

Current Science Reports

Integrated Agroforestry *Optimum farming*

In semi-arid regions, cultivating food crops along with trees saves land and optimises the use of sunlight to fix carbon. But what is the best combination of trees and crops that has both economic and environmental benefits?

Researchers from the Indian Council of Agriculture Research tried different combinations of crops along with plantation trees in a semi-arid field in New Delhi. For three years, they grew annual crops like cowpea, along with plantation trees like guava.

To quantify the best combination of tree and crop, the researchers analysed the productivity and efficiency of the crops grown. Phalsa, *Grewia asiatica*, a type of berry and moong dal, rotated with mustard, resulted in maximum system productivity and best water-use efficiency. The phalsa-based crop system also returned the most carbon to the soil.

Another type of berry, karonda, *Cari-ssa carandas*, grown with cowpea and mustard, had the maximum benefit–cost ratio in terms of production.

The researchers say that agroforestry makes crop production cost-effective and sustainable. Farmers themselves need to experiment with the crops and trees in tune with their environment to optimise their resources, and to balance their needs with those of consumers.

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Severe Dengue Fever *Biomarkers for prediction*

Dengue fever is usually self-limiting. But, in some cases, there can be haemorrhagic complications. Red blood cells that leak out of blood vessels are broken down by the liver and the heme in the haemoglobin is converted to ferritin, a protein that stores iron.

Besides high serum ferritin levels, gallbladder wall thickening is also detected in severe dengue fever. Can serum ferritin levels and gallbladder wall thickness predict the severity of dengue fever?

Recently, researchers from the Kasturba Medical College, Mangalore took the data of dengue fever patients from

two different tertiary referral hospitals. They checked the serum ferritin level and gallbladder oedema on the third or fourth day of fever, along with other clinical parameters.

Out of about 130 patients, 50 suffered from severe dengue fever with complications. Along with reduction in thrombocytes, cells that help blood clotting, the researchers found higher serum ferritin levels and an increase in gallbladder wall thickness in these patients.

Clinicians can use this news to monitor the severity of dengue fever and to manage complications. However, increased serum ferritin levels and gallbladder oedema are also found in various other conditions. So, associated clinical findings need to be considered to identify the exact cause.

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COVID-19 Infection *From mother to baby*

The COVID-19 virus infects many pregnant women. There is a possibility of transmitting the virus to the baby during pregnancy, birth and breastfeeding. Are babies at risk of getting an infection from their COVID-19 positive mother?

Sangam Jha and colleagues from the All India Institute of Medical Sciences, Patna recruited fifty pregnant mothers and baby dyads. The women had tested COVID-19 positive and were admitted to the hospital before delivery.

To check mother to child transmission, the researchers performed RT-PCR tests on amniotic fluid and swabs from placenta, maternal vaginal secretions, foetal membranes and breast milk.

They also tested the new born babies for COVID-19 infection. For the first twenty-four and forty-eight hours, all the babies tested negative.

In one case, the virus was detected in amniotic fluid and in the foetal membrane. However, the baby tested negative after birth.

The researchers looked for IgG and IgM antibodies in the cord blood of the new born babies.

IgG antibodies were present in twelve samples, and IgM antibodies in three.

Though none of the fifty babies developed COVID-19, the possibility of transmission of SARS-CoV-2 from mother-to-baby during pregnancy and childbirth can not be ruled out, say the researchers.

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Monitoring Bilirubin *Fluorescent carbon dots*

Monitoring bilirubin levels is necessary to diagnose jaundice in adults and new born babies. Various detection methods exist using different processes, but they are either complicated or costly. How can we develop better sensing methods?

Recently, Sasmita Mohapatra and Balam Barik from NIT Rourkela developed a fluorescent sensor based on carbon dots for detecting total bilirubin in human serum. Quantum dot-based fluorescent sensors have relatively high sensitivity, easy operational procedure and affordability. Carbon quantum dots are more biocompatible than metal quantum dots and they have been prepared from different biomolecules. But none of them is reported to recognise bilirubin.

To prepare carbon dots, the researchers decomposed resorcinol and sucrose hydrothermally. Under ultraviolet light, the yellow solution containing the carbon quantum dots exhibited intense green fluorescence. To reduce the intensity of fluorescence, the researchers added copper ions to the quantum dot solution.

Bilirubin solution at different concentrations was added to the carbon quantum dot solution with copper ions. The fluorescent spectrum was recorded. Bilirubin displaced the copper ions to enhance fluorescence.

The researchers repeated the process with other biomolecules such as glucose, fructose and urea to compare selectivity. The presence of other biomolecules did not interfere with the sensor.

To test with actual blood serum, the duo collected samples from a healthy adult, a jaundiced patient and a new born baby. They diluted the serum samples and added a small quantity of

bilirubin at a known concentration to make the solution even. They detected and calculated bilirubin levels by analysing the fluorescent spectrum.

To check whether a paper strip sensor could be developed, the researchers put a few drops of the carbon quantum dot solution on filter paper. After the filter paper dried, they added drops of bilirubin of different concentrations on the dried spot. After the solution dried, they tested the paper under UV light. There was dose-dependent fluorescence.

The method showed good selectivity towards bilirubin even in the presence of other biomolecules and a better detection limit among existing quantum dot-based methods.

Biomedical equipment manufacturers can now develop this highly selective sensor with better detection limits as bilirubin monitoring devices.

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Medicine for Pain *Transdermal delivery*

To reduce pain, we use analgesic and anti-inflammatory medications. But, on long-term use, non-steroidal anti-inflammatory drugs like ketorolac lead to gastric irritation and bleeding. To avoid such negative effects during oral intake, can ketorolac tromethamine be used as transdermal patches?

There are synthetic polymer carriers for transdermal patches. But they are not environmentally friendly. Why not create a patch with nanocellulose?

Researchers from the University of Kolkata, in association with colleagues from South Africa and Nigeria, used waste produced during the carding of jute as starting point. To create cellulose nanocrystals, they digested jute fibres with dilute sulphuric acid. After rinsing and neutralising the acid, they broke the fibres further with nitric acid.

Chitosan and methyl cellulose were used in the solution and a nanocomposite was left behind after solvent evaporation. For patch testing, ketorolac tromethamine, a non-steroidal anti-inflammatory medication, was then added to the composite.

The researchers investigated the properties of the nanocomposite. Tests confirmed the stability of the ketorolac tromethamine, chitosan and methyl cellulose blend. There was no bonding between the drug and the carrier. The composite matrix formation was better than that offered by other nanocelluloses, making it ideal for the gradual release of the medicine. The material also had a greater contact angle of 74.5 degrees for the medicine in the transdermal patch. The synthetic polymer's was 67.2 degrees.

Moisture absorption and water vapour transmission rate, properties important for material worn next to skin, were also encouraging.

The researchers conducted toxicity studies on human blood to ensure that the patch was biocompatible.

Franz diffusion cells were used to test the cytocompatibility of the bionanocomposites *in vitro*, and the results suggested a potential use for long-term transdermal drug delivery.

The nanocomposite patch made of chitosan, methyl cellulose, and one per cent by weight of jute cellulose nanocrystals constituted a promising drug delivery system.

Animal studies are needed before the painkiller patch with jute composites can be used on humans. Will the jute industry support the endeavour?

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Recycling Graphite *From used lithium batteries*

Lithium-ion batteries have high energy density and are rechargeable. Over

time, their ability to hold a charge and to get recharged dwindles. There are methods to recover lithium from spent batteries. But the batteries contain graphite, another economic resource. How can we extract graphite from lithium-ion batteries in a sustainable way?

Researchers from the Institute of Minerals and Materials Technology, Bhubaneswar, and the Academy of Scientific and Innovation Research, Ghaziabad, tackled the problem.

They pretreated the spent batteries to separate plastics and other materials and used a hydro-metallurgical recycling method to extract the graphite. The spent cathode component was treated with various acids to form a metal-ion solution, from which metals can be easily extracted.

The researchers used acetic acid, and any residue resulting from the reaction was treated with acid again. Using absorption and optical spectroscopy, they inferred that the material thus extracted had the typical characteristic properties of graphite.

Electrochemical analysis showed that the extracted graphite did not lose its electrochemical nature. The graphite had improved ion pathways and crystallite size. There was better interaction between the active electrode and the electrolyte medium.

Manufacturers of equipment for lithium extraction from batteries may consider the economic scope of recycling graphite.

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