Readers Shelf

VOLUME No. :21	ISSUE NO: 08	May 2025
No. of Pages in this issue		28pages
Date of Posting: 10-11 at RMS, Jodhpur		

Editorial Office

J.V. Publishing House, 15, Gajendra Nagar, Near Old FCI Godown, Shobhawaton Ki Dhani, Pal Road, Jodhpur-5

Website: www.readersshelf.com

*Email:*readersshelf@gmail.com, jvph@rediffmail.com

Typesetting: Ankita, Jodhpur

Printed by: Manish Kumar, ManakOffset, Jodhpur

Published by

Smt. Neeta Vyas

For J.V. Publishing House,

Jodhpur

RNI No.: RAJENG/04/14700

ISSN No.:2321-7405

Subscription Charges: Single Copy: Rs.50.00

Annual Subscription: Individual: Rs.**500.00**

Annual subscription: Institution: Rs.900.00

Contents

1. AGRICULTURE EXTENSION

Prosocial Behaviour: Importance in Agricultural Extension

Dr. Marepally Udaya Sindhu

ICAR- SMS, KVK Lakshadweep (CMFRI)

Introduction

Prosocial behaviour refers to voluntary actions intended to benefit others or society at large. It includes behaviours such as helping, sharing, donating, cooperating, and volunteering. Coined in the 1970s by social psychologist C. Daniel Batson as an antonym to antisocial behaviour, prosocial conduct is crucial in fostering community bonds and societal functioning.

In the context of agricultural extension, prosocial behaviour plays a pivotal role. Extension personnel are expected not only to transfer knowledge but also to build trust, share resources, and support farming communities in a participatory and empathetic manner. Understanding prosocial behaviour is therefore essential to designing effective rural development programs.

Understanding Prosocial Behaviour

According to Staub (1979), prosocial behaviour is "voluntary behaviour intended to benefit another person." Similarly, Bierhoff (2002) defines it as any act performed with the goal of benefiting another person. It encompasses a wide range of actions such as helping in distress, sharing information, cooperating on community tasks, and offering comfort or support.

In contrast, **antisocial behaviour** includes actions that harm individuals or society—such as breaking rules, causing conflicts, or reducing social capital.

Forms and Dimensions

Prosocial behaviour takes many forms

- Helping (offering assistance),
- Sharing (resources, time),
- Comforting (emotional support),
- Cooperating (teamwork),
- Donating (money or goods),
- Volunteering (services without personal gain).

It also includes several **dimensions**

- **Proactive** – Self-benefiting, yet helpful actions.
- **Reactive** – Responses to specific needs.
- **Altruistic** – Actions with no expectation of return.
- **Public** – Helping in view of others.
- **Anonymous** – Helping without recognition.
- **Emotional** – Assisting those in distress.
- **Compliant** – Helping upon request.
- **Reciprocal** – Expecting future help in return.

Prosocial Behaviour in Extension Context

Agricultural extension workers regularly engage in activities that mirror prosocial behaviours

- Sharing scientific knowledge with farmers.
- Helping communities manage risks or disasters.
- Volunteering for community-based projects.
- Supporting women's self-help groups or youth clubs.

Extension's success depends not just on technical expertise but also on empathy, fairness, reciprocity, and a strong sense of social responsibility. These align closely with the **prosocial personality traits**.

Theories behind Prosocial Behaviour

Several theories explain why people act prosocially

- **Empathy-Altruism Hypothesis** (Batson, 1991): People help others out of empathy, not for personal benefit.

- **Negative State Relief Model** (Baumann et al., 1981): Helping others reduces one's own negative emotions.
- **Kin Selection Theory**: People help relatives to preserve shared genes (inclusive fitness).
- **Reciprocal Altruism**: Helping others with the expectation of mutual benefit in the future.

Factors Influencing Prosocial Acts

Why People Engage in Prosocial Behaviour

- **Altruism** – Selfless concern for others.
- **Reciprocity** – Expectation of returned help.
- **Fairness and justice** – Promoting equity and equality.
- **Rule of law** – Following and enforcing societal norms.
- **Social status** – Gaining respect and prestige.

Why People Avoid Helping

- **Bystander effect** – Assuming others will help.
- **Fear of embarrassment** or being judged.
- **Time pressure** – Inability to help due to urgency.

According to Darley and Latané, individuals must notice a situation, interpret it as needing help, feel responsible, know how to help, and decide to act.

Role of Personality in Prosociality

Key prosocial personality traits include

- **Empathy** – Understanding others' feelings (Bierhoff, 2002).
- **Social Responsibility** – Fulfilling moral obligations (Berkowitz & Daniels, 1964).
- **Internal Locus of Control** – Belief in one's ability to effect change.
- **Just-World Belief** – Belief that good is rewarded and justice prevails.

People with these traits are more likely to engage in helpful behaviour, especially in structured settings like agricultural extension services.

Volunteerism and Motivation

Volunteering is a long-term commitment to prosocial behaviour, often seen in NGO work, farmer training, or natural disaster response. The **Volunteer Functions Inventory** (Clary et al., 1998) lists six motivational functions

- Understanding,
- Protective,
- Values,
- Career,
- Social,
- Enhancement.

Batson (1994) also identifies motivation types: **egoism** (personal gain), **altruism** (others' welfare), **collectivism** (group benefit), and **principlism** (moral values).

Research Insights

Studies support the relevance of prosocial behaviour in youth and rural development

- **Sharun P.B.** studied higher secondary and undergraduate students, finding moderate but significant levels of prosociality, with gender-based variations.
- **Deepty Gupta & Geeta Thapliyal** found a strong relationship between self-concept and prosocial behaviour among adolescents.
- A GKVK-based study revealed that students showed promising levels of prosocial behaviour, suggesting potential for future rural leadership.

Implications for Agricultural Extension

Prosocial behaviour enhances the **effectiveness and credibility of extension personnel**. Traits like empathy, fairness, and responsibility improve communication, build trust, and increase adoption of innovations.

By fostering prosocial tendencies in training programs, agricultural universities and extension systems can build more responsive, ethical, and community-oriented change agents.

Conclusion

Prosocial behaviour is central to building sustainable, cohesive, and empathetic rural

societies. In agricultural extension, it complements technical expertise with human connection, making outreach more inclusive and impactful. Cultivating prosocial traits among extension workers can thus significantly enhance rural development efforts.

References

Aronson, E., Wilson, T.D., & Akert, R.M. (2004). *Social Psychology*.

Batson, C.D. (1991). *The Altruism Question: Toward a Social Psychological Answer*.

Bierhoff, H.W. (2002). *Prosocial Behaviour*.

Berkowitz, L., & Daniels, L.R. (1964). *A Social Responsibility Scale*.

Baumann, D.J., Cialdini, R.B., & Kenrick, D.T. (1981). *Altruism as hedonism: Helping and self-gratification*.

Clary, E.G., et al. (1998). *Understanding and Assessing the Motivations of Volunteers: A Functional Approach*.

Sharun, P.B. (2021). *Prosocial Behaviour of Students*.

Gupta, D., & Thapliyal, G. (2021). *Study on Prosocial Behaviour and Self-Concept of Adolescents*.

www.verywellmind.com

http://egyankosh.ac.in

https://scholar.valpo.edu/jvbl

2. AGRICULTURE

Collaboration Opportunities between Agricultural Engineering Institutions and Space Agencies (ISRO, DRDO)

F.G.Sayyad S.S.Chinchorkar and Dr.J.Sravan

Anand Agricultural University,Gujarat, India

Introduction to Collaboration

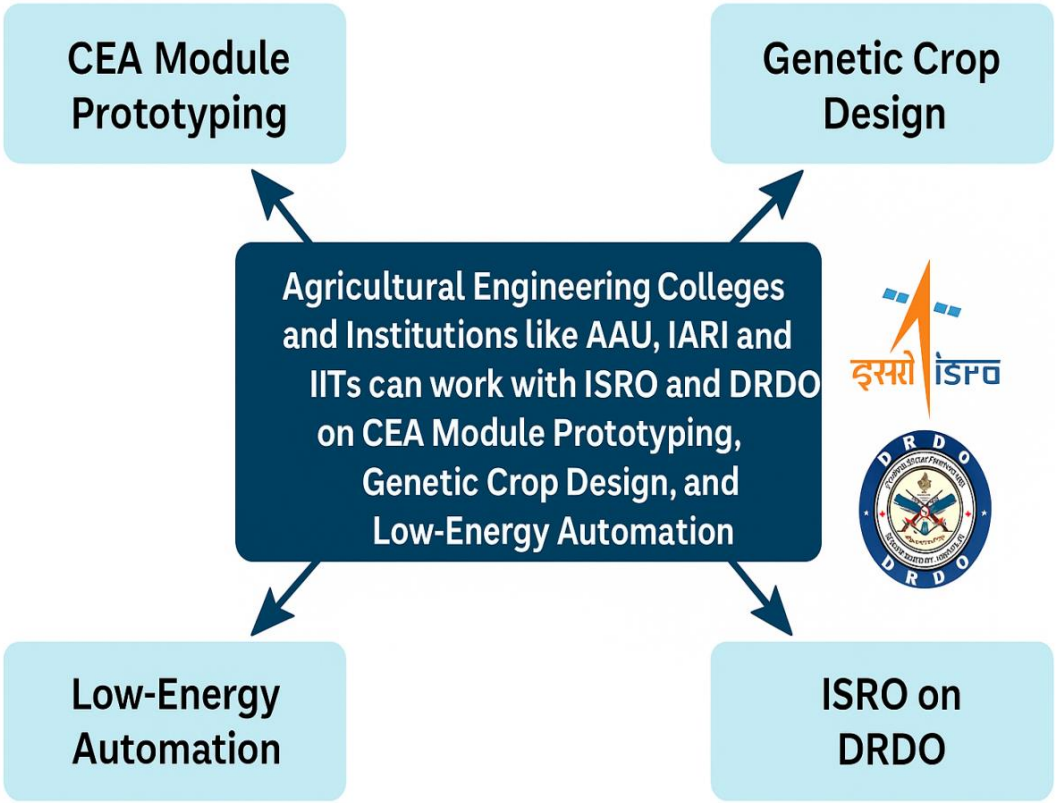
Agricultural Engineering colleges and institutions like **Anand Agricultural University (AAU)**, **Indian Agricultural Research Institute (IARI)**, and **Indian Institutes of Technology (IITs)** can play a crucial role in advancing space agriculture by collaborating with space agencies like **ISRO** (Indian Space Research Organisation) and **DRDO** (Defence Research and Development Organisation). The combination of agricultural engineering expertise with space technology can lead to the development of sustainable, efficient, and resilient systems for farming in extraterrestrial environments.

1. CEA Module Prototyping
   a. **Controlled Environment Agriculture (CEA)** systems are essential for growing crops in space, as they provide the necessary conditions for plant growth, including light, temperature, humidity, and air composition control.
   b. **AAU, IARI, and IITs** can work alongside **ISRO** and **DRDO** to develop **prototype CEA systems** that are compact, efficient, and capable of operating in closed-loop systems. These systems would be tested in space environments, such as aboard satellites or on the International Space Station (ISS).
   c. These collaborations would involve designing energy-efficient, low-maintenance, and high-yield farming modules that can be adapted to the challenges of space, such as low gravity, limited space, and the absence of natural sunlight.
2. Genetic Crop Design
   a. One of the challenges of growing food in space is the ability to design crops that can survive in harsh extraterrestrial conditions, such as high radiation levels, low gravity, and extreme temperatures.
   b. **CRISPR-Cas9** gene-editing technology can be used to design **genetically modified crops** that are resistant to space-related stressors like radiation and low gravity.
   c. Institutions like **IARI** and **AAU** can

contribute by selecting and genetically modifying crop species for improved resilience, nutritional value, and faster growth cycles suitable for space habitats.

d. Collaboration with **ISRO** and **DRDO** can help test the genetic modifications under space conditions, ensuring they meet the demands of long-term space missions.

3. Low-Energy Automation in Space Farming
   a. Space missions are highly constrained in terms of energy resources, so **low-energy automation** is a critical area of research.
   b. **Automation** in space farming systems involves using **robots**, **sensors**, and **artificial intelligence (AI)** for tasks like planting, harvesting, irrigation, and monitoring plant health.
   c. **IITs** and agricultural engineering colleges can develop **robotic systems** and **AI algorithms** for automating these processes in a low-energy environment.
   d. Working with **ISRO** and **DRDO**, these institutions can test the automation technologies in space modules, ensuring minimal energy consumption while maintaining maximum productivity.



4. Benefits of Collaboration
   a. **Interdisciplinary Expertise:** Combining the expertise of agricultural engineers, biotechnologists, space scientists, and defense researchers leads to holistic solutions for space farming, addressing both technical and

biological challenges.

b. **Innovation in Agriculture Technology:** Collaborating on **CEA systems**, **automation**, and **genetically engineered crops** will drive new innovations in agriculture technology, which can also have applications on Earth, such as in resource-limited or urban farming.
c. **Advancement of Space Exploration:** The success of space farming systems is essential for the long-term viability of missions to Mars, the Moon, and beyond. These collaborations ensure that India's space missions are equipped with the necessary tools to support human life through sustainable agriculture.
d. **Global Collaboration:** These efforts contribute to India's growing presence in global space research, aligning with international initiatives like **NASA's Veggie Project** and **ESA's MELiSSA project**, but with India playing a key role in developing practical solutions for space farming.

Conclusion

By partnering with **ISRO** and **DRDO**, agricultural institutions such as **AAU**, **IARI**, and **IITs** can significantly contribute to the development of **sustainable space farming technologies**. This collaboration will not only support space exploration but also promote agricultural innovations that can benefit Earth's farming systems, improving food security, resource efficiency, and environmental sustainability.

References

NASA (2021). The Veggie Project: Space Farming on the ISS.

European Space Agency (ESA) (2022). MELiSSA: Micro-Ecological Life Support System Alternative.

Indian Space Research Organisation (ISRO) (2023). Towards Sustainable Space Missions: Role of Life-Support Systems.

Dey, S., & Sharma, V. (2022). Agriculture in Space: Prospects and Challenges. Journal of Space Research, 10(4), 204–210.

ICAR (2023). Innovations in Controlled Environment Agriculture for Space Applications. ICAR Technical Reports.

****

3. AGRIULTURE ECONOMICS

Taxation of Agricultural Income in India: A Comprehensive Review

Dr. Marepally Udaya Sindhu

ICAR- SMS, KVK Lakshadweep (CMFRI)

1. Introduction

Agriculture employs over 50% of India's population and has been constitutionally exempted from central income taxation since independence. While the exemption aimed to protect small and marginal farmers, it has also become a loophole exploited for tax evasion and money laundering. This article examines the legal, economic, and policy dimensions of agricultural income taxation in India, drawing on historical reforms, legal provisions, data, and expert recommendations.

2. Tax Revenue and Composition

India's total revenue comes from tax and non-tax sources. Tax revenue includes

- **Direct taxes** (e.g., income and corporate tax)
- **Indirect taxes** (e.g., GST, customs duties)

According to Factly (2021), tax revenue has grown over time. However, indirect taxes outweigh direct taxes, reflecting regressive tendencies. India's tax-to-GDP ratio remains lower than many OECD nations, indicating potential for expansion of the direct tax base.

3. Definition of Agricultural Income

As per Section 2(1A) of the Income Tax Act, 1961, agricultural income includes

- Revenue from agricultural land
- Income from sale and processing of produce
- Rent from farmhouses on agricultural land
- Income from nurseries

Examples include income from crops, horticulture, floriculture, and sale of replanted trees.

4. Taxability of Agricultural Income

Under **Section 10(1)** of the Income Tax Act, agricultural income is exempt from central taxation. However, **state governments** are allowed to levy such taxes. Karnataka, Assam, and Kerala are among the few that have experimented with this.

Section 54B allows capital gains exemption if profits from sale of agricultural land are reinvested in similar land within two years.

5. Key Judicial Interpretation

In *PHI Seeds Pvt. Ltd. v. DCIT*, the court held that corporate entities can claim agricultural income exemption only if they genuinely engage in agricultural activities, not merely supervise or outsource them.

6. History of Reform Efforts

Several committees have reviewed the issue

- **Taxation Enquiry Committee (1925):** Opposed full exemption.
- **Raj Committee (1972):** Favoured moderate taxation of agriculture.
- **Kelkar Committee (2002):** Suggested centralized taxation with state authorization.
- **TARC (2014):** Highlighted widespread misuse of exemptions.

7. State Example: Karnataka

Karnataka levies a **composition tax on plantation crops**

- Estates up to 15 hectares are exempt.
- Tax slabs apply progressively to larger landholdings. (Source: Overview of Tax Systems in Indian States, 1992)

8. Why Tax Agricultural Income?

Key justifications include

- Preventing **tax evasion and laundering**.
- Widening the **tax base**, since only a small fraction of citizens pay income tax.
- Ensuring **equity**, as rich agriculturists benefit from exemptions meant for smallholders.

Case in Point

In 2015–16, 2,746 individuals declared agricultural incomes exceeding ☐1 crore. Many prominent political figures reported crores in agricultural income despite owning modest landholdings. (Source: Ministry of Finance, 2012; Income Tax Dept.)

9. Revenue Potential and Case Studies

Study by Sengupta & Rao (2010)

Agricultural income taxation could have generated **50,000 crore** in 2009–10, contributing up to 19% of state revenues.

Study by Mishra & Kulkarni (2017)

- **67%** of farmers are marginal (<1 hectare), and **18%** are small (1–2 hectares), falling below taxable thresholds.
- Only **1%** are large farmers (>10 hectares), who could be justifiably taxed.

10. Landholding Data

- **Marginal farmers**: <1 hectare – 67%
- **Small farmers**: 1–2 hectares – 18%
- **Others (semi-medium to large)**: <15% combined

This supports a **targeted taxation policy** that spares the majority while taxing high-income earners and large landholders.

11. Misuse and Evasion

Findings show widespread abuse of exemptions

- **Fake agricultural income certificates** used to convert black money to white.
- **Cash transactions** dominate land deals due to discrepancy between market and recorded values.
- **Banks** can help trace illicit funds if agri-transactions are integrated with the financial system. (Source: Ground Report on Agricultural Income Tax)

12. NITI Aayog's Recommendations

In 2017, NITI Aayog proposed **rationalizing exemptions** to curb misuse

- The top 10 claimants of agricultural exemptions in 2014–15 were **corporations or government departments**.
- Its "New India 2022" strategy recommended taxing high-income agri-entities.

13. GST and Agricultural Income

Under the **CGST Act, 2017**, land leases for farming are taxed as services (18% GST). This could bring **contract farming and agri-businesses** into the indirect tax net. (Source: The Wire, 2020)

14. Analysis and Recommendations

The current blanket exemption is both **inequitable and inefficient**. It protects the poor but enables evasion by the rich.

A **tiered tax policy** could

- Protect small and marginal farmers.
- Tax large landowners, agri-corporates, and non-farm entities.
- Use land records, digitization, and banking integration to ensure transparency and enforcement.

15. Conclusion

India's exemption of agricultural income was designed for social equity but has become a **conduit for tax evasion**. Without targeted reforms, it reduces government revenues and promotes inequality. A **threshold-based, progressive tax model** that targets large landowners and agri-corporates—while shielding smallholders—can enhance fiscal responsibility without harming rural livelihoods.

References

Income Tax Act, 1961. Government of India.

Ministry of Finance. (2012). White Paper on Black Money.

Tax Administration Reform Commission. (2014). Third Report.

NITI Aayog. (2017). Strategy for New India @75.

Sengupta, D.P., & Rao, K. (2010). *Taxation of Agricultural Income: A Missed Opportunity*.

Mishra, U.M., & Kulkarni, A. (2017). *Study on Tax Avoidance in Agricultural Sector*.

Factly. (2021). *www.factly.in*

The Wire. (2020). *New Farm Laws and Taxation of Agricultural Income*.

Department of Agriculture and Cooperation. (2019). *Agricultural Census*.

Overview of Tax Systems in Indian States. (1992).

****

4. AGRIULTURAL EXTENSION

M- Kisan Portal Mobile Based Services for Farmers in India

Surkunta Kiran Reddy

Ph.D. Scholar, Department of Agricultural Extension, U.B.K.V, Pundibari-736165, West Bengal

Introduction

Pervasive and extensive use of the ICT is an important tool of agricultural extension. Under the National e-Governance Plan – Agriculture (NeGP-A), various modes of delivery of e-enabled services have been envisaged. These include internet, touch

screen kiosks, agriclinics, private kiosks, mass media, Common Service Centres, Kisan Call Centres, and integrated platforms in the departmental offices coupled with physical outreach of extension personnel equipped with pico-projectors and hand held devices. However, mobile telephony (with or without internet) is the most potent and omnipresent tool of agricultural extension. The project conceptualized, designed and developed in-house within the Department of Agriculture & Cooperation has widened the outreach of scientists, experts and Government officers posted down to the Block level to disseminate information, give advisories and to provide advisories to farmers through their mobile telephones. SMS Portal was inaugurated by the Hon'ble President of India on July 16, 2013 and since its inception nearly 50 crore messages or more than 152 crore SMSs have been sent to farmers throughout the length and breadth of the country. These messages are specific to farmers' specific needs & relevance at a particular point of time. These messages generate heavy inflow of calls in the Kisan Call Centres where people call up to get supplementary information. SMS Portal for Farmers has empowered all Central and State Government Organizations in Agriculture & Allied sectors (including State Agriculture Universities, Krishi Vigyan Kendras, Agromet Forecasts Units of India Meteorological Department, ICAR Institutes, Organization in Animal Husbandry, Dairying & Fisheries etc.) to give information/services/advisories to farmers by SMS in their language, preference of agricultural practices and locations. To put it succinctly, almost every Government Department, Office and Organisation from the Ministry Headquarters down to the level of Block having anything to do with agriculture and allied sectors in every nook and corner of the country has been authorised to use this Portal to provide information to farmers on vast gamut of issues.

USSD (Unstructured Supplementary Service Data), IVRS (Interactive Voice Response System) and Pull SMS are value added services which have enabled farmers and other stakeholders not only to receive broadcast messages but also to get web based services on their mobile without having internet. Semi-literate and illiterate farmers are also targeted to be reached by voice messages.

Genesis of the Requirement

Extension services in India have gone through vicissitudes since the Green Revolution (from monologues & speeches to personal outreach to farmer to farmer extension to bulk use of non-P2P methods) when targeted approach centred around specific crops in irrigated areas of North India became the major focus. Before modified Agriculture Technology Management Agency (ATMA) scheme was launched in the year 2010, there was no dedicated manpower for extension in agriculture and allied sectors. The Government officials and specialists were also burdened with multifarious duties of implementation of projects, scheme and programmes besides participating in various meetings. Thus a large number of villages remain deprived of interactive methods direct training which were launched after Training & Visit Programme lost its relevance due to sheer disproportionate numbers (farmer population : extension workers) in the rain-fed area that was being focussed upon. Due to vast size, huge population and difficult topography of the country, dissemination of information in timely manner was a major challenge. Electronic media also had its own constraints due to limitation in time slot available and vast area & subjects to be covered in variegated scenario of Indian Agriculture.

Despite major improvement in the state of affairs on extension front, the divergent need of the farmers could not be fully addressed. Specific requirements of the farmers based on their crops and agro climatic situation also could not be addressed on a large scale. Therefore, during the XII Plan, a National Mission on Agricultural Extension & Technologies was formulated encompassing not only Extension & ICT but also Seeds & Planting Material, Mechanisation and Plant Protection. SMS Portal has been conceptualised to give a quantum leap in coverage of farmers and

geographical area in a timely, specific, holistic and need based knowledge dissemination among the farmers by leveraging the power of mobile telephony in such a way that all sectors use this platform to not only reach out to the farmers but also to address their concerns and queries.

Objectives of the Portal Include:

- To make SMS and other mobile based services as a tool of 2 way agricultural extension in which not only information/advisory services are provided to farmers as per his/her need in a broadcast mode (in keeping with selection of crop / agricultural practice, requirements and location) but they can also raise specific queries through Pull SMS or USSD.
- Making use of huge spread of mobile telephony in the rural areas to cover every farm household in the country to overcome the major impediment in bringing level playing field for small and marginal farmers. Presently, there are about 38 crore mobile telephones in rural areas as against nearly 9 crore farm households.
- Centralized system wherein different modes of information flow are channelized and spread to the farmers in their own language.
- Integrated Portal to ensure proper storage in previous advisories/messages and also effective monitoring at various levels.
- Integration of database of farmers from the State Governments, Universities, KVKs web based registration, Kisan Call Centres etc.
- Since effective internet penetration in the rural areas is about 5% only, text messaging in the language of the farmer transcends the barriers of digital divide.
- Provision of web based services through SMS or USSD is thus the fulcrum of the whole Project.
- Integration with other farmer-centric services such as Kisan Call Centres, Common Service Centres, Web Portals for extracting relevant information and also for feeding data from remote locations where Internet is not available or is unreliable.

Unique Features of m-Kisan

- The SMS Portal has unique features like database to sift farmers down to Block level & to select specific agricultural commodities/animal/bird/fish, rating/correction of messages by the supervisory officers, searchable database of previous advisories, phone number-wise status report on a dashboard, drillable & graphical dashboard, query review interface with email piping etc. Some of the key features are explained in succeeding paragraphs.
- Nearly 3000 officers and experts from the Government of India (DAC, ICAR, DAHDF, IMD, CWC) and State Governments & its organisations down to Block level, SAUs, KVKs and AMFUs have been activated and are using the Portal in 12 different languages by using easy phonetic typing. More than thousand more such officers & experts have recently applied to get activated.
- About 70 lac farmers have already opted to receive advisories & services on their mobile phones. The farmers have been grouped based on the State, District, Block and the Crops/Activities selected by respective farmers.
- Messages are sent based on technical literature prepared by the authorities, Government orders, websites and, most importantly, Farmers' Portal (Beta Version) of which SMS Portal is a part.
- Now, nearly 20 web based services across the country have already been integrated with the SMS Portal and

many more are in the queue. Some of these include Buyer-Seller Interface, choice of machine & dealer, Kisan Call Centre, market prices, agro-meteorology advisories, NeGP-A roll-out, farm-mechanisation, micro-irrigation, animal husbandry, fertilizer testing etc.

The Portal Also Has Following Useful Concepts:

- Concept of approval request protected by mobile and email verification and further safe-guarded by physical cross-check by Activation Authority. This is necessary as messages have monetary value and Portal should not get inadvertently in to the hands of unauthorised persons.
- Rating and monitoring of messages (including supersession of an earlier message)
- Drillable dashboard down to the level of every message.
- Automatic reminder by SMS and email to Activation Authority in case of delay in approval.
- Blocking and Unblocking wrong and mischievous users.
- Concept of Guest User for testing of the interface till the stage of composing message (but not sending the same).
- Auto-signatures in language selected.
- Deregistration in case of transfer, retirement etc.
- SMS Delivery Report for every mobile number along with reasons for failure, if any.
- Integrated Feedback and Query option Uploading of Database
- Search by topic, location, administrative unit, location and keyword among previous messages.

Governance Practices Involved:

- Registration of experts has been simplified and made more broad based reaching out to every nook and corner of the country in every aspect of agriculture and allied sectors in terms of personnel and gamut of issues. The software captures relevant credentials of the expert / officer followed by verification through email and mobile. As a third level safeguard, persons registering for sending SMS to farmers have also to be approved by an administrator before being able to send the message.
- Apart from advisories and information, a number of government services have been integrated with the portal viz. e-Payment, Licensing of Dealers (Seeds, Fertilizers and Pesticides), Soil Testing and Soil Health Cards, Commodity Price Alerts etc.
- Monitoring of advisories sent by the experts at different levels is also an inbuilt process wherein a senior officer can view the advisories sent by his subordinates and also rate the same. Wherever needed, these advisories can be revised and resent to the farmers in supersession to the earlier ones.
- The Dashboard of the portal provides a transparent view of the SMSs sent by experts, which can be drilled down from National to Grassroots (Block) level officers presenting the messages sent by individual experts at respective levels.
- Instead of generic advisories & information, area and crop specific information and technical inputs are provided.

Future Road Map on Coverage, Up Gradation/Integration

SMS portal has created a platform wherein user departments or applications need not worry about the back-end integration. In case of SMS based services, they are just required to register and plug in a short code in their applications and rest all activities are taken care of by SMS portal.

Depending upon the numbers, both SMS Gateways are utilised as per a dynamic load distribution. Also, users from Agriculture, Horticulture, Animal Husbandry, Fisheries, and States (up to block level) ICAR, Agriculture universities and Met Departments can select target beneficiary farmers with the help of multiple selectable drop downs for sending messages. Specific commodity/produce can be selected as per farmer preference. Experts and officials from different fields/departments can choose their subjects easily from the lists which has been made possible by complex back end categorization of subjects and topics. Easily comprehensible dash board provides complete information to each individual user about the status of his/her messages as well as number of farmers benefited. o Keeping in view the increasing awareness of farmers towards SMS based services it is planned to include more services under the SMS Portal. Mechanisms for registration of farmers are being simplified by involving common service centres/ Kisan Call Centres more pro-actively so as to get large number of farmers included in this service. Looking into literacy concerns in the farming community and limitations in receiving and interpreting text based messages efforts are underway to send voice based advisories to those of the farmers who opt for it.

References

Source: http:/ /mkisan.gov.in/aboutmkisan.aspx

*****

*****

5. GENETICS AND PLANT BREEDING

Plant Tissue Culture Medias and Their Functions

Umesh Babu B S[1], Manjunath S[2] and Surekha S[3], Afsanabanu Manik[3]

Ph.D. Research Scholar, [1] Department of Genetics & Plant Breeding & [2] Department of Seed science & technology, [3] Department of Crop physiology UASR, Raichur, Karnataka-584104

Introduction

Plant-tissue culture is in-vitro cultivation of plant cell or tissue under aseptic and controlled environment conditions, in liquid or on semisolid well defined nutrient media for the production of primary and secondary metabolites or to regenerate plant. It is an experimental technique through which a mass of cells (callus) is produced from an explant tissue. The callus produced through this process can be utilized directly to regenerate plantlets or to extract or manipulate some primary and secondary metabolites. The plant tissue culture refers to the cultivation of a plant cell which normally forms a multicellular tissue. When grown on plant tissue culture media, the tissue forms a callus or a mass of undifferentiated cells. The technique of cell culture is convinient for starting and maintaining cell lines, as well as, for studies pertaining to organogensis and meristem culture. For the successful completion of the plant tissue culture technique, Culture media plays an important role and acts as a main component in tissue culture technique.

Types of Media

There are a number of culture medias known to date such as MS media, B5 media, LS media, White's media, etc. This article will provide you a brief of five widely used culture media in labs worldwide.

1. **White's Media**: The media was developed by P. R. White in 1963 for the establishment of the root culture of tomato. This was the earliest plant tissue culture media developed for root culture. The main purpose of these media can be used for the purpose of shoot culture and callus culture and it is mainly suitable for culture Musa and Daucus species.
2. **Murashige and Skoog (MS) Media**:

This media was invented by two scientists named Toshio Murashige and Folke K. Skoog in 1962. It is the most commonly used media in the tissue culture lab. The formulation is a blend of nutrients like inorganic salts, vitamins, and amino acids. The main purpose of this media is used to induce organogenesis, callus culture, micropropagation, and cell suspension.

3. **Gamborg (B5) Media**: This media was developed by O. L. Gamborg in 1968. He used the media for the callus and cell suspension culture of Glycine max belonging to the family of Fabaceae. This media is a blend of nutrients like inorganic salts, vitamins, and carbohydrates. The main purpose of these media is used in protoplast culture.
4. **CHU (N6)** Medium has been developed by C.C. *et al*. in 1975. for the *in vitro* anther culture of *oryza sativa* family *Graminae*. The medium helps in the initiation, growth and differentiation of callus from the rice pollen cultures. Medium is a nutrient blend of inorganic salts that consists of macroelements, microelements, vitamins and amino acid.
5. **Nitsch and Nitsch (NN) Media**: The media was developed by J. P. Nitsch in 1969 for the establishment of the in vitro anther culture of Nicotiana, from family Solanaceae. The main purpose of these media is to establish the in vitro anther culture.

Functions of Media

- Provide water
- Provide Mineral Nutritional needs
- Provide Vitamins
- Provide Growth Regulators
- Access to atmosphere for gas exchange
- Removal of plant metabolite waste

Composition of Commonly Used Plant Tissue Culture Media

COMPONENTS	Amount (mg l^{-1})				
	WHITE'S	MURASHIGE & SKOOG (MS)	GAMBORG (B5)	CHU (N6)	NITSCH'S
Macro Nutrients					
$MgSO_4.7H_2O$	750	370	250	185	185
KH_2PO_4	-	170	-	400	68
$NaH_2PO_4.H_2O$	19	-	150	-	-
KNO_3	80	1900	2500	2830	950
NH_4NO_3	-	1650	-	-	720
$CaCl_2.2H_2O$	-	440	150	166	-
$(NH^4)_2.SO_4$	-	-	134	463	-
Micro nutrients					
H3BO3	1.5	6.2	3	1.6	-
MNSO4. 4H2O	5	22.3	-	4.4	25
MNSO4. H2O	-	-	10	3.3	-
ZnSO4.7 H2O	3	8.6	2	1.5	10
Na2MoO 4. 2H2O	-	0.25	0.25	-	0.25
CuSO4.5 H2O	0.01	0.025	0.025	-	0.025
CoCl2. 6H2O	-	0.025	0.025	-	0.025
Kl	0.75	0.83	0.75	0.8	-
FeSO4. 7H2O	-	27.8	-	27.8	27.8
N2 EDTA 2HO	-	37.3	-	37.3	37.3
Organic Suppplements					
Vitamins					
THIAMINE HCI	0.01	0.5	10	1	0.5
PYRIDOXINE (HCI)	0.01	0.5	1	0.5	0.5
NICOTINIC ACID	0.05	0.5	1	0.5	5
MYOINOSITOL	-	100	100	-	100
Others					
GLYCINE	3	2	-	-	2
FOLIC ACID	-	-	-	-	0.5

BIOTIN	-	-	-	-	0.05
PH	5.8	5.8	5.5	5.8	5.8

Reference

Tissue culture media. (1996). Studies in Plant Science, 39–62.

Nandkishore Jha. Plant Tissue Culture Media: Types, Constituents, Preparation, and Selection.

Abobkar I.M. Saad and Ahmed M. Elshahed (October 17th 2012). Plant Tissue Culture Media, Recent Advances in Plant in vitro Culture, Annarita Leva and Laura M. R. Rinaldi, IntechOpen.

****

6. PLANT BREEDING

Transcription Factors: Governing Stress Responses in Crops

Vaishali Ladumor[1], Stuti Krishna[1], V. B. Parekh[2]

[1]*Department of Genetics & Plant Breeding, Navsari Agricultural University*
[2]*Aspee College of Horticulture & Forestry, Navsari Agricultural University*

Introduction

The production of RNA copies of a DNA template is known as transcription. Transcription factors are proteins that binds to specific sequence of DNA (*cis*-acting) component in promoter region and control transcription. Transcription factors (TFs) are central regulators of gene expression, and as such they modulate essential aspects of plant function, including responses to environmental factors and hormones, and cell differentiation and development of plant organs. TFs binds DNA at enhancer sites or supplementary proteins in initiation complex. Some TFs may bind to numerous genes and each gene may be controlled by multiple transcription factors. TFs governs the stress responses and are therefore favorable candidates for genetic engineering.

Stress in plants refers to external conditions that adversely affect growth, development or productivity of plants. Abiotic and biotic stresses are major threats that causes severe yield reduction in crop plants. Plant response strategies to mitigate stress effects involve changes at the molecular, cellular, biochemical, and physiological levels. These responses are generally controlled by key genes encoding transcription activators and repressors that control the downstream stress-induced genes and different pathways.

General Activation and Activity of TFs

When plant cells receive a signal of stress, the sensors present in the cell wall detect the stress signals than followed by a rapid response that transduces the external signal to intracellular signals. The cytoplasmic signal cascades require intracellular molecules or ions are operated along with kinase cascades. Calcium ions (Ca^{2+})and reactive oxygen species (ROS) are some important signal cascades. Some phytohormones like jasmonic acid (JA), abscisic acid (ABA),ethylene (ET) and salicylic acid (SA)are strong secondary messengers that co-ordinate signal transduction pathways during stress responses. These signals activate several parallel transduction pathways, which often involve phosphatases and protein kinases. In the first step,perception of signal and plants turn on two major signal cascades are calciumdependent protein kinase (CDPK) and mitogen-activated protein kinase (MAPK) pathways. Through theprotein kinases or phosphatases, important TFs are upregulated or downregulatedand the TFs bind to cis-component of stress related genes to suppressor enhance their transcription. (Fig.1).

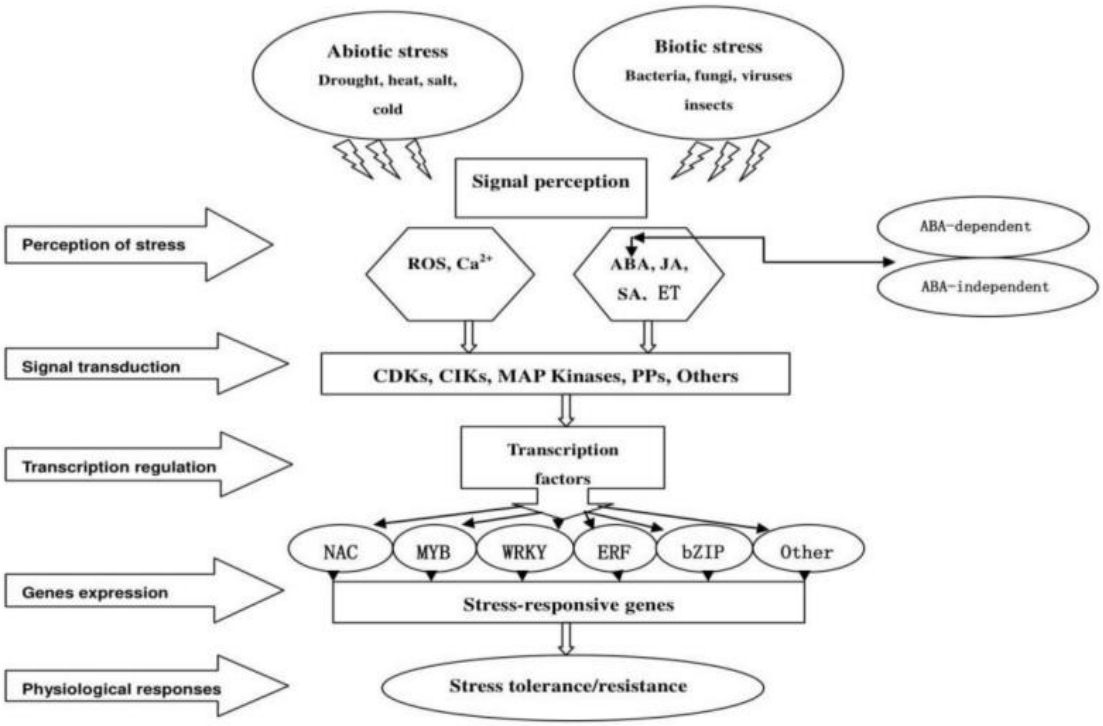


Fig. 1A schematic model of the signaling pathways involved in stress responses.

Different Plant Stress TFFs

1. **NAC TFF:** The NAC (NAM, CUC, and ATAF) TF family is one of the huge plant specific TF families.Petunia (*Petunia hybrida*) include NAM and Ataf1/2 and Cuc2 proteins from *Arabidopsis thaliana* are the first reported NAC proteins.
2. **MYB TFF:** The first identified plant MYB gene COLORED1 (C1) gene found in *Zea mays*. The MYB domain protein is crucial for anthocyanin biosynthesis in the aleurone of maize.
3. **WRKY TFF:**This TFs family one of the huge TFs families for transcriptional regulators and also regulate the diverse processes in the plants. In the sweet potato (*Ipomoea batatas*; SPF1), the first WRKY TF was identified from 25 years ago.
4. **ERF/DREB TFF:** This TF family was first found in Arabidopsis. Ethylene-responsive factor/dehydration-responsive element-binding (ERF/DREB) proteins make up a huge TF subfamily belonging to the AP2/ERF TF family.
5. **bZIP TFF:** Basic leucine zipper TFs family also one of the huge TF families, they conserved with highly dimerization domain of bZIP and comprises a basic region and a less conserved leucine zipper domain.
6. **Others:** Some of the examples of TF include heat shock (Hsf) TFs, bHLH family and stress associated protein.

Future Thrust

- The combinatorial approaches to study multiple TFs and multiple stresses to elucidate the cross-talk among different TFs, as opposed to a single TF and stress.
- Genomic identification strategies have benefited tremendously from technologies such as chromatin immunoprecipitation with massively parallel sequencing (CHIP-Seq) and next-generation sequencing (NGS).
- CRISPR/Cas9 (clustered regularly interspaced short palindromic

repeats/CRISPR-associated protein 9) gene editing is a powerful tool that could be used to modulate TFs with the goal of improving plant stress tolerance.

Conclusion

TFs could be exploited to improve the tolerance of different crops to both abiotic and biotic stresses. After two decades, some significant development in the identification and characterization of important TF families such asDREB, WRKY, NAC, MYB, bZIP and other TFs family in reaction to both the stresses.

Referances

Devi, E. L., Grosser, H. S. and Dutt, J. W. 2018. Potential use of the DREB/ERF, MYB, NAC and WRKY transcription factors to improve abiotic and biotic stress in transgenic plants. *Plant Cell Tissue Organ Cult.***132**: 1–25.

7. AGRICULTURAL CREDIT

Flow of Institutional Credit in Agriculture: A Comprehensive Analysis

Marepally Udaya Sindhu

ICAR- SMS, KVK Lakshadweep (CMFRI)

Introduction

Agriculture remains the backbone of India's economy, employing nearly half of the workforce and contributing significantly to the GDP. Institutional credit plays a vital role in boosting agricultural productivity by enabling farmers to purchase essential inputs like seeds, fertilizers, and machinery. It also offers support during non-harvest periods, helping reduce dependence on moneylenders. Over the years, India has made conscious efforts to expand institutional credit and promote financial inclusion in rural areas.

This article reviews the types and sources of agricultural credit, trends in credit flow across regions and timeframes, key challenges such as rural indebtedness, and government policy interventions.

Types of Agricultural Credit

Agricultural credit is categorized based on duration and usage

1. **Short-Term Credit (STC):** Duration of 12 to 15 months, mainly used for seasonal operations like sowing, irrigation, and harvesting.
2. **Medium-Term Credit:** Tenure of up to five years, used for purchasing cattle, farm equipment, or land development.
3. **Long-Term Credit:** Extends beyond five years, generally for capital-intensive projects such as land improvement or purchasing tractors.

Sources of Institutional Credit

1. **Commercial Banks:** Now the leading source, commercial banks' share rose from 38.4% in 1980–81 to 71% by 2014–15. They dominate both short- and long-term lending, accounting for nearly three-fourths of total agricultural credit.
2. **Regional Rural Banks (RRBs):** RRBs aim to serve small and marginal farmers. Their contribution reached 12% in 2018–19, with a compound annual growth rate (CAGR) of 6% between 2015–16 and 2017–18.
3. **Cooperative Banks:** Earlier dominant, their share has declined from 61.6% in 1980–81 to just 12% in 2014–15. These include
   - **Short-term institutions:** PACS, DCCBs, and State Cooperative Banks.
   - **Long-term institutions:** SCARDBs and PARDBs.

Trends in Credit Flow (2011–2019)

Short-Term Credit

- **Cooperative Banks:** ☐150,000 crore disbursed in 2018–19, though they faced a negative CAGR of -0.6%.
- **RRBs:** Showed consistent growth due to targeted outreach.

- **Commercial Banks:** Significantly increased their credit disbursement.

Long-Term Credit

- Commercial banks remained dominant. In 2017–18, they disbursed around ☐886,000 crore, accounting for 76% of total agricultural credit.
- RRBs and cooperatives showed moderate growth.

Regional Disparities

Credit flow varies considerably across regions

- **Southern Region:** Received the largest share (35%) in 2016–17, amounting to ☐444,000 crore. It registered the highest CAGR of 12% from 2014–15 to 2016–17.
- **Eastern Region:** Inconsistent growth—☐104,000 crore in 2015–16 fell to ☐87,000 crore the next year. CAGR remained positive at 3%.
- **North-Eastern Region:** Continues to suffer from poor infrastructure and low financial penetration.

Rural Indebtedness and Informal Credit

Despite institutional expansion, **52%** of agricultural households remain indebted. Alarmingly, **40%** of these loans come from **non-institutional sources** like moneylenders. Informal borrowing often entails high interest rates, trapping farmers in debt cycles. Barriers such as lack of collateral, formal documentation, and credit history hinder access for tenant and marginal farmers.

Institutional Interventions

The government and RBI have introduced several schemes to address credit access challenges

1. **Priority Sector Lending:** Banks and RRBs must allocate 18% of their adjusted net bank credit (ANBC) to agriculture, including 8% for small and marginal farmers.
2. **Interest Subvention Scheme:** Offers interest rebates on short-term crop loans up to ☐3 lakh, easing repayment burdens.
3. **Loan Simplification Measures**
   - No margin/security for loans under ☐1 lakh.
   - No due certificate required for loans under ☐50,000.
   - Self-declaration allowed for marginal farmers.

Kisan Credit Card (KCC) Scheme

Launched in 1998, the **KCC Scheme** revolutionized agricultural lending by offering

- Flexible, revolving credit limits
- Simplified documentation
- Interest subvention and insurance benefits

It significantly boosted institutional credit post-1999 and remains a key tool in promoting rural financial inclusion.

RBI's Internal Working Group on Agricultural Credit (2019)

The RBI established an IWG to assess credit effectiveness and suggested improvements

- **Credit Reach:** Need to extend credit to unbanked farmers.
- **Inclusiveness:** Simplify access for smallholders.
- **Credit Discipline:** Warned against the negative effects of loan waivers, which erode repayment culture and affect banking health.

Agricultural Credit vs. Agricultural GDP

The **Agricultural Credit to GDP ratio** highlights credit expansion

- From 0.6% in 1950–51 to 9.8% by 1971–72 due to bank nationalization and RRBs.
- Sharp rise post-1999, reaching 39.55% in 2006–07 due to KCC and related reforms.
- Climbed to 51.56% by 2017–18, indicating deeper credit penetration.

However, this growth is vulnerable to political interference (e.g., loan waivers), which weakens credit discipline.

Rising NPAs in Agriculture

High **Non-Performing Assets (NPAs)** reflect credit stress among farmers. This deters

banks from lending and forces borrowers back to informal sources. Strengthening risk assessment and expanding crop insurance are necessary to protect both farmers and lenders.

Conclusion

India has made substantial progress in building an institutional framework for agricultural credit. Commercial banks, RRBs, and cooperatives now cover a wide rural base. Still, challenges such as regional imbalances, farmer indebtedness, and reliance on informal credit remain.

Going forward, reforms should focus on

- Strengthening cooperative and regional rural banks
- Expanding KCC coverage
- Promoting digital credit delivery
- Ensuring region-specific credit planning
- Encouraging responsible lending practices

Effective and inclusive agricultural credit is vital for sustainable rural development and doubling farmers' incomes.

References

- Department of Agriculture & Farmers Welfare. (2019). *Pocket Book of Agricultural Statistics*.
- NABARD. (2018). *All India Rural Financial Inclusion Survey 2016–17.*
- RBI. (2019). *Report of the Internal Working Group to Review Agricultural Credit*.
- RBI. *Report on Trend and Progress of Banking in India (Various Years)*.
- University of Agricultural Sciences, Bengaluru. (2025). *Seminar Presentation by Gadde Sai Siva Rama Krishna*.

8. CROP PRODUCTION AND MANAGEMENT

Scope of Robotics in Future Farming

S. Saravanakumar

Scientist (Agronomy)

ICAR – Krishi Vigyan Kendra, MYRADA, Erode District, TamilNadu

ICAR – ATARI, Zone X, Hyderabad

Advanced technologies and its application in agriculture revolutionised in agriculture production system. The ever increasing population and drastic reduction in agricultural land, trigger the researchers to focus on advanced technologies for increasing productivity in the limited area. Application of latest technologies like Internet of Things in agriculture, precision farming, mechanised farming, artificial intelligence and robotics is essential for sustainable food production in the upcoming years. The recent applications of robotics in agriculture are paving the way for bright future for the farmers. Robotics is an intelligent machine created by engineering marvel of computing, electronics and mechanical engineering which resembles the work pattern of human beings. Robots can fill the gap between manpower and production needs. Robotic technology in agriculture for various operations like seeding, planting, spraying, weeding, harvesting and post-harvest operations. Robotic technology not only removes the drudgery in farm operations, but also protects the farmers from work under harsh environmental conditions. The applications of robotics in farming operations are inevitable in the future. The future of robotics in agriculture is anticipated in the following aspects.

Precision Seeding

The process of sowing is normally done by manually using their hands. It leads to uneven plant population and encourages high crop competition. When modern sowing and planting equipments came into place, the operation of sowing becomes easier. Autonomous precision seeding in combination with robotics and geo mapping helps to place the seeds exactly where it needs to be for good growth.

Micro Spraying

Spraying of pesticides and other chemicals on plants by using hand and power sprayer leads to consume more chemicals and soil contamination takes place over a period of time. This will hamper to the environment. To narrow down the application of chemicals to the plants which is affected by pests, disease and nutrient deficiency, micro spraying robots helpful to the farming community. The robots with computer vision technology, it can detect the problems and then spray to the targeted plants intern helpful for the excess and avoidance of chemicals on all the plants.

Weed Management

Weeds are unwanted plants and are the biggest enemies to the main crops. Removal of notorious and poisonous weeds are time consuming and create health hazards to the human beings involved in weeding process. The delay in weeding leads to further spread in the larger areas. The use of robots with computer vision technology capable of identifying the unwanted plants and uproot them easily before it matures and prevent the further spread.

Field Survey and Data Collection

Knowing the fertility level of the soil and status of the plants in important to manage the crop successfully from biotic and abiotic stresses. The conventional method of soil and plant analysis take many days to get the results and adopt the recommended package of practices. Though the researchers are involved in developing simple mechanism to analysis the soil and plants, the farmers couldn't get accurate results in time. The LiDAR powered robots helpful to collect the data on plant health, physiology, stress response, soil fertility and moisture level and use it to improve the conditions.

Precision Irrigation

Acute water shortage for agricultural operation is realised by the farmers in the recent years. Climate change plays a major role in uncertainty of rainfall and poor ground water availability. Effective utilization of available water sources for farming is crucial and the current conventional irrigation systems require more water and 40 percent of the water goes unused. Micro irrigations like drip and sprinkler system helpful to reduce the water usage in crops. Robot assisted micro or precision irrigation systems helps to reduce the wastage of water by targeting the specific plants.

Drones

Application of chemicals and nutrients to the crop requires man power and non-availability of skilled labour leads to the delay in application of chemicals and fertilizers in time. Drones are unmanned vehicle used to capture the aerial photography of the fields. Drones are used to capture imaging, mapping the fields and monitoring the crops. Drones powered with artificial intelligence helps to do the many farming operations in time with field accuracy.

Harvesting

Harvesting operations is monotonous work to be done to reap the economical food products. This is the tedious task in the farming practices. Robots are well known for replacing the human works. Reaping the matured plants can be done easily by robots and multi-talented robots helpful to harvest the fruits, vegetables and other economic parts of the plants.

Sorting and Packing

More than the agricultural operations in the field, sorting and packing of harvested produces consume more man power requirement. The need of man power for postharvest processing is increasing drastically. The robots are streamlined to perform sorting and packing of produces without any damaging. The robots are even better in working compared to human labourers in this field.

Multi-Tasking Robots

Though the robots are used for performing selected operations in the agriculture and other fields, the making of robots is found high cost. Development of robots with multi features technology can perform multi task operations. The multi-tasking robots perform all the farming operations starting from cloud seeding, planting, irrigation, weeding, soil and plant analysis, harvesting and environmental monitoring. These type of robots take care of plough to plate agricultural processes in time.

The Future

The revolution of robotics is evidently happening in front of our eyes on many field. Agriculture is the backbone of our country that feeds millions of people. Shrinking of cultivable lands and other resources, the advanced technologies like artificial intelligence and robots play a major role in performing various agricultural operations in time bound manner. It is the right time to implement the application of robots in faming for enhancing productivity.

*****

9. AGRICULTURAL MICROBIOLOGY

Motility Mechanisms of Non-Motile Organisms by Hitchhiking on Motile organisms

Bindushree, C

Department of Agricultural Microbiology, GKVK Bengaluru

Microbes perform various actions to get a better place for nutrients and favorable condition. Searching for the better niche is easy for motile microbes, as they could travel but not for non-motile ones. Then there is curiosity that how does these nonmotile microbes inhabit the favorable ecosystem. There comes the question that how non motile microorganisms use the motility mechanism of motile microbes? Here arises the new concept of 'Intermicrobial hitchhiking' which focuses on the motility of non-motile organisms assisted by motile ones.

This area of research will certainly changes the prospective of looking the microbial world, where non motile microbes exhibit different mechanisms to travel along with the motile organisms, *i.e.*, mechanical pushing by motile cells, direct attachment to the cell bodies or bacterial flagella and internal transport by cells (Muok and Briegel, 2020). There are reports where hitchhiking mechanism between motile and non-motile organisms is supported by co-evolution and mutualism concepts (Finkelshtein *et al*., 2015; Monteil *et al*., 2019). This mechanism is ubiquitous in nature and also can be seen between prokaryotes and eukaryotic microbes. Spores of eukaryotes and prokaryotes also get benefitted by this mechanism (Ingham *et al*., 2011; Muok and Briegel, 2020).

There are several effects of hitchhiking on plants (eg. colonization by beneficial spores of *Streptomyces*, attack of *Xanthomonas* sp. and other diseases etc.) and on human (eg. colonization of opportunistic microbes in mouth cavity, increases threat of severity of lungs in multiple attack, uses of cellular defense mechanism for hitchhiking *etc*).

Transport *via* hitchhiking occurs among bacteria found in the soil, on plant tissues on abiotic surfaces, and in human tissues. Hitchhiking is advantageous to nonmotile microbes that would otherwise occupy a single location and can also be favorable to the motile partner. For example, the soil-dwelling motile bacterium *Paenibacillus vortex* is noted for its 'hyper-swarming' behavior. *Paenibacillus vortex* can swarm on hard surfaces, whereas most other bacteria are nonmotile under such conditions. To aid in its migration, *Paenibacillus vortex* is able to carry antibiotic-resistant nonmotile bacterial 'cargo' at the leading edge of the swarm. As the cargo degrades antibiotics to nonlethal substances, the trailing *P. vortex* can then occupy the previously toxic niche. *P. vortex* can effectively carry many nonmotile bacteria as cargo (nonmotile strains of *Escherichia coli*, *Klebsiella pneumoniae*, and *Enterobacter aerogenes*) and this cotransport can be advantageous as long as the cargo possesses the antibiotic resistance necessary for survival in the new niche.

Motility assays and microscopy studies reveal that *Streptomyces* spores are transported to plant tissues by interacting directly with the flagella of both gram-positive and gram negative bacteria. Genetics experiments demonstrate that this form of motility is facilitated by structural proteins on the spore coat. These results demonstrate that

nonmotile bacteria are capable of utilizing the motility machinery of other microbes to complete necessary stages of their lifecycle (Alise *et al*., 2021).

Microbial hitchhiking has been observed in diverse prokaryotes and eukaryotes, suggesting that such interactions are ubiquitous in nature. Remarkably, all reports of microbe-microbe hitchhiking, with the exception of *L. pneumophila's* transport by amoebae, were made within the last decade. As methods for studying multiplex biological systems advance, it is likely that emerging research will elucidate the pervasiveness of microbial hitchhiking in natural settings. In most reported instances, the molecular components and physiological interactions that underlie hitchhiking are unclear. Scientists have predicted that intermicrobial hitchhiking can be developed into an independent subfield in microbiology and collectively, these insights may help to identify infection mechanisms for pathogens and underscore the importance of examining microbes in the context of their native microbiomes.

References

Alise, R. M., Dennis, C. And Ariane, B., 2021, Microbial hitchhiking: how *Streptomyces* spores are transported by motile soil bacteria. *Multidiscip. J. Microb. Ecol*., **4**(9).

Finkelshtein, A., Roth, D., Jacob, E. B. And Ingham, C. J., 2015, Bacterial swarms recruit cargo bacteria to pave the way in toxic environments. *J. Am. Soc. Microbiol*., **6**(3).

Ingham, C. J., Kalisman, O., Finkelshtein, A. And Ben-Jacob, E., 2011, Mutually facilitated dispersal between the nonmotile fungus Aspergillus fumigatus and the swarming bacterium *Paenibacillus vortex*. *Proc. Natl. Acad. Sci*., **108**(49): 19731-19736.

Monteil, C. L., Vallenet, D., Menguy, N., Adryanczyk, G., Leonhardt, N., FAIVRE, D., Pignol, D., Weld, R. J. And Lefevre, C. T., 2019, Ectosymbiotic bacteria at the origin of magnetoreception in a marine protist. *Nat. microbiol*, **4**(7), 1088–1095.

Muok, A. R. And Briegel, A., 2020, Intermicrobial Hitchhiking: How Nonmotile Microbes Leverage Communal Motility. *Trends Microbiol.,* **4**:1-9

****

10. SOIL SCIENCE

Soil Carbon Sequestration to Mitigate Climate Change

Mitali Tiwari, Ritu kumari Vashishtha

Navsari Agricultural University, Bharuch (Gujarat)

Introduction

World soils and terrestrial ecosystems have been a source of an atmospheric abundance of carbon dioxide ever since settled agriculture began about 10-13 millennia ago(Rattan Lal). Human activities especially the burning of fossil fuels has caused a substantial increase in the carbon dioxide in the atmosphere. This increase in carbon dioxide levels from 280 to more than 380 parts per million is leading to measurable global warming.

Thus, there is an urgent need to reduce carbon dioxide emissions and maintain the optimum level of carbon dioxide in the atmosphere.

Carbon Sequestration: The term C-Sequestration describes both natural and deliberate process by which carbon dioxide is either removed from the atmosphere or diverted from emission sources and stored in the oceans, terrestrial environments and geologic formations.

Benefits of Carbon Sequestration: It improves soil quality by increased fertility, soil structure and stability. It also increases water holding capacity and further crop production. It reduces soil erosion and losses of nutrients from soil.

Management Techniques for Carbon Sequestration: There are many techniques such as Conservation agriculture, minimum or zero tillage, cover crops, crop rotation, crop sequencing, crop residues, organic agriculture, rotational grazing, inorganic fertilizers and

grasses and forages.

Soil Carbon Pool

Sources of soil carbon pool: It can be divided into 3 parts- source, known sinks and missing sinks. Source includes fossil fuel combustion and cement production and land use change. These are the sources that contribute maximum to the soil carbon pool. However, Known sinks include the contribution of the atmosphere and oceans. And the last missing sinks include terrestrial sinks. There are 5 principal global carbon pools it includes oceanic pool, geologic pool, soil carbon pool, atmospheric pool and biotic pool.

Factors affecting soil carbon pool: Soil carbon pool serves numerous on and off-site functions to the human society and well being. Indeed the unwise cultivation of this precious resource is due to human greed and short-sightedness causing land misuse and soil mismanagement. Some other factors such as anthropogenic perturbations, deforestation, biomass burning, ploughing, drainage of wetlands, shifting cultivation, soil erosion and some methods of tillage have the most severe impact on the SOC pool.

Impact of potential climate change on soil Quality: The effect of climate change varies in temperate, tropical and boreal regions. Some major impacts are -

- Reduction in net primary productivity due to increase in temperature of the soil.
- Due to changes in moisture and temperature regimes, it affects the composition of species in the ecosystem.
- Due to changes in biomass, it affects the soil physical properties.
- It leads to a susceptibility of soil to erosion, crusting, compaction and runoff.
- astly it affects the microflora and fauna of the ecosystem.

Technological Options

1. Conservation Tillage:- Conservation tillage, a conventional term inferring all culturing strategies that decrease runoff and soil disintegration in examination with furrow based tillage, is known to expand the SOC substance of the surface layer. Head components of carbon sequestration with conservation tillage are increment in miniature accumulation and profound situation of SOC in the subsoil horizons. Other helpful agricultural practices related to conservation tillage are those that lead to increment in biomass production (e.g., soil fertility upgrade, improved harvests and species, cover crops and fallowing, improved fields and deep-rooted crops). It is likewise important to adopt soil and crop management practices that highlight humification and lead increment in the passive fraction of SOC. Due to the enormous importance of C sequestration, soil quality should be assessed based on its SOC content.
2. Cover Crops:- The benefits of adopting conservation tillage for SOC sequestration are greatly enhanced by growing cover crops in the rotation cycle (R.Lal/Geoderma 123, 2004). Cover crops are a significant soil carbon sequestration technique. The roots and shoots of cover crops feed microbes, parasites, nightcrawlers and other soil living beings, which expand soil carbon levels after some time. A few farmers consider this sequestration "restoring" their soil carbon to the level that it was before cultivation or the initial furrowing of the soil for agricultural practices. However, to enhance the SOC pool, using cover crops as a green manure crop but in short term may not necessarily be a good plan.
3. Irrigation:- The judicious use and application of irrigation water in the soil which is drought-prone can lead to not only the enhancement of biomass production but also increment in the amount of above-ground and the root biomass returned to the soil. Better irrigation practices also improve the SOC concentration of the soil.
4. Restoring Degraded Soils:- There is an immense potential for sequestrating soil C through the restoration of degraded soils and ecosystems. The large amount of the antecedent SOC pool lost by most degraded soils can be very efficiently restored by adopting various judicious

land-use practices.

5. Pasture Management:- On a global basis, 3460 Mha land is occupied by grassland/grazing lands. For sequestering SOC and SIC, improving forage species and restoring degraded grazing lands are important. Furthermore, converting marginal croplands to pastures can also sequester C.
6. Forest Soils:- Another one of the most ignored ways of enhancing the SOC pool is converting the degraded lands under agriculture and other land uses into forests and perennial land use.
7. Urban Soils:- In North America, Europe and other developed countries, Urban forestry is an important land use practice. We can drastically alter the SOC fluxes and pool, simply by transforming landscapes from non-urban to urban land use.
8. Nutrient Management:- Judicious nutrient management is crucial to SOC sequestration. In general, the use of organic manures and compost enhances the SOC pool more than the application of the same amount of nutrients as inorganic fertilizers (Gregorich et al., 2001). The impact of fertilizer on the SOC pool is mainly related to humification and C biomass produced/returned to the soil.

The Potential of the Soils All Around the World To Sequester Carbon

The capacity of SOC sequestration is high in the world's degraded soils and the ecosystems which are assessed at 1216 Mha and the soils under agriculture which are assessed at 4961 Mha. These soils have a large capacity to sequester C by using restorative land use management practices as they have lost a huge amount of their original SOC pool. Keeping all the factors same, the sequence of the potential of SOC sequestration for different soils is as follows: degraded soils and desertified ecosystem>cropland>grazing lands>forest lands and permanent crops. It is estimated that a huge part of the historic carbon loss (~ 66 - 90 Pg) can be sequestered in over 25- 50 years.

Benefits

- As well as diminishing the pace of improvement of air centralization of CO2, upgrading the SOC pool would improve soil quality and agronomic/biomass efficiency.
- The procedures of SOC sequestration laid out thus are expected to meet the food requests of the developing populace, with an auxiliary advantage of SOC sequestration.

The decline in the amount of SOC leads to disruption of soil structure and affect the quality of soil resources, these can be considered as symptoms of non-sustainable land use. These effects can be easily reversed by using various practices known for increasing SOC sequestration.

Thus, SOC Sequestration is a win-win Strategy.

Research Findings

Thus, the potential of SOC sequestration is finite in magnitude and duration as it is a short term strategy to mitigate anthropogenic enrichment of atmospheric carbon dioxide. So a long term alternative solution to fossil fuels must be required.

According to the intergovernmental panel on climate change fourth assessment report of 2007, sequestration over the next 2 to 3 decades will potentially have an impact to mitigate climate change and even stabilizes the level of atmospheric carbon dioxide.

Yet SOC sequestration can be considered and implemented in alternative to fossil fuels. It is a bridge to the future. Soil carbon sequestration is something that we cannot afford to ignore.

References

R. Lal (2004) Soil Carbon Sequestration to mitigate climate changes, R lal, geoderma 123 (1-22)

Reena Nair, Shefali Sharma and Cr M (2015), Carbon Sequestration in Soils Volume-36 No.-12

R. Lal, B. A Stewart and J.M. Kimble (2007), Conservation tillage for Carbon Sequestration 943- 956 Vol.172, No.-12

Lal, R. 2015 Cover Cropping and the “4 per Thousand” proposal. J. Soil Water Conservation.

Subscription form

☐NEW ENROLLMENT		☐INDIVIDUAL (12 ISSUES)	Rs. 500.00
☐RENEWAL	[Subscription No.]	☐INSTITUTIONAL (12 ISSUES)	Rs. 900.00
SUBSCRIBE FROM	Click here to enter a date. TO Click here to enter a date.		
	Date: Click here to enter a date.		

Please clearly mention new enrollment / renewal (mention subscription no.)

Please Enroll / Renew me for Readers Shelf (12 ISSUES) at following Address:

ADDRESS			
TITLE:	[First Name][Middle Name][Last Name]		
ADDRESS	[Address]		
CITY	[City]		
DISTRICT	[District]		
STATE	[State]	[Pin Code]	

COMMUNICATION DETAILS			
STD CODE	[STD Code]	PHONE NO.	[Phone No.]
MOBILE NO.	[Mobile No.]	ALTERNATIVE MOBILE	[Mobile No.
EMAIL ID	[Primary email ID]		
ALTERNATIVE EMAIL ID	[Secondly email ID]		

I am enclosing herewith annual subscription for Readers Shelf by Demand Draft / NEFT

PAYMENT DETAILS			
DEMAND DRAFT NO.	[DD No.]	DATE OF ISSUE	[DD Date]
ISSUING BANK	[Issue Bank Name]		
ONLINE TRANSFER TRANSACTION NO.	[Bank Transaction No.]	DATE	[Transaction Date]

Please send your DD in favour of J. V. PUBLISHING HOUSE, Payable at JODHPUR

Authorized Signature
With seal

Subscription Department

J. V. PUBLISHING HOUSE

Plot No. 15, Gajendra Nagar, Near Old FCI Godown, Shobhawaton Ki Dhani, Pal Road, Jodhpur Phone: 94141 28105 E.Mail: m_vyas@outlook.com Website: www.readersshelf.com