a) Range (Operation) : 0 to 60m/s or better b) Sustainability : Up to 75 m/secc) Accuracy: 0.5 m/s or better d) Resolution: 0.1 m/s e) Sensor Type: Ultrasonic f) Threshold: 0.5 m/s or less g) Response time: 10 sec. or better

Wind Direction: a) Range: 0 to 359 Degrees b) Accuracy: 5 degrees or better c) Resolution: 1 deg. d) Sensor Type: Ultrasonic e) Threshold: 0.5 m/s or better f) Response time : 10 sec. or better

Pressure Sensor: a) Range (with single sensor) : 600 to 1100hPa, b) Accuracy : 0.2 h Pa or better c) Resolution : 0.1 hPa d) Sensor Type : Solid state e) Response Time : 10 sec. or better

Relative Humidity Sensor: a) Range: 0 to 100% RH b) Accuracy: 3% or better c) Resolution: 1% d) Sensor Type : Capacitive / Solid-state e) Response Time : 10 sec. or better

Rainfall Sensor: a) Range : 0 to 1023 mm/hr b) Accuracy : 5% or better c) Resolution : 0.5 mm d) Sensor Type : Tipping bucket rain gauge or any other suitable sensor. e) Option for Snow bound AWS : Rainfall/snowfall measurement may be added

Global Radiation Sensor: a) Range : 0 to 1500 W/m2 b) Accuracy : 5% or better c) Resolution : 5 W/m2 Soil Temperature a) Range : -40°C to +55°C b) Accuracy : 0.1°C or better c) Resolution : 0.01°C d) Sensor Type : Resistance type or equivalent e) Response Time : 10 seconds or better f) Depths : Two (5 cm and 20 cm)

Soil moisture: a) Range: 10 to 200 centibars suction b) Sensor type : TDR c) Units : Percent Units: Percentage of moisture / mm d) Accuracy : 2 per cent e) Resolution : 10 centibar suction f) Depths : Ground level + Five **

Datalogger specifications: The system provided to collect the observations automatically from attached sensors, process the same and store them into its memory as per the pre programmed procedure at every full hour UTC and data shall be transmitted to the INSAT-DRT in TDMA (TIME DIVISION MULTIPLE ACCESS) mode.

Applications

1) Meteorological research, 2) Environmental impact studies, 3) Emergency response 4) Fire weather, 5) Waste management

NOTE: Wind Speed and Wind Direction measurements can be made at a height of 10 metres above ground level. Necessary arrangement is made to locate sensors on the tower for the maintenance and sensor upkeep by the observational staff.

Ultra Low Deep Freezers

Ultra-low temperature freezers are specially designed for safe, reliable storage of plant and animal samples at ultra low temperatures (-40°C to -80°C) with cost-effective operation and innovative features. The inner walls of these instruments are manufactured from high quality acrylic materials to avoid temperature loss. It is equipped with thermostat and digital controller for effective monitoring of temperatures. These ultra-low temperature freezers safeguard precious samples at low temperatures with advanced technology platforms, maximum temperature recovery, microprocessor controls and high-quality refrigeration.

Ultra deep freezer is used for storing plant and animal tissues for long time under very low temperatures

Specifications:

- ➢ Temperature ranges: -40°C to ambient -80°C
- ➢ LED Temperature display
- ➢ Audio visual alarm for door open, power failure & temp. variation
- ➢ Internal stainless steel door with PUF insulation
- ➢ Quick and easy alarm set point programming
- ➢ Display accuracy: +0.5%, full scale
- ➢ Power supply: Single phase 230 Volts, 50 Hz
- ➢ Capacity 101 litres

Applications

- ❖ Deep freezers are used for scientific research, low temperature experiments
- ❖ They used in freeze and storage of special materials like hematid white blood cell, skin, bone, bacteria semen, biological products, deep-sea products, electric products etc.

Cold Room Facility

Cold rooms are the facilities for storing large quantities of thermo-labile materials and perishable products at low temperature. They are standard preservation chambers built at site to desired dimensions and cooling specifications

Cold rooms facility created at ICAR NEH for storing fruits and vegetables

Specifications

Cold room size: 10ft x 10ft x 8ft (L x W x H)

Insulation : Thickness of the insulation PPGI on outside /Inside Pre Fab Modular PUF panels 60 mm, density >40 kg/m3

Type of insulation for floor: 60 mm PUF panel with aluminium checkered sheet finish, 3mm thickness Door size and Type PUF –Flush in type with 34” x 78” clear opening with accessories: Pad Lock System, Posi seal Closure, Human Safety Release knob. Provision of PVC/PP curtains

Pull down time: 10Hrs

Max. Product Incoming temperature: 35°C temp

Temperature required in cold room: +2°C to +8° C

Door openings: About 10 times in a day for 2-3 min each time

Refrigeration and Compressor Refrigeration Capacity: 15,000 BTU/hr @ + 2° C Room temp. & 35° C ambient. Split type Air-cooled with R134A/404 gas

Digital Temperature indicator: Provided controller Microprocessor based LED display

Internal – Lighting (with cover): Electrical sockets 5/15amps Racks SS with 4 shelves with equidistance on two side from top to bottom in conformity with dimensions

Max. Ambient Conditions: +35 ° C

Power Requirement: 440 volts, 3-phase, 50hz

Drain: Duly insulated Copper pipe with "U" trap.

Applications

1. Cold room with highest quality & refrigeration system helpful to maintain desired cold temperature, humidity level and air flow, which ensures freshness of fruits, vegetables, flower & other perishable products.
2. Cold room facility helpful for storage of vaccines, blood samples, drugs, bio products and lots of thermo-labile chemicals with lot of safety factors like humidity and high & low- temperatures alarms
3. Cold room insulated with high-efficiency PUF panels to control the temperature can be used for ripening of fruits with the ethylene generators, adequate airflow and refrigeration regulation

Dew Point Potentiometer

A Dew point potentiometer measures soil water potential. Water potential is measurement of the energy status of the water in a system. It indicates how tightly water is bound, structurally or chemically, within a substance. Water potential can be computed from the vapour pressure of air in equilibrium with a sample in a sealed measurement chamber. The dew point potentiometer uses the chilled-mirror dew point technique to measure the potential of a sample. Here the sample is equilibrated with the headspace of a sealed chamber that contains a mirror and a means of detecting condensation in the mirror. At equilibrium the water potential of the air in the chamber is the same as the water potential of the sample. Here the mirror temperature is precisely controlled by a thermoelectric (peltier) cooler. Detection of the exact point at which condensation first appears on the mirror is observed with a photoelectric cell. A beam of light is directed onto the mirror and reflected into a photodetector. The photodectector senses the change in reflectance when condensation occurs in the mirror. A thermocouple attached to the mirror than records the temperature at which condensation occurs. The final water potential and temperature is displayed on a LED screen.

Dew point Potentiometer procured at ICAR NEH for soil water measurements

Specifications

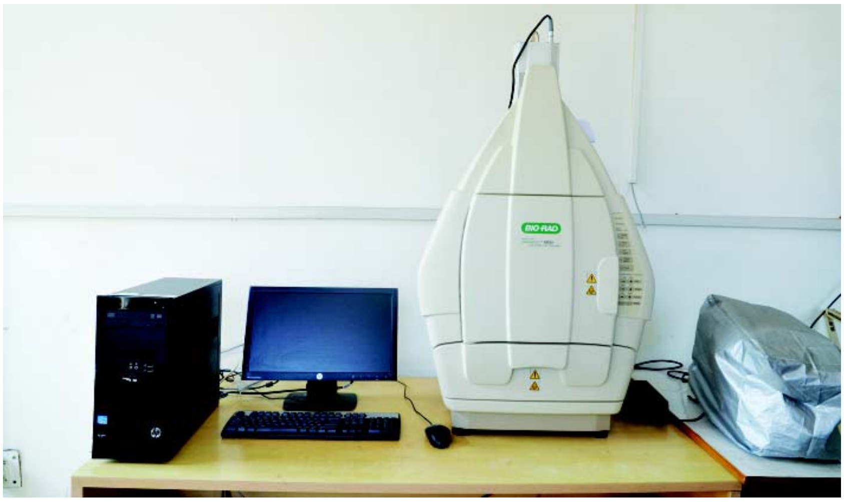
Accuracy	:	±0.1 MPa from 0 to -10 MPa, 1% from -10 to -300 MPa
Range	:	0 to -300 MPa
Measurement time	:	~5 minutes for most soil samples, ~20 minutes for plant tissue samples
Temperature control	:	15 to 50°C (± 0.2°C)
Sensor type	:	1) Chilled-mirror dew point sensor 2) Infrared temperature sensor
Operating environment	:	5 to 43°C (41 to 110°F)
Universal power	:	5 to 43°C: (41 to 110°F)
Sample dish capacity	:	7 ml recommended (15 ml full)
Weight	:	3.2 kg (5.2 kg shipping weight)
Dimensions	:	24.1 x 22.9 x 8.9 cm (9.5 x 9.0 x 3.5 in)
Case material	:	Powder-painted aluminum
Display	:	20 x 2 alphanumeric dot-matrixes LCD with backlighting
Interface cable	:	Standard RS232 serial cable (included)

Applications

1. Soil water potential can be determined quickly with this device.
2. The instrument is very much suited for measuring water potentials less than about -0.25 bars, but will not provide accurate measurements for soils at moisture content above field capacity.
3. Accurate measurements require 10- to 15-minute reading times. To operate the instrument a disturbed sample of the soil is placed in a dish that is then placed inside the instrument.

Gel Documentation Unit

A Gel doc, also known as a gel documentation system, gel image system or gel imager, is equipment widely used in molecular biology laboratories for the imaging and documentation of nucleic acid and protein suspended within polyacrylamide or agarose gels. These gels are typically stained with ethidium bromide or other fluorophores such as SYBR Green. Generally, a Gel doc consists of an ultraviolet (UV) light transilluminator, a hood to shield external light sources and protect the user from UV exposure, and a camera for image capturing.



Gel documentation system

Specifications

Chemi-luminescence	No
Fluorescence	Yes Note: Options to convert UV to blue screen available to visualize DNA samples while protecting against UV damage.
Colorimetry/densitometry	Yes
Illumination control	3 modes (trans-UV, trans white, epi-white)
Detector	CCD
Image resolution	4 megapixels
Pixel size (H x V)	4.65 x 4.65 µm
Filter holder	3 positions (2 for filters, 1 without filter)
Emission filters	1 included (standard), 3 optional

Gel documentation system is used for detection of nucleic acids and proteins in plant and animal tissues

Dynamic range	>3.0 orders of magnitude
Instrument size	36 x 60 x 96 cm (L x W x H)
Instrument weight	32 kg
Operating voltage	110/115/230 V AC nominal
Operating temperature	10–28°C (21°C recommended)
Operating humidity	<70% non-condensing
Workflow reproducibility	100% repeatability via recallable protocols; from image capture to quantitative analysis and reports
Auto-exposure	2 user-defined modes (intense or faint bands)

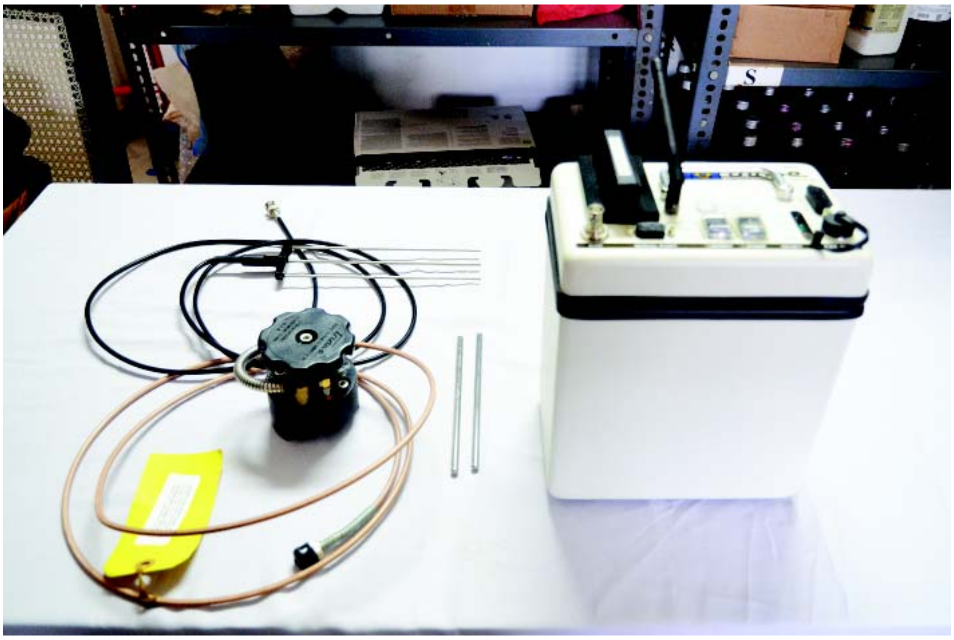
Applications

1. Gel and blot imaging and analysis: This system accommodates a wide array of samples from large handcast polyacrylamide gels to small precast gels and blots
2. The system is an ideal accomapaniment to PCR, Purification and electrophoresis systems enabling image analysis and documentation of restriction digests amplified nucleic acids, genetic finger printing, RFLPs, and protein purification and characterisation
3. Can view protein gels stained with Coomassie Blue, Silver Stain and colorimetric gel stains
4. Comprehensive, automated quantitative analysis of protein and DNA samples
5. Repeatable, reproducible accurate and easy to use imaging facility through high resolution high sensitivity CCD detection technology and modular options to accommodate wide range of samples.

Time Domain Reflectometer(TDR)

A time-domain reflectometer (TDR) is an electronic instrument that uses time-domain reflectometry to measure instantaneously the volumetric water content and electrical conductivity of soil and other porous media. Water content is inferred from the dielectric permittivity of the medium, whereas electrical conductivity is inferred from TDR signal attenuation. Empirical and dielectric mixing models are used to relate water content to measured dielectric permittivity. Clay and organic matter bind substantial amounts of water, such that measured bulk dielectric constant is reduced and the relationship with total water content requires individual calibration.

A variety of TDR probe configurations, connectors and waveguides for depth measurement ranging from 08 cm to 100 cm are available. Time domain reflectometry systems based around the TDR100 consist of a reflectometer, datalogger, coaxial multiplexer(s), cables, and probes. Advances in TDR technology and in other dielectric methods offer the promise not only for less expensive and more accurate tools for electrical determination of water and solute contents, but also a host of other properties such as specific surface area, and retention properties of porous media.



The components of TDR for measurement of water content of soil

Specifications

Measurement range	**:**	0 – 100% vol. moisture
Accuracy	**:**	+2%
Operating temperature	**:**	0-45°C
Power supply	**:**	Ni cad battery
Sampling resolution	**:**	10 picoseconds
Measuring pulse amplitude	**:**	1'6 volt peak

Applications

1. Time Domain Reflectometry (TDR) is widely used to measure soil water content, bulk electrical conductivity, and rock mass deformation.
2. For most soils, excluding those with very high in organic matter (OM>10%), the TDR method provides water content in the range from zero to 0.5 m^3 m^{-3} with accuracy better than 0.01 to 0.02 m^3 m^{-3}
3. TDR probes/measurements are ideal to assess a wide range of soil volumes including thin layers near the soil surface
4. TDR measurements are nondestructive offer excellent accuracy and precision.
5. It is also very useful in root water uptake studies where information from discrete parts of the root zone is desired. Since TDR accurately integrates soil water content changes occurring along the length of the probe rods, TDR probes may be inserted vertically into soils to accurately assess mean water content over the length of the rods, even in soils exhibiting sharp water content changes with depth.

Line and Point Quantum Sensors (LQS and PQS)

Line/point quantum sensors measure photosynthetically active radiation (PAR, 400-700 mm) in terms of photosynthetic photon flux density (PPFD). It is also used to determine the plant intercepted radiation, which is almost linearly proportional to net radiation.

The line quantum sensor is usually 1 m in length and 12.7 mm in width. It is made from an array of high stability silicone photo voltaic detectors placed at 2.38 cm apart. These detectors are placed in a water proof anodized aluminum case with acrylic diffuser and stainless hardware.

Line quantum sensor components and light intensity measurements near plant canopy

Specifications

LQS – Unit: Micromoles per m^2 per sec.
Spectral response: 400-950 mm
400-700 mm
Range: 0-5 milli moles/sec

PQS – Range: 0-5000 micro moles per m^2 per sec

Conversion equation for PQS

Micromoles per m^2 per sec = RAW data (1500/4096) x 50

Sensitivity	:	Typically 7 µA per 1000 µmol s^{-1} m^{-2}.
Linearity	:	Maximum deviation of 1% up to 10,000 µmol s^{-1} m^{-2}.
Stability	:	< ± 2% change over a 1 year period.
Response Time	:	10 µs.
Temperature Dependence	:	± 0.15% per °C maximum.
Sensitivity	:	Variation over Length: ± 7% maximum using a 1" wide beam from an incandescent light source.
Sensing Area	:	1 meter L x 12.7 mm W (39.4" x 0.50").
Detector	:	High stability silicon photovoltaic detector (blue enhanced).
Sensor Housing	:	Weatherproof anodized aluminum case with acrylic diffuser and stainless steel hardware.
Size	:	121.3 L x 2.54 W x 2.54 cm D (47.7" x 1.0" x 1.0").
Weight	:	1.4 kg (3.0 lbs.).
Cable Length	:	3.1 m (10.0 ft.).

Applications

- ❖ Plant scientists, Horticulturists, Ecologists and other Environmental scientists use quantum and point sensors to measure PAR accurately
- ❖ Quantum sensor output is given in micro moles per second per m^2 which can be converted to WM^{-2}.

  I WM^{-2} = 0.2174 micro moles per sec. per m^2

  Plant absorbed PAR is determined as follows:

  Absorbed PAR = Incident PAR – (Reflected PAR + Transmitted PAR)

Environmental Gas Analyzer (EGA) for CO_2 Emissions

Carbon dioxide is a gas of interest in many analytical applications. Carbon dioxide can be measured in percent (%) and parts per million (ppm) depending on the requirements of the application. Infrared detectors can be used to measure CO_2 because it is an excellent absorber of infrared energy. Carbon dioxide gas analyzer procured under NICRA is a portable unit with rechargeable battery backup. It is a non-dispersive, infrared gas analyzer that features an "Auto-Zero" facility. Using this equipment, CO_2 concentration at ppm level can be readily measured. It is a high precision instrument for the use of CO_2 monitoring applications such as greenhouses, environment control rooms, nurseries and laboratories. It may be equipped with additional sensors for measurement of humidity, temperature, PAR, O_2, soil respiration, soil temperature and canopy assimilation.

EGA measurements in dry seeded paddy field

System Features:

- High precision, compact CO_2 analyzer
- Accuracy: < 1% of span concentration over calibrated range
- Lightweight, field portable
- Built-in sampling pump
- Automatic pressure and temperature compensation
- High resolution LCD display
- Voltage, current and digital (RS232) output
- Visual and audible alarm
- Integral data logging capability

Specifications

Analysis Method:	Non-dispersive infrared, configured as an absolute absorptiometer with microprocessor control of linearization.
Measurement Range of CO_2:	0-2,000 ppm (µmol mol^{-1})
Accuracy:	< 1% of span concentration over the calibrated range, but limited by the accuracy of the calibration gas mixture.
Stability:	Automatic Zero at regular intervals, corrects for sample cell contamination, source and detector ageing and pre-amplifier gain changes.
Sampling Pump:	Integral DC pump operating at a flow rate of 350 ml/min. Pump can be disabled for static measurements on demand.
Gas Flow Rate:	200 ml/min - 500 ml/min
Environmental Sensor Interface:	Two inputs available for use with external sensors (humidity, temperature, PAR, oxygen, soil respiration, etc.). Air Filter Filtered sample line (hydrophobic).
CO_2 Control:	High and low set points.
Alarm:	Audio alarm
Real Time Clock:	Accuracy > 1 minute per month at 25° C, operating temperature 0-70° C. Automatic correction for month end and leap years. Recording Manual (by keypress) or automatic at user selected intervals between 1 and 250 minutes.
Keypad:	Custom, tactile keypad.
Data Storage:	512K
Battery backed:	RAM (1,000 records).
Response Time Display:	Analog Output: 1.6 seconds
Display:	High contrast 2 x 16 character LCD.
Power Consumption:	12V @ 0.7A (warm-up) 12V @ 0.4A (normal operation).

	Power Supply 12V rechargeable lead acid battery providing up to 4 hours continuous operation
Operating Environment:	-5° C - 50° C, non-condensing. In dirty environments, external air filtration is required.
Dimensions:	18 cm (W) x 21.5 cm (H) x 6.3 cm (D)
Weight:	1.9 kg

Applications

1. Soil CO_2 efflux rate or exchange rate or soil respiration
2. Soil temperature, Soil moisture and Relative humidity measurements
3. Carbon sequestration
4. Animal or insect respiration
5. Whole canopy assimilation
6. Environmental toxicology
9. Bioremediation

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