ONLINE ISSN 2583-4339
www.journalworlds.com

Agri JOURNAL WORLD

Volume 3 issue 9 September 2023 Pages 40

PUBLISHED BY LEAVES AND DEW PUBLICATION

www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 3 ISSUE 9 SEPTEMBER, 2023

Editor-In-Chief

Associate Editor-In-Chief

Editors

Board of Directors

Published By

LEAVES AND DEW PUBLICATION
B- 132, Nanhey Park,
Uttam Nagar, New Delhi 110059

Agri JOURNAL WORLD
www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 3 ISSUE 9 SEPTEMBER, 2023

CONTENTS

www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 3 ISSUE 9 SEPTEMBER, 2023

CROP INSURANCE PROGRAMS IN INDIA: A COMPREHENSIVE REVIEW

Y A Garde[1*], Alok Shrivastava[1], Nitin Varshney[1], V S Thorat[2], and V Y Garde[3]

[1]*Department of Agricultural Statistics, N.M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat, India – 396 450*

[2]*Department of Agribusiness Economics & Finance, ASPEE Agribusiness Management Institute, Navsari Agricultural University, Navsari, Gujarat, India – 396 450*

[3]*Naran Lala Institute of Teacher Education, VNSGU, Navsari, Gujarat, India – 396 450*

**Corresponding author email: y.garde@nau.in*

ABSTRACT

The article explores India's complex agricultural insurance landscape, with a focus on the National Agricultural Insurance Scheme (NAIS) and its evolution. Agriculture's vital role, contributing 22% to GDP and engaging over half the workforce, underlines its importance. Challenges from unpredictable weather and pests are mitigated by crop insurance, shielding farmers from yield-affecting variables. From the 1970s' Individual Approach Scheme to NAIS's 1999 inception, it shifts to individual assessment with affordable premiums and tech-driven loss evaluation, covering diverse crops and non-loanee farmers. Coverage, insurable sum, premiums, subsidies, and loss evaluation are key aspects. NAIS benefits around 193 million farmers across 25 seasons, but hurdles persist. Recommendations encompass coverage, premiums, indemnity, and administration, addressing concerns such as adverse selection. Despite NAIS's favorable metrics, limited adoption calls for alignment with farmer expectations.

INTRODUCTION

Agriculture stands as a cornerstone of the Indian economy, contributing a significant 22 percent to the Gross Domestic Product (GDP), employing approximately 58 percent of the workforce, providing sustenance to about 69 percent of the population, meeting the nation's complete food and nutritional requisites, furnishing essential raw materials to pivotal industries, and accounting for approximately 14 percent of total exports. Given its intricate dependency on meteorological patterns and its protracted production cycle, agriculture emerges as an economically precarious pursuit.

The agricultural sector in India assumes a pivotal role in the national economy, not only in terms of its substantial contribution to GDP and employment generation but also in fulfilling essential food and nutritional requirements. However, this sector confronts an array of challenges, encompassing erratic weather patterns, pest infestations, and crop diseases. The resultant crop losses have profound implications for the livelihoods of millions of farmers across the nation. In order to mitigate the inherent uncertainty associated with crop production, largely influenced by uncontrollable natural factors, crop insurance has

been established as a mechanism. This serves to protect farmers from the vagaries of crop production and functions as a financial safeguard by accounting for a multitude of unpredictable variables that impact crop yields. This strategy effectively distributes the burden of losses. Particularly pertinent in a country like India, where agricultural output is susceptible to the volatility of weather patterns and substantial damages arising from pest and disease outbreaks, the importance of crop insurance cannot be overstated.

The inception of the Comprehensive Crop Insurance Scheme (CCIS), encompassing major crops, dates back to 1985, coinciding with the commencement of the VII-Five Year Plan. This seminal initiative was succeeded by the introduction of the National Agricultural Insurance Scheme (NAIS), initiated from the Rabi season of 1999-00 onwards. The formulation and execution of these schemes were underpinned by extensive groundwork, meticulous studies, strategic planning, experimental phases, and pilot trials. Tracing a concise chronology leading up to the present NAIS would provide valuable insights into the developmental trajectory.

1. *Individual Approach Scheme (1972-1978):* The inaugural scheme was initiated with a focus on individual farmers, commencing with H-4 cotton in Gujarat and subsequently encompassing multiple crops and states. The scheme benefited 3,110 farmers who collectively paid a premium of Rs. 4.54 lakhs, resulting in claims disbursed amounting to Rs. 37.88 lakhs.
2. *Pilot Crop Insurance Scheme (PCIS) - (1979-1984):* Enacted based on recommendations by the late Prof. V.M. Dandekar, PCIS adopted a "Homogeneous Area" approach. It initially covered diverse crops, such as food crops, oilseeds, cotton, and potatoes, targeting loanee farmers on a voluntary basis. The program was implemented across 13 states, extending coverage to 6.27 lakh farmers. Premium payments aggregated Rs. 196.95 lakhs, while claims worth Rs. 157.05 lakhs were settled.
3. *Comprehensive Crop Insurance Scheme (CCIS) - (1985-1999):* Evolving from PCIS, CCIS became obligatory for loanee farmers. Premium rates were set at 2 percent for cereals and millets and 1 percent for pulses and oilseeds. Claims and premium contributions were shared between the Central and State governments in a 2:1 ratio. Implemented in 16 states and 2 Union Territories, CCIS extended coverage to 7.63 crore farmers. Total premium collection reached Rs. 403.56 crores, with claims disbursed amounting to Rs. 2319 crores. Gujarat accounted for 47 percent of claims, followed by Andhra Pradesh (21 percent), Maharashtra (9 percent), and Orissa (8 percent). The majority of claims (75 percent) were attributed to deficient rainfall, while cyclones and floods contributed to 20 percent. The claim ratio was 5.75, and the loss cost was 9.29 percent.
4. *Experimental Crop Insurance Scheme (ECIS) - (Rabi 1997-98):* As an experimental endeavor, ECIS aimed to extend coverage to non-loanee small and marginal farmers in 14 districts across 5 states. This

initiative provided a complete premium subsidy. The scheme benefited 4.55 lakh farmers who collectively paid a premium of Rs. 2.84 crores, resulting in claims worth Rs. 37.80 crores being settled.

NATIONAL AGRICULTURAL INSURANCE SCHEME (NAIS) ERA (LATE 1990S-2000S)

The NAIS, introduced in 1999, brought about a transformative phase in crop insurance. It shifted the approach from area-specific coverage to individual farmer-level assessment. Premium rates were made affordable, and technology-driven methods for loss assessment were implemented. NAIS aimed to cover a broader spectrum of crops and risks, along with non-loanee farmers. NAIS was introduced during Rabi 1999-00 by improving the scope and content of erstwhile CCIS.

SALIENT FEATURES OF THE SCHEME

- *States and Areas covered:* The Scheme is available to all States and Union Territories on optional basis. A State opting for the Scheme will have to continue for a minimum period of three years.
- *Farmer covered:* All farmers including sharecroppers and tenant farmers growing the notified crops in the notified areas are eligible for coverage. The scheme is compulsory for farmers availing loans and voluntary for others.
- ***Crops covered**:* The Scheme covers

✓ Food crops (Cereals, Millets & Pulses)

✓ Oilseeds

✓ Annual Commercial / Horticultural crops of Sugarcane, Cotton, Potato, Onion, Chilly, Turmeric, Ginger, Jute, tapioca, annual Banana & annual Pineapple

- *Sum insured:* The minimum Sum Insured (SI) in case of loanee farmer is the amount of loan availed, which can be further extended upto 150% of average yield. For non-loanee farmer, it can be upto value of 150% of average yield.
- *Premium Rates:* The premium rates are 3.5% for oilseeds & bajra and 2.5% for cereals, millets & pulses during Kharif; 1.5% for wheat & 2% for other food crops and oilseeds during Rabi. The rates for annual commercial / horticultural crops are actuarial**.**
- *Premium subsidy:* Small / Marginal farmers are subsidized in premium to the extent of 50 percent, to be shared equally between the Centre & States. The premium subsidy is, however, to be phased out over five years period on sunset basis. Accordingly the eligible subsidy during 2004-05 is 10 percent.
- *Scheme approach:* The scheme covers losses from sowing to harvesting, and operates on 'area approach' for widespread calamities. For this purpose a unit of insurance is defined which may be a Village Panchayat, Mandal, Hobli, Circle, Phirka, Block, Taluka etc. to be decided by the State govt. / UT.

However, each participating State govt. / UT was required to reach the level of Village Panchayat as the unit within a maximum period of three years.

The Scheme is to operate on 'individual' basis for specified localized calamities. However, individual assessment of losses is experimented only in a few areas – one block / taluka in each state.

- *Loss assessment, Levels of Indemnity & Threshold Yield:* The Threshold Yield (TY) or Guaranteed Yield for a crop in a Insurance Unit shall be the moving average yield based on past three years in case of Rice & Wheat and five years yield in case of Other crops, multiplied by the level of indemnity. Three levels of Indemnity, viz., 90%, 80% & 60% corresponding to Low Risk, Medium Risk & High Risk areas shall be available for all crops. The insured farmers of unit area may also opt for higher level of indemnity on payment of additional premium.

  If the 'Actual Yield' (AY) per hectare of the insured crop for the defined area falls short of the specified 'Threshold Yield' (TY), all the insured farmers growing that crop in the defined area are deemed to have suffered shortfall in their yield.

- *Sharing of Risk:* Until transition is made to actuarial regime, Govt. of India and States shall share claims beyond 100% of premium for food crops & oilseeds on 50:50 basis. In case of annual commercial / horticultural crops, claims beyond 150% of premium in the first 3 or 5 years and 200% thereafter are borne by Centre and State on 50:50 basis

EXTENT OF COVERAGE IN NAIS

The National Agricultural Insurance Scheme (NAIS) provides its coverage across diverse geographical territories. At present, the operationalization of the scheme is in progress within 24 states and 2 union territories. However, it is notable that there exists a group of 4 states and 5 union territories which are presently abstaining from participation in the scheme. Over the duration of the preceding twenty-five crop seasons (spanning from Rabi 1999-2000 to Rabi 2011-12), an estimated 193 million farmers have been encompassed within its protective ambit. This expansive outreach entails an agricultural expanse of approximately 291.9 million hectares. The aggregated sum of insured value accounts for approximately Rs. 2,56,065 crores, a representation of the collective protective value the scheme offers. The cumulative claims, either disbursed or pending, amount to roughly Rs. 25,001 crores, juxtaposed against a premium sum of approximately Rs. 7,565 crores. This endeavour has directly benefited an approximate tally of 5.18 million farmers, encompassing activities until the Rabi season of 2011-12.

MODIFIED NATIONAL AGRICULTURAL INSURANCE SCHEME (MNAIS)

To enhance effectiveness and user-friendliness, a Joint Group was established by the Government of India (GOI) to assess prevailing crop insurance programs. Drawing on the Joint Group's recommendations and

feedback from diverse stakeholders, a proposal was formulated for the Modified Agricultural Insurance Scheme (MNAIS), subsequently approved for a pilot implementation in 50 districts for the remaining span of the 11th Plan, commencing from Rabi 2010-11. Notable enhancements introduced in MNAIS include:

1. Actuarial premium with subsidy up to 75% for all farmers.
2. Central and State Governments equally share upfront premium subsidy, while the insurance company shoulders all claims liabilities.
3. Unit area of insurance refined to the village or village panchayat level for major crops.
4. Coverage extended to prevent sowing/planting risks and post-harvest losses due to cyclones in coastal areas.
5. Immediate on-account payment of up to 25% of likely claims for prompt relief to farmers.
6. Uniform seasonality discipline for both loanee and non-loanee farmers.
7. Improved methodology for threshold yield calculation; minimum indemnity level increased to 70% from the previous 60%.
8. Compulsory for loanee farmers and voluntary for non-loanee farmers.
9. Engagement of private sector insurers to foster competition in crop insurance.
10. Establishment of a national-level catastrophic fund contributed equally by central and state governments to safeguard insurance companies in scenarios where the premium to claim ratio surpasses 1:5 nationally, or when suitable reinsurance cover cannot be secured at competitive rates.
11. Withdrawal of the National Agricultural Insurance Scheme (NAIS) from areas/crops where RAIS is implemented.

The pilot initiative was executed across all 50 districts during the Rabi 2011-12 season, followed by 44 districts in the Kharif 2012 season. Presently, it is underway in 35 districts for the Rabi 2012-13 season. Since the inception of the pilot phase, RAIS has extended coverage to 3.326 million farmers across 3.627 million hectares, with a total insured sum of Rs. 8,063.73 crore. Claims amounting to approximately Rs. 234.27 crore have become payable, derived from a premium of around Rs. 824.38 crore, ultimately benefiting approximately 229,000 farmers (up to the Kharif 2012 season).

MAIN CHALLENGES AND PERCEPTIONS

Despite offering a juxtaposition of compellingly high claim ratios and economically favorable premium rates, the broad adoption of crop insurance among the farming community remains an elusive goal. This intricate duality serves as an unmistakable indicator that the existing crop insurance scheme falls short of aligning with the aspirations and needs of farmers. The National Agricultural Insurance Scheme (NAIS), strategically formulated to provide a protective buffer against an array of agricultural uncertainties,

has engendered extensive deliberations within both formal and informal discourse arenas. These deliberations are undertaken with the intent of unraveling the underlying complexities that contribute to the scheme's limited resonance and acceptance among farmers.

The discussions centered on the NAIS have engendered the emergence of a series of cogent suggestions and insightful perspectives, all aimed at elevating the scheme's appeal and relevance within the agrarian community. These recommendations span a spectrum of facets intrinsic to the insurance framework, encompassing considerations ranging from coverage enhancements to administrative refinements.

Undoubtedly, the coverage dimension, a pivotal hallmark of any insurance scheme, has garnered substantial attention. A proposition has been put forth for the introduction of an inclusive comprehensive policy, enveloping not just crop coverage but also the safeguarding of other pivotal agricultural assets. The envisioned policy could be seamlessly accessed through a consolidated interface, thus streamlining the procedural intricacies for farmers. Furthermore, a call has resonated for the incorporation of perennial horticulture and vegetable crops into the scheme's purview, thereby broadening its compass to encompass a more extensive array of agricultural undertakings. By extending its reach, the scheme could encompass the mitigation of risks spanning the pre-sowing phase to post-harvest losses. Notably, to avoid an undue concentration of risk exposure, the upper limit for coverage is suggested to be capped at 100% of the threshold yield.

Turning attention to the sphere of premium-related considerations, a proposal has been posited to institute a ceiling on the actuarial premium rates for Annual Commercial and Horticulture crops, pegged at 3%. Alternatively, introducing a voluntary enrollment structure for these specific crops is advocated. This strategic step is aimed at achieving a harmonious equilibrium between affordability for farmers and the sustainable operability of the insurance providers. In addition, a resurgence of premium subsidies for Small and Marginal farmers is proposed, with a recommendation to confer complete premium subsidies for these segments within rainfed areas. A shift towards regional premium rating is endorsed to better accommodate regional disparities in risk, supplanting the prevailing uniform state-level rates. The prevailing incongruence in premium rates between the agricultural community and administrative stakeholders necessitates a reevaluation and alignment of premium rates with the actual underlying risks.

To address concerns pertaining to indemnity, the suggestions converge on the optimization of the claims settlement process. Recommendations encompass the expeditious disbursement of claims following losses, the possibility of ad-hoc or on-account settlements, and the implementation of personalized evaluation mechanisms. It is articulated that the established guaranteed yield should be anchored on the

most favorable 3 to 5 years from the preceding decade, thereby ensuring an equitable reflection of historical yield trends. Additionally, advocating for a minimum indemnity limit of 80% is championed, enhancing the protective shield offered to farmers.

In the realm of administration, the proffered recommendations are oriented towards enhancing implementation efficiency and expanding the scheme's outreach. Proposals advocate for a reduction in the sample size of Crop Cutting Experiments, stipulated timelines for scheme-related activities, and the augmentation of infrastructure and human resources within implementing bodies to better serve the agricultural community. An integrated network at the district level is envisaged to facilitate effective communication with farmers. Additionally, a clarion call is sounded for the Central Government to undertake awareness campaigns and absorb publicity expenditures to propagate the scheme's inherent benefits. Recognizing banks as pivotal actors in the scheme's execution, efforts are directed towards enhancing their efficacy and refining operational protocols.

These suggestions permeate into the realm of fundamental insurance principles. Confronting challenges such as adverse selection issues, claims inflation resulting from counterfeit coverage or manipulated yield data, and the absence of risk diffusion due to the non-participation of significant states, these recommendations collectively shape the trajectory towards the enhancement of the scheme's viability and its amplified impact.

SUMMARY

The agriculture sector in India plays a pivotal role in the economy, contributing 22% to GDP, employing 58% of the workforce, and meeting food and raw material needs. However, it faces challenges from weather fluctuations, pests, and diseases. To mitigate risks, crop insurance has been adopted. The Comprehensive Crop Insurance Scheme (CCIS) emerged in 1985, followed by the National Agricultural Insurance Scheme (NAIS) in 1999. NAIS shifted to individual-level assessment and technology-driven loss evaluation, covering diverse crops and risks, including non-loanee farmers. Over 25 crop seasons, NAIS reached 193 million farmers, covering 291.9 million hectares with an insured sum of Rs. 2,56,065 crore. Modified NAIS (MNAIS) improved upon NAIS by implementing actuarial premiums, equal sharing of subsidies, and other enhancements. Challenges persist, necessitating coverage expansion, premium subsidies, improved claims settlement, and administrative efficiency for successful crop insurance implementation.

REFERENCES

Banita, Gurung Pratiksha (2023). Insights into Crop Insurance in the Agriculture Industry in India: An Overview. *Bhartiya Krishi Anusandhan Patrika*. 38(1): 19-28. doi: 10.18805/BKAP604.

Chadha & Srivastava (2022). Crop Insurance: An Economic Review of its Performance in India. *Biological Forum – An International Journal* 14(1): 434-439.

https://agricoop.nic.in/

https://agricoop.nic.in/sites/default/files/AGRICULTURE%20INSURANCE-Credits.pdf

Paul and Nisha (2020). Crop Insurance in India: Evolution, Issues and Way Forward. *Journal of Critical Reviews* 7(11):2851-2869

****

www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 3 ISSUE 9 SEPTEMBER, 2023

VIRGIN COCONUT OIL'S NUTRITIONAL PROFILE AND THERAPEUTIC ADVANTAGES

Srinivasu P[1], Kalpana M[2] and Aparna V[3]

[1]Department of Plantation, Spices, Medicinal and Aromatics Crops, HC&RI, TNAU, Coimbatore, Tamil Nadu

[2]Professor & Head, Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, Dr.Y.S.R Horticultural University, Venkataramannagudem-534101, West Godavari, Andhra Pradesh, India

[3]Scientist, Department of Horticulture, ICAR-CPCRI, Kasaragod, Kerala, India

Corresponding author email: Psrinivasu344@gmail.com

ABSTRACT

Virgin coconut oil is a product that can be produced from fresh coconut meat,milk, or residue. It has earned a reputation as a well-liked cooking oil that serves several purposes. It is regarded as the newest, highest-quality coconut product, and consumers are particularly interested in it because of its functional food qualities and human, nutraceutical advantages. Many studies that demonstrate its positive effects are to blame for its rising popularity. A number of research have looked at the pharmacological effects of virgin coconut oil, including its anti-inflammatory, analgesic, antipyretic, antioxidant, anti-stress, and antibacterial activities. The benefits of virgin coconut oil in preventing bone loss and cardio protection have also been examined in another research.

KEYWORDS: Introduction, Virgin coconut oil, Chemical composition and Health benefits,

INTRODUCTION

Coconut oil is a crucial ingredient in a variety of traditional Asian and Pacific cuisine recipes. Coconut oil differs from other vegetable oils due to its high content of medium chain fatty acids (MCFAs), particularly lauric acid. Since MCFAs are quickly burned up after consumption, the body uses them to create energy right away as opposed to storing them as body fat. Lauric acid is converted into the antiviral and antibacterial compound monolaurin, which has several beneficial properties. Therefore, it is thought that consuming coconut oil may help with infection prevention. Typically, mechanical or natural methods, together with heat or without it, are used to extract coconut oil from wet coconut meat. It's not necessary to use chemical methods for refining, bleaching, or deodorizing. As a result, virgin coconut oil (VCO), which has not had its nature changed, has been created. VCO is quickly gaining enormous significance because of its many health advantages, high saturation level, and strong stability. Coconut oil in its most pure state,

VCO has a flavor and fragrance that are uniquely coconut. It becomes colorless like water when it liquefies after becoming solid at low temperatures. This type of coconut oil is the purest; it smells like a fresh coconut, includes natural Vitamin E, and contains other priceless ingredients found in coconut meat. Because VCO is a source of saturated fatty acids (SFAs), it has positive benefits that dispel all myths that were prevalent. Analgesic, antipyretic, antioxidant, anti-stress, antibacterial, anti-obesity, anti-HIV, and cardioprotective effects are just a few of the impressive functional qualities that health experts believe this amazing meal offers.

Table 1. Fatty acid profile of virgin coconut oil

Fatty Acids	Composition (% of Total Fatty Acids)
Lauric Acid	45-53%
Myristic Acid	16-21%
Caprylic Acid	5-10%
Palmitic Acid	7-10%
Capric Acid	5-8%
Oleic Acid	2-8%
Linoleic Acid	1-3%

NUTRITIONAL PROFILE

VCO is primarily composed of various types of fatty acids. Saturated fats make up nearly 87% of the fats in virgin coconut oil. The medium-chain triglycerides (MCTs) that make up the saturated fat in coconut oil are shorter than the long-chain triglycerides (LCTs) that are found in the majority of other dietary fats. The potential health benefits of coconut oil are becoming more and more popular since it differs from other oils in terms of composition. Here's a table outlining the approximate composition of fatty acids found in VCO.

PROCESSING METHODS OF VCO:

Virgin coconut oil (VCO) is often made using a cold-pressing or wet-milling method in order to preserve the natural tastes and health-improving compounds present in coconuts. The steps involved in generating VCO:

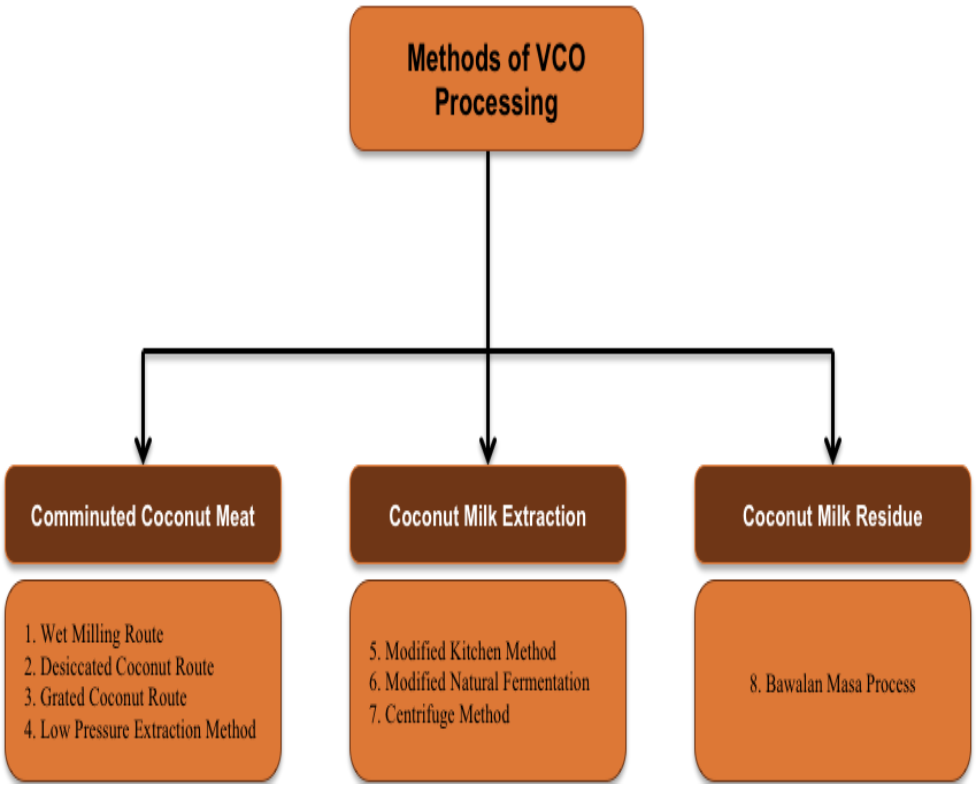


Figure 1. Methods of VCO processing

THERAPEUTIC ADVANTAGES

The possible health advantages of virgin coconut oil have grown in popularity, but it's vital to keep in mind that scientific study is continuing and that some claims may need to be supported by more evidence. Here are a few potential health advantages of virgin coconut oil:

- *Anti-inflammatory properties of VCO:* Although the immune system uses inflammation as a defence against infections, it can have negative effects if it is not controlled. Many illnesses can be caused by and made worse by the intricate immune systems and mediators that play a role in the inflammatory response. Inflammation has been linked to a number of human diseases, including cancer, atherosclerosis, ischemic heart disease, and neurological diseases like Alzheimer's, according to recent studies. These diseases include some that are not predominantly immune system problems. The demand for more potent and secure anti-inflammatory treatments exists, nonetheless, as the existing drugs have side effects. As a result, VCO presents a chance for more investigation into and creation of anti-inflammatory treatments. Due to VCO's high phenolic content, several groups have expressed a strong interest in researching its anti-inflammatory properties. Caffeic acid, p-coumaric acid, and ferulic acid are a few of the phenolic acids found in VCO. Through a number of routes, polyphenols regulate and lower inflammation, which prevents cancer and other illnesses with an inflammatory pathophysiology. This section should thus summarise the research on VCO's potential anti-inflammatory effects.
- *Analgesic and Antipyretic potential of VCO:* The capacity of VCO to inhibit the production and release of these endogenous chemicals that cause pain may be the cause of the analgesic effect. The VCO had an analgesic effect in both the hot plate test and the abdominal constriction test, demonstrating that they are active in blocking peripherally and centrally mediated pain brought on by chemical and heat stimuli. The efficacy of VCOs in lowering pain during the formalin test provided additional evidence of both the peripheral and central effects.

  Elevated body temperature, or fever, is a clinical indicator of inflammation that happens when the PGE2 content in particular regions of the brain rises. By using yeast-induced hyperthermia as a test subject, the team showed that VCO has antipyretic properties. The suppression of cyclooxygenase, which prevents PGs from being produced or released in the thermoregulatory center, is most likely what causes VCO's antipyretic effects.
- *Anti-cancer:* One of the main ingredients in coconut oil, lauric acid, has been investigated for its possible anticancer properties. The fatty acid portion of coconut oil specifically targets the liver through

portal circulation and lymph as chylomicron. The anti-cancer effectiveness of coconut oil against oral cancer cells and liver cancer.

- *Cardioprotective effect of VCO:* In the VCO, there are significant amounts of the MCFAs lauric acid, caprylic acid, capric acid, and capric acid. Large amounts of it (65%) are composed of medium chain triglycerides (MCTs). These MCTs are promptly absorbed from the intestinal tract and delivered to the liver, acting as an instant source of energy, without taking part in the production or transportation of cholesterol. This led to the discovery that VCO was effective in lowering cholesterol levels.
- *Obesity:* Coconut oil's MCTs are thought to speed up metabolism and heighten feelings of satiety, which may help with weight control. When they are a part of a balanced diet, several studies have suggested that they may help people lose body weight and shrink their waistlines.
- *Bone loss prevention:* Free radicals and oxidative stress are linked to the pathophysiology of osteoporosis. Antioxidants are hence likely to stop the illness. In one study, it was demonstrated that VCO significantly restored bone structure and stopped bone loss in rats with osteoporosis. The polyphenols in VCO are responsible for this benefit. By reducing lipid peroxidation and raising levels of the enzyme's glutathione peroxidase and superoxide dismutase in the osteoporotic rat model, VCO supplementation also demonstrated a considerable increase in the bone's antioxidant state.
- *Anti-microbial:* As an antibacterial agent, VCO has a long history of usage. There are additional applications for VCO against infections thanks to its history of safe topical use and the absence of any known or documented incidences of side effects. Lauric acid, caproic acid, and caprylic acid are only a few of the many MCFA found in VCO. The antibacterial, antifungal, antiviral, and other activities of this substance are due to MCFA.
- *Heart health:* Although medium-chain triglycerides (MCTs) like lauric acid make up the majority of coconut oil, it does include a lot of saturated fats. According to some research, the cholesterol-lowering effects of these MCTs may be negligible or even somewhat beneficial. Although excessive consumption of saturated fats might be harmful to heart health, it must be done in moderation.
- *Skin and Hair care:* The moisturizing and nourishing qualities of virgin coconut oil make it a popular ingredient in skincare and haircare products. In addition to promoting healthy-looking hair, it can help hydrate the skin and lessen dryness.
- *Digestive health:* Coconut oil is used to enhance digestive health by those who claim it is beneficial for conditions including irritable bowel syndrome (IBS). Additional study is necessary to verify these effects.

- *Brain health:* MCTs may have advantages for the health of the brain, according to ongoing studies. They have been researched as a potential treatment for some neurological diseases, including Alzheimer's disease, and may offer the brain an alternative energy source.
- *Oral health:* It is believed that oil pulling, a practice that involves swishing oil in the mouth (often coconut oil), may improve oral health. It might promote gum health and lessen dangerous microorganisms in the mouth.

CONCLUSION

In summary, virgin coconut oil has a variety of possible health advantages, but it should only be taken sparingly and as a part of a healthy diet and way of life. The virgin coconut oil (VCO) is produced from the young, mature kernel (flesh) of the coconut using mechanical or natural means, heat may or may not be applied, and the oil is not subjected to any chemical refining, bleaching, or deodorizing procedures. This process keeps virgin coconut oil from losing its properties while preserving the beneficial ingredients such as tocopherols (vitamin E), vital amino acids, and other useful chemicals.

BIBLIOGRAPHY

Arlee. R, Suanphairoch. S and Pakdeechanuan. P. Differences in chemical components and antioxidant-related substances in virgin coconut oil from coconut hybrids and their parents. *Int Food Res J*., 2013, 20(5), 2103–9.

Arunima, S; Rajamohan, T. Effect of virgin coconut oil enriched diet on the antioxidant status and paraoxonase-1 activity in ameliorating the oxidative stress in rats–a comparative study. Food Funct. 2013, 4(9), 1402–9.

Babu, AS; Veluswamy, SK; Arena, R; Guazzi, M; Lavie, CJ. Virgin coconut oil and its potential cardioprotective effects. *Postgrad Med*. 2014 Nov, 126(7), 76–83.

ChiawMei, S; HipSeng, Y; ChoonMei, L. Commercial virgin coconut oil: assessment of antimicrobial potential. *Asian J Food Agro-Ind*., 2010, 3(6), 567–79.

Kamisah, Y; Periyah, V; Lee, KT; Noor-Izwan, N; Nurul-Hamizah, A; Nurul-Iman, BS. Cardioprotective effect of virgin coconut oil in heated palm oil diet-induced hypertensive rats. *Pharm Biol*. 2015, 53(9), 1243–9.

Nevin, KG; Rajamohan, T. Beneficial effects of virgin coconut oil on lipid parameters and *in vitro* LDL oxidation. *Clin Biochem*. 2004 Sep, 37(9), 830–5.\

Nevin, KG; Rajamohan, T. Effect of Topical Application of Virgin Coconut Oil on Skin Components and Antioxidant Status during Dermal Wound Healing in Young Rats. *Skin Pharmacol Physiol*. 2010, 23(6), 290–7.

Raghavendra, SN; Raghavarao, KSMS. Effect of different treatments for the destabilization of coconut milk emulsion. *J Food Eng*. 2010, 97(3), 341–7.

Subermaniam, K; Saad, QHM; Bakhtiar, S; Hamid J; Sidek, F; Othman, F. Effects of Virgin Coconut Oil on the Histomorphometric Parameters in the Aortae and Hearts of Rats Fed with Repeatedly Heated Palm Oil. *International Journal of Bioscience, Biochemistry and Bioinformatics*., 2015, 5(2), 120–31.

****

www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 3 ISSUE 9 SEPTEMBER, 2023

Regenerative Agriculture: Nurturing Ecosystems for Sustainable Farming

Krishna[1], Fiskey Vrushabh Vijay[1], M B Reddy[2] and Sanjeev Kumar[1]

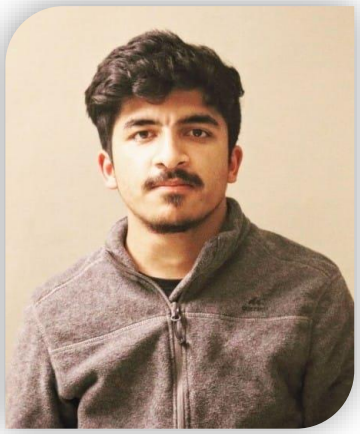
[1]Agronomy Section, ICAR-National Dairy Research Institute, Karnal Haryana 132001

[2]Animal Nutrition Division, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly (UP)-243122, India

Corresponding author email: 3182000krishna12345@gmail.com

ABSTRACT

Regenerative agriculture is a holistic approach to farming and land management that focuses on restoring ecosystems, improving soil health, biodiversity, and sustainability. This article explores its principles, emphasizing its importance in tackling modern agricultural and environmental issues. By prioritizing soil health, diversifying crops, integrating livestock, promoting agroecology, and fostering resilience, regenerative agriculture offers a path to sustainable farming. Growing adoption, policy backing, and benefits are also highlighted, showcasing its potential in addressing soil degradation, climate change, biodiversity loss, water scarcity, and human health challenges.



INTRODUCTION

Regenerative agriculture is a farming and land management practice that focuses on improving soil health, biodiversity, and ecosystem services. It involves a holistic approach that aims to restore the natural cycles and functions of the ecosystem, rather than simply extracting resources from it.

Regenerative agriculture typically involves practices such as minimal tillage, cover cropping, crop rotation, and the integration of livestock. These practices promote soil health by increasing organic matter, improving soil structure and fertility, reducing erosion, and enhancing soil water-holding capacity. In turn, healthier soils support healthier plants and animals, which can lead to increased yields, reduced input costs, and improved ecosystem services such as carbon sequestration and water filtration.

Regenerative agriculture also emphasizes the importance of building resilience into agricultural systems, which can help farmers adapt to the challenges of climate change, economic volatility, and other environmental pressures. By working with nature rather than against it, regenerative agriculture offers a promising approach to sustainable agriculture that can benefit both farmers and the planet.

WHAT IS THE NEED OF REGENERATIVE AGRICULTURE?

There are several reasons why regenerative agriculture is becoming increasingly important:

1. Soil Degradation: Conventional farming practices, such as excessive tilling, monoculture cropping, and heavy use of chemical fertilizers and pesticides, have contributed to widespread soil degradation. This has reduced soil health, fertility, and resilience, and has negatively impacted crop yields and food security.

2. Climate Change: Agriculture is a significant contributor to greenhouse gas emissions, and conventional farming practices can exacerbate climate change. Regenerative agriculture, on the other hand, promotes carbon sequestration, reduces emissions, and can help mitigate the effects of climate change.

3. Biodiversity Loss: Agricultural practices that prioritize high yields and monoculture cropping have contributed to the loss of biodiversity and habitat destruction. Regenerative agriculture, on the other hand, focuses on creating diverse, healthy ecosystems that support a variety of plant and animal life.

4. Water Scarcity: Conventional farming practices can also contribute to water scarcity by degrading soil health and reducing water-holding capacity. Regenerative agriculture, on the other hand, can improve soil health and increase water infiltration and retention, which can help address water scarcity.

5. Human Health: The use of synthetic fertilizers and pesticides in conventional farming can lead to negative health impacts for farmers and consumers, as well as contribute to the development of antibiotic resistance. Regenerative agriculture, which prioritizes soil health and biodiversity, can lead to healthier food systems and improved public health.

WHAT ARE THE BASIC PRINCIPLES OF REGENERATIVE AGRICULTURE?

Regenerative agriculture is based on a set of core principles that guide its approach to farming and land management. While the specifics of regenerative agriculture practices can vary depending on the specific ecosystem and farming context, the following principles are commonly associated with regenerative agriculture:

1. Building Soil Health: Regenerative agriculture prioritizes the health and vitality of soil ecosystems, recognizing that healthy soils are essential for producing healthy crops, sequestering carbon, and supporting biodiversity. Regenerative farmers focus on building soil organic matter, promoting beneficial soil microbial communities, and minimizing soil disturbance.

2. Diversifying Crop Rotations: Regenerative agriculture promotes crop diversity and rotation, recognizing that diverse cropping systems can improve soil health, reduce pest and disease pressure, and increase ecosystem resilience. This can include practices such as intercropping, cover cropping, and crop rotations that involve a range of different crops and plant families.

3. Managing Livestock: Regenerative agriculture recognizes the potential benefits of integrating livestock into farming systems, through practices such as rotational grazing and agroforestry. Well-managed

livestock can help to improve soil health, reduce the need for chemical fertilizers, and provide additional sources of income for farmers.

4. Promoting Agroecology: Regenerative agriculture is based on ecological principles, such as promoting biodiversity, minimizing waste, and using natural inputs such as compost and cover crops. This can involve practices such as reducing chemical inputs, minimizing soil disturbance, and promoting natural pest control mechanisms.

5. Supporting Resilience: Regenerative agriculture promotes farming systems that are resilient to environmental and economic stresses, such as climate change, drought, and market fluctuations. This can involve practices such as improving water management, diversifying income sources, and promoting regenerative land management practices.

6. Continuous Improvement: Regenerative agriculture involves a commitment to continuous improvement and adaptive management, based on monitoring and evaluation of ecosystem health, crop yields, and other indicators. This allows farmers to adjust their practices and management strategies over time, based on the specific needs of their farm and ecosystem.

(Photo curtesy by Jan Kopřiva at https://unsplash.com/photos/LTMaAwxanGk)

WHAT IS THE SCOPE OF REGENERATIVE AGRICULTURE IN PRESENT SCENARIO?

Regenerative agriculture is gaining momentum and recognition as a promising approach to sustainable agriculture, and its scope is expanding rapidly in the present scenario. Here are some of the ways in which regenerative agriculture is being adopted and promoted:

1. Policy and Funding Support: Governments and organizations around the world are increasingly recognizing the importance of regenerative agriculture and providing policy and funding support to promote its adoption. For example, the U.S. Department of Agriculture recently announced a new program to support regenerative agriculture practices, and the European Union is developing a "Farm to Fork" strategy that includes a focus on regenerative agriculture.

2. Farmer Adoption: More and more farmers are adopting regenerative agriculture practices as they recognize the benefits of improved soil health, increased resilience, and reduced input costs. In addition, a growing number of farmers are recognizing the market potential for regenerative products, as consumers become more interested in sustainably produced food.

3. Education and Research: There is a growing body of research and educational programs focused on regenerative agriculture, which is helping to spread awareness and knowledge about the approach. For example, universities and non-profits are developing training programs for farmers, and research institutions are studying the ecological and economic benefits of regenerative agriculture.

4. Corporate Investment: Large corporations are also starting to invest in regenerative agriculture, recognizing its potential to reduce supply chain risks, improve brand reputation, and meet consumer demand for sustainably produced products.

HOW TO ADOPT AND PROMOTE THE REGENERATIVE AGRICULTURE?

Regenerative agriculture is gaining momentum and recognition as a promising approach to sustainable agriculture, and its scope is expanding rapidly in the present scenario. Here are some of the ways in which regenerative agriculture is being adopted and promoted:

1. Policy and Funding Support: Governments and organizations around the world are increasingly recognizing the importance of regenerative agriculture and providing policy and funding support to promote its adoption. For example, the U.S. Department of Agriculture recently announced a new program to support regenerative agriculture practices, and the European Union is developing a "Farm to Fork" strategy that includes a focus on regenerative agriculture.

2. Farmer Adoption: More and more farmers are adopting regenerative agriculture practices as they recognize the benefits of improved soil health, increased resilience, and reduced input costs. In addition, a growing number of farmers are recognizing the market potential for regenerative products, as consumers become more interested in sustainably produced food.

3. Education and Research: There is a growing body of research and educational programs focused on regenerative agriculture, which is helping to spread awareness and knowledge about the approach. For

example, universities and non-profits are developing training programs for farmers, and research institutions are studying the ecological and economic benefits of regenerative agriculture.

4. Corporate Investment: Large corporations are also starting to invest in regenerative agriculture, recognizing its potential to reduce supply chain risks, improve brand reputation, and meet consumer demand for sustainably produced products.

WHAT ARE THE BENEFITS OF REGENERATIVE AGRICULTURE?

Regenerative agriculture offers a number of potential benefits, including:

1. Improved Soil Health: Regenerative agriculture practices can improve soil health by increasing organic matter, improving soil structure, and reducing erosion. This leads to healthier soil that is more resilient, fertile, and productive.

2. Carbon Sequestration: Regenerative agriculture can help mitigate climate change by sequestering carbon in soil and biomass. This can help reduce greenhouse gas emissions, and may also help farmers adapt to the effects of climate change.

3. Biodiversity: Regenerative agriculture promotes diverse ecosystems that support a variety of plant and animal life. This can help protect biodiversity and promote ecological resilience.

4. Water Management: Regenerative agriculture practices, such as cover cropping and reduced tillage, can improve soil water-holding capacity and reduce water runoff. This can help reduce water pollution and address water scarcity.

5. Economic Viability: Regenerative agriculture can reduce input costs, improve crop yields, and provide new market opportunities for farmers. By promoting sustainable and resilient farming systems, regenerative agriculture can also help ensure long-term economic viability for farmers.

6. Healthier Food: Regenerative agriculture promotes healthier soil and crop diversity, which can lead to healthier and more nutrient-dense food. This can have positive impacts on public health, as well as promote more sustainable and ethical food systems.

WHAT ARE THE BASIC STEPS INVOLVED IN REGENERATIVE AGRICULTURE?

Regenerative agriculture involves a range of practices that are tailored to the specific needs of each farm and ecosystem. However, there are some basic principles and steps that are commonly associated with regenerative agriculture. Here are some of the key steps involved in regenerative agriculture:

1. Minimizing Soil Disturbance: Regenerative agriculture involves reducing soil disturbance as much as possible, through practices such as reduced tillage, cover cropping, and intercropping. This helps to maintain soil structure and health, and can reduce erosion and nutrient loss.

2. Diversifying Crop Rotations: Regenerative agriculture involves promoting crop diversity, through practices such as intercropping and rotating crops. This helps to promote soil health, reduce pest and disease pressure, and improve ecosystem resilience.

3. Managing Livestock: Regenerative agriculture can involve integrating livestock into farming systems, through practices such as rotational grazing and agroforestry. This can help to improve soil health, reduce the need for chemical fertilizers, and provide additional sources of income for farmers.

4. Promoting Agroecology: Regenerative agriculture involves promoting ecological principles in farming systems, such as promoting biodiversity, minimizing waste, and using natural inputs such as compost and cover crops. This can help to reduce environmental impacts and improve ecosystem health.

5. Building Soil Health: Regenerative agriculture involves promoting healthy soil ecosystems, through practices such as composting, mulching, and promoting soil microbial diversity. This can help to improve nutrient cycling, increase soil fertility, and reduce the need for chemical fertilizers.

6. Continuous Improvement: Regenerative agriculture involves a commitment to continuous improvement and adaptive management, based on monitoring and evaluation of ecosystem health, crop yields, and other indicators. This allows farmers to adjust their practices and management strategies over time, based on the specific needs of their farm and ecosystem.

CONCLUSION

Regenerative agriculture represents a transformative shift in modern farming practices, focusing on the restoration of natural ecosystems and the promotion of sustainable food production. By acknowledging the fundamental interconnectedness of soil health, biodiversity, and ecosystem resilience, regenerative agriculture offers a holistic approach that addresses the multifaceted challenges of the 21st century. As governments, farmers, and organizations increasingly recognize its potential, regenerative agriculture is gaining momentum as a pathway to mitigate climate change, safeguard biodiversity, ensure food security, and cultivate healthier agricultural systems. Embracing regenerative principles not only holds the promise of a more sustainable future but also underscores the power of working collaboratively with nature to foster thriving ecosystems for generations to come.

****

www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 3 ISSUE 9 SEPTEMBER, 2023

OPEN-SOURCE SOFTWARE FOR ADVANCED STATISTICAL DATA ANALYSIS

Yogesh Garde, Nitin Varshney*, and Alok Shrivastava

Department of Agricultural Statistics, Navsari Agricultural University, Navsari, Gujarat– 396450

**Corresponding author email: nitin.caw@nau.in*

ABSTRACT

The utilization of open-source software has significantly revolutionized the landscape of advanced statistical data analysis. This paper explores the dynamic role that open-source software plays in empowering researchers, analysts, and organizations to conduct sophisticated statistical analyses. By offering accessible tools and resources, open-source platforms have democratized data analysis, fostering collaboration, innovation and cost-effectiveness. Through a comprehensive investigation of popular open-source software alternatives, this paper highlights concise applications in various fields. From enhancing research methodologies to enabling evidence-based decision making, the paradigm shift toward open-source software is reshaping the way we approach and use statistical insights for multiple purposes.

INTRODUCTION

Open-source software for statistical data analysis has become increasingly important and prevalent in recent years. This article highlights the significance and the recent era of usage of open-source software in statistical data analysis. Open-source software provides numerous advantages, including accessibility, flexibility, transparency, and cost-effectiveness. These features have made it a popular choice among researchers, analysts, and organizations in various fields. It breaks down barriers to access and allows users to freely obtain, use, modify, and distribute the software. Open-source software also provides a wide range of statistical techniques, algorithms, and visualization tools that cater to diverse analytical needs.

In the recent era, open-source software has gained significant traction due to several factors:

a. The exponential growth of data requires scalable and efficient tools for analysis. Open-source software enables the processing and analysis of large and complex datasets. This is crucial in fields such as big data analytics, bioinformatics, social sciences, finance, etc.
b. The advancements in machine learning and artificial intelligence have increased the demand for open-source software that supports these techniques.
c. The growing emphasis on reproducibility and transparency in research has fuelled the adoption of open-source software. Researchers are increasingly turning to open-source tools for their data

analysis needs, as it allows them to share their code, methods, and results openly, facilitating the replication and validation of their findings.

d. The cost-effectiveness of open-source software makes it an attractive option for organizations and individuals.

There are several open-source software options available for statistical data analysis. A few of them are listed below:

1. R & R STUDIO:

R is a widely used programming language and software environment for statistical computing and graphics. It provides a vast collection of packages for various statistical analysis tasks and data visualization. RStudio is a popular integrated development environment (IDE) for working with R.

Applications of R:

Sl No.	*Application*	Description	Packages
1	*Data Analysis and Exploration*	R is extensively used for exploratory data analysis	R's data manipulation packages like ***dplyr*** and ***tidyr*** make it easy to manipulate and reshape data for analysis.
2	*Statistical Modelling*	R is a powerful tool for statistical modelling and inference	***stats, lme4, survival,*** and ***brms***.
3	*Data Visualization*	R offers numerous options for creating high-quality visualizations	***ggplot2***
4	*Machine Learning*	R provides a rich set of packages for machine learning tasks	***Caret, random Forest, xgboost***, and ***keras***
5	*Bioinformatics and Genomics*	R is widely used in the field of bioinformatics for analysing and interpreting genomic data	***Bioconductor***
6	*Econometrics and Finance*	R is commonly used in econometrics and finance for analysing economic data and financial markets	***plm*** for panel data analysis ***forecast*** for time series forecasting ***quantmod*** for financial modelling ***Portfolio Analytics*** for portfolio optimization
7	*Social Sciences*	R is popular among researchers in social sciences, including psychology, sociology, and political science	***plyr***
8	*Data Science and Big Data Analytics*	R is frequently used in data science workflows, combining data manipulation, statistical modelling, and machine learning	***sparklyr*** and ***dplyr***

Some popular sources to help you get started with learning R:

i. ***R Documentation***: The official R documentation (https://www.r-project.org/) is a comprehensive resource that provides detailed information about R's functions, packages, and syntax.

ii. ***RStudio Education****:* RStudio, the popular IDE for R, offers a dedicated website for learning R called RStudio Education https://education.rstudio.com/

iii. ***RStudio Online Learning****:* https://rstudio.com/online-learning/

iv. ***R for Data Science:*** "R for Data Science" by Hadley Wickham and Garrett Grolemund is a widely recommended book for learning R.

v. ***DataCamp:*** It is an online learning platform that offers interactive courses on R and data science https://www.datacamp.com/

vi. ***Coursera:*** Coursera (https://www.coursera.org/) offers several R-related courses, including "R Programming" by Johns Hopkins University and "Data Science and Machine Learning Bootcamp with R" by the University of Washington.

vii. ***YouTube Tutorials***: YouTube has a wealth of R tutorials and channels dedicated to R programming. Channels like "R Programming A-Z" and "R Tutorial Series" provide comprehensive video tutorials on various aspects of R, from the basics to advanced topics.

viii. ***R-Bloggers:*** R-Bloggers (https://www.r-bloggers.com/) is a popular community-driven blog aggregator that compiles R-related articles, tutorials, and resources from various sources.

ix. ***Stack Overflow:*** Stack Overflow (https://stackoverflow.com/) is a question-and-answer website where you can find answers to specific R programming questions. There are numerous books available that provide in-depth coverage of R programming and statistical analysis. Some popular titles include "*R for Data Science*"

x. by Hadley Wickham and Garrett Grolemund, "*The Art of R Programming*" by Norman Matloff, and "*R Cookbook*" by Paul Teetor.

2. PYTHON:

Python is a versatile programming language that offers various libraries for statistical analysis. ***NumPy***, ***SciPy***, and ***pandas*** are commonly used libraries for numerical computing and data manipulation. Additionally, libraries like ***StatsModels*** and ***scikit-learn*** provide statistical modelling and machine learning capabilities.

Applications of Python:

Sl No.	*Application*	Description	Libraries
1	*Data Analysis and Exploration*	Python is widely used for data analysis and visualization tasks	***NumPy, pandas, matplotlib, Seaborn and Plotly***
2	*Scripting and Automation*	for writing scripts and automating tasks	***stats, lme4, survival,*** and ***brms***.
3	*Web Development*	Python has several frameworks, which simplify web development	***Django*** and ***Flask***
4	*Machine Learning and Artificial Intelligence*	It is a new choice for many machine learning and AI applications	***scikit-learn, TensorFlow, PyTorch, and Keras***
6	*Scientific Computing*	Python is widely used in scientific computing and simulation	***SciPy***
7	*Internet of Things (IoT)*	Python is used in IoT projects for data collection, device communication, and analytics	***PySerial***, frameworks like Raspberry Pi and MicroPython support IoT development.
8	*Natural Language Processing (NLP)*	R is frequently used in data science workflows, combining data manipulation, statistical modelling, and machine learning	NLTK (Natural Language Toolkit), ***spaCy***

Some popular sources to help you get started with learning Python:

i. ***Python's Official Documentation****:* Python's official website (https://www.python.org/) provides comprehensive documentation that covers all aspects of the language. It includes tutorials, guides, and references for both beginners and advanced users. The "Python Tutorial" section is an excellent starting point.

ii. ***Codecademy:*** Codecademy offers an interactive Python course for beginners that allows you to learn Python syntax and concepts through hands-on coding exercises. You can access it at https://www.codecademy.com/learn/learn-python.

iii. ***Automate the Boring Stuff with Python:*** This popular online book by Al Sweigart is aimed at beginners who want to learn Python by automating everyday tasks. The book is available for free at https://automatetheboringstuff.com/.

iv. ***Python Crash Course****:* Written by Eric Matthes, Python Crash Course is a beginner friendly book. The book is available at https://nostarch.com/pythoncrashcourse.

v. ***Real Python:*** Real Python is an online platform that offers tutorials, articles, and video courses on various Python topics. You can find their resources at https://realpython.com/.

vi. ***"Learn Python the Hard Way" (LPTHW):*** This book by Zed Shaw provides a hands-on approach to learning Python. You can access the Python 3 version at https://learnpythonthehardway.org/python3/.

vii. ***Python.org Beginner's Guide:*** Python.org provides a Beginner's Guide that offers step-by-step instructions to learn Python. You can find it at https://docs.python.org/3/tutorial/index.html.

viii. ***YouTube Tutorials:*** YouTube hosts numerous Python tutorial channels that cater to different learning styles. Channels like Corey Schafer, Sentdex, and Tech with Tim offer beginner-friendly Python tutorials and cover various Python topics with practical examples.

3. GNU OCTAVE:

GNU Octave is a high-level programming language primarily intended for numerical computations and scientific simulations. It is compatible with MATLAB syntax and provides a wide range of built-in functions for statistical analysis and data visualization. https://www.gnu.org/software/octave/

4. JUPYTER NOTEBOOK:

Jupyter Notebook is an open-source web application that allows you to create and share documents containing live code, equations, visualizations, and narrative text. It supports multiple programming languages, including R and Python, making it an excellent choice for interactive data analysis.

Some popular sources to help you get started with learning Jupyter Notebook:

i. ***Jupyter Notebook Documentation:*** The official Jupyter Notebook documentation https://jupyter-notebook.readthedocs.io/.

ii. ***Jupyter Notebook Tutorial on Real Python:*** Real Python offers a comprehensive tutorial on Jupyter Notebook (https://realpython.com/jupyter-notebook-introduction/)

iii. ***YouTube Tutorials:*** Many YouTube channels offer Jupyter Notebook tutorials for different levels of expertise. Channels like Corey Schafer, DataCamp, and Jupyter offer video tutorials.

iv. *Jupyter Notebook Examples on GitHub:* The Jupyter organization on GitHub (https://github.com/jupyter/jupyter/wiki/A-gallery-of-interesting-Jupyter-Notebooks).

5. JULIA:

Julia is a high-level programming language specifically designed for numerical and scientific computing. It offers a comprehensive ecosystem of packages for statistical analysis, data visualization, and machine learning. It is available on https://juliaacademy.com/.

6. KNIME:

KNIME (Konstanz Information Miner) is an open-source data analytics platform that allows you to visually create data workflows, combining different data processing and analysis steps. It supports a wide range of statistical analysis techniques and integrates with various programming languages and tools. It is available on https://hub.knime.com/, https://www.knime.com/learning-hub.

7. ORANGE:

Orange is an open-source data visualization and analysis tool that provides a visual programming interface for building data analysis workflows. It offers a wide range of statistical and machine learning methods and supports interactive data visualization. It is available on https://docs.orange.biolab.si/.

8. PSPP:

PSPP is a free and open-source alternative to IBM SPSS, a popular commercial software for statistical analysis. PSPP provides a user-friendly interface and supports basic statistical procedures, including descriptive statistics, hypothesis testing, and regression analysis. https://www.gnu.org/software/pspp/manual/

9. APACHE SPARK:

Spark is an open-source big data processing framework that includes a module called MLlib for scalable machine learning and statistical analysis. It provides a distributed computing environment and supports various statistical algorithms. It is freely available on https://spark.apache.org/documentation.html.

10. OPSTAT

Prof. O.P. Sheoron, Statistics programmer, Chaudhary Charan Singh Haryana Agricultural University developed web based statistical software for data analysis. (http://14.139.232.166/opstat/)

11.PBTOOLS:

Plant Breeding Tools (PBTools) is a software that has been developed to assist plant breeders in the design of experiments and analysis of data. It has an easy-to-navigate graphical user interface that does not require users to have programming skills to perform data manipulation and analysis. It uses R functions that were specifically written for the development of this software.

12.STATISTICAL TOOL FOR AGRICULTURAL RESEARCH (STAR):

STAR is a **computer** program for data management and basic statistical analysis of experimental data. It has a user-friendly graphical interface where items are accessible via drop-down menus. Its graphical interface was created using the Eclipse Rich Client Platform (RCP) and uses the R language and environment for statistical computing and graphics. The programs uses functions in R that are specifically written for the development of this computer program. STAR has been developed primarily for the analysis of data from agricultural field trials, but many of the features can be used for analysis of data from other sources.

Some other open-source software which can be used in data analysis are listed below:

Sr. no	Name of the Software	Whether Open-source	Free version available	Best Feature
1.	Atom	Yes	✓	Key binding customization
2.	Brackets	Yes	✓	Pre-processor support
3.	Bluefish	Yes	✓	Can open 500+ files at a time
4.	Visual Studio code	Yes	✓	Intellisense function
5.	Notepad++	Yes	✓	Plug-in for MIME tools, NPP export, and converter
6.	Cuda text	Yes	✓	Smart auto-completion for HTML, CSS
7.	Emacs	Yes	✓	Debugger interface
8.	ConText	No	✓	Powerful command-line handler
9.	Editpadlite	No	✓	Opens large text files with ease
10.	Komodo IDE	Yes	✓	Code folding and cold blocks

AGD-R (Analysis of Genetic Designs with R)	
META-R: Multi Environment Trail Analysis with R	
Molecular Evolutionary Genetics Analysis (MEGA)	
Trait Analysis by association, Evolution and Linkage (Tassel)	
DARwin: Dissimilarity analysis and Representation for Windows	
PAST	

SUMMARY

In conclusion, the integration of open-source software has brought about a substantial transformation in the realm of advanced statistical data analysis. This study delves into the dynamic role of open-source software in empowering researchers, analysts, and organizations to conduct intricate statistical analyses. These accessible platforms have democratized data analysis, promoting collaboration, innovation, and efficiency. Through a thorough exploration of prevalent open-source software options, this paper succinctly illustrates their diverse applications across various domains. From refining research methodologies to facilitating evidence-driven decision-making, the shift towards open-source software is reshaping the utilization of statistical insights across multiple objectives.

REFERENCES

Open Source (Free) Statistical Software. Retrieved from: https://u.osu.edu/qmc/open-source/

Quantitative Analysis Software- Open Source. Retrieved from: https://researchguides.uoregon.edu/How-to-Choose-Data-Analysis-Software/open

The 7 Data Analysis Software Applications You Need to Know. Retrieved from: https://www.coursera.org/articles/data-analysis-software

****

www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 3 ISSUE 9 SEPTEMBER, 2023

SOIL HEALTH CARD: A BOON FOR HEALTHY EARTH AND GREEN FARM

M B Reddy[1], Krishna[2], Fiskey Vrushabh Vijay[2], and Sanjeev Kumar[2]

[12]Agronomy Section, ICAR-National Dairy Research Institute, Karnal Haryana 132001

[1]Animal Nutrition Division, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly (UP)-243122, India

Corresponding author email: mbrkisan1@gmail.com

ABSTRACT

Soil health and fertility are paramount for achieving optimal crop yields. Implementing judicious soil fertilizer management practices is essential for maintaining Earth's well-being. Indiscriminate use of chemical fertilizers negatively impacts soil health and productivity. Soil degradation and climate change pose threats to food security and livelihoods. Restoring degraded soils requires site-specific nutrient management, facilitated by soil testing-based fertilizer recommendations. Soil health cards offer comprehensive insights into soil fertility, aiding farmers in making informed decisions. Scientific cultivation practices coupled with balanced nutrition from soil health cards enhance crop yields, soil health, and productivity, addressing contemporary concerns.

KEYWORDS: climate change, food security, soil health, soil health card and profitable crop yields.

INTRODUCTION

Soil health and soil fertility are the two key components that play an inevitable role to realize sustainable profits for the farming community. Adopting sustainable soil fertility management (SFM) practices is necessary to achieve sustainable agricultural production. The question here is how many farmers are using SFM practices. In fact, the majority of the farmers use either sub or supra-optimal levels of chemical fertilizers which result in declined soil health and inherent soil fertility. A survey by Kumar *et al*. (2021)revealed that knowledge level and adoption of SFM are relatively much less and only 8% of the farmers are aware of it and more than 65% have no knowledge regarding SFM practices. Undoubtedly, the usage of chemical fertilizers is necessary to realize crop yields. However, the usage should be optimal and scientific which means it should be in accordance with the 4 R's (right source, right time, right amount and right method). A study by Chowdary *et al.*, 2018reported that most farmers use chemical fertilizers without knowing the actual fertility status of their fields. Ultimately, this indiscriminate use of fossil fuel-based chemical fertilizers led to reduced soil health, soil biodiversity, fertilizer use efficiency (crop: nutrient

response ratio has moved down to 8.59 in 2009-10 from 14.06 in 1990-91) and environmental pollution(Singh *et al*., 2020).

(Photo curtesy Markus Spiske @https://unsplash.com/photos/FwW5fhFKM6k)

A single solution to address these problems is to optimize fertilizer usage by adopting sustainable soil fertility management practices based on soil testing reports(Singh *et al.*, 2023). Soil testis a well-proven scientific tool that helps farmers in the judicious application of chemical fertilizers by providing reliable information about nutrient deficiency and the soil's physical and biological status/health status. But farmers themselves neglect to get a test of their soil. Therefore, keeping in view all these facts government of India launched a national flagship program namely the soil health card scheme (SHCs) on February 19th of 2015 with an aim to do a soil test of each and every individual farm and to formulate micro-level soil fertility maps(Singh *et al*., 2020).

WHAT IS SOIL HEALTH CARD?

SHC is a complete prescription of soil quality, from its functional characteristics to nutrient and other biological properties. It provides the farmers with crop-wise fertilizer recommendations for each type of soil. Every three years, SHC will be made available to all farmers in the nation, allowing them to apply the appropriate nutrient doses based on the results of soil tests, leading to increased soil fertility, enhanced soil health, lower costs, higher and profitable crop yields.

OBJECTIVES OF THE SHC

a) To provide comprehensive information about current soil health status of farm fields
b) To know the soil nutrient status and to warn the deficiencies
c) To find out major soil related constraints in enhanced crop production
d) To educate farmers about importance of balanced crop nutrition

e) To restore productivity of the degraded soils to ensure better crop performance

PARAMETERS TESTED

SHC is a printed report that a farmer will be handed over for each of his holdings. It will contain the status of his soil with respect to 12 parameters, namely N, P, K (Macro-nutrients); S (Secondary-nutrient); Zn, Fe, Cu, Mn, Bo (Micro - nutrients); and pH, EC, OC (Physical parameters). Based on this, the SHC will also indicate fertilizer recommendations and soil amendment required for the farm.

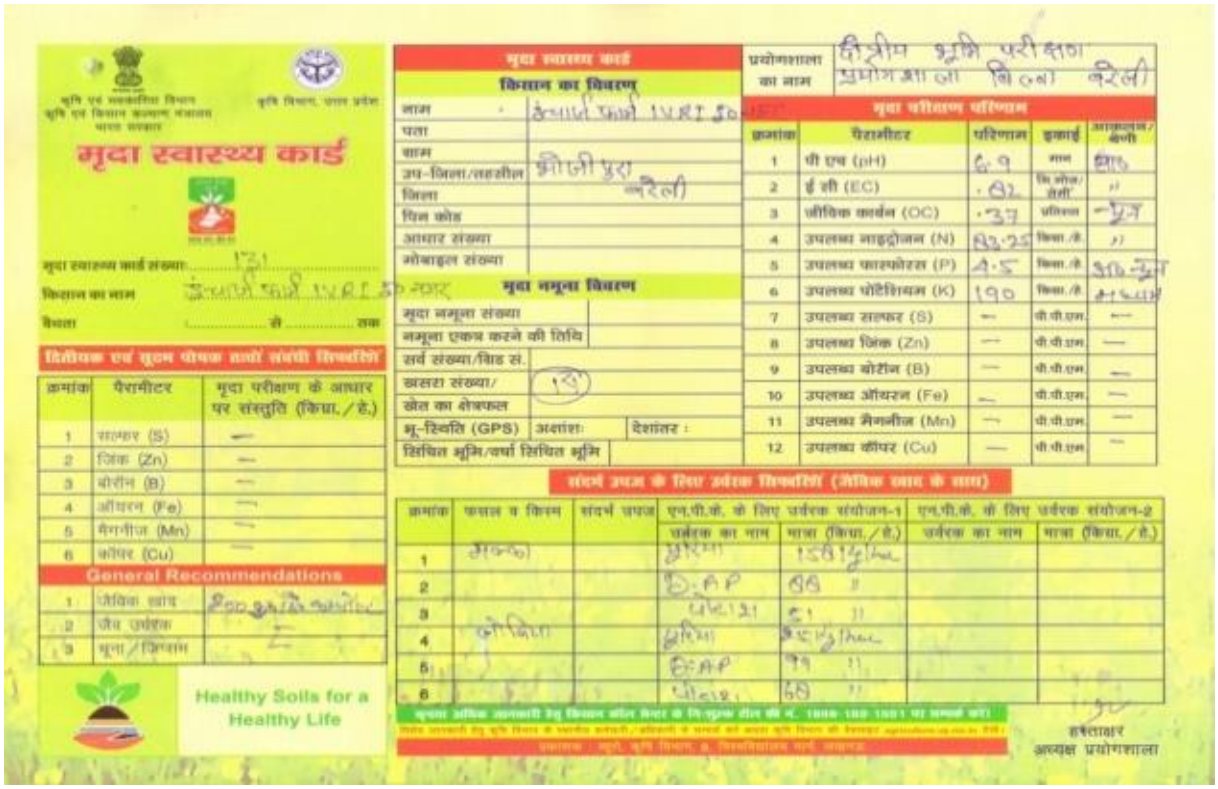


Figure 1. Soil test report and fertilizer recommendations for Fodder Farm fields, ICAR-IVRI

ADVANTAGES OF SHC SCHEME

1) Under the scheme the farm fields of farmers will tested well in time and which ensures the farmers to choose suitable crop and cropping system for particular soil type based on soil fertility status.
2) Regular soil testing helps the farmers to know the changes taking in their soils and remedial measures to adopt well in time.
3) SHC ensures the rational use of both organic and inorganic fertilizers in balance which further improves soil health, fertility and productivity on sustainable basis.
4) Result in reduced cost of cultivation and increased crop yields and profitability to the farmers.
5) Above all cut down of excess fertilizer use improves our mother earth health by reducing environmental pollution and climate change.

RESEARCH EVIDENCE'S

Author	Key research finding
Singh *et al*. (2023)	The adoption of fertilizers based on SHC; the wheat yields have increased from 14.6±0.4 q/acre to 19.1±0.4 q/ha indicating an increase of 30.80 per cent. Whereas in paddy the yields raised to 22.2±0.6 q/acre from 17.1±0.4 q/ha indicating a 29.80 per cent change in paddy yields. Also, the number of farmers using FYM in wheat has increased from 14 to 23 with a percent change of 64.30and the amount of FYM usage in wheat rose to 6000 ± 1239.2 kg/acre from 2664.2± 469.4 kg/acre indicating a change of 125.20%.
Kumar et al. (2020)	Adoption of SHC recommendations resulted in reduction in use of urea and DAP by 20 to 30% in paddy and cotton. And also decreased the cost of cultivation by Rs.1000 and Rs.4000 per acre.
Kumar *et al*. (2019)	After following soil test-based fertilizer recommendations, fertilizer usage came down to 275 kg urea and 10 kg Zn per ha in paddy and 275 kg urea and 125 kg DAP per ha in case of wheat, indicating a net saving of ₹4,414/- per hectare per annum under Rice-wheat cropping system.
Chouhan *et al.* (2017)	The study has found that yield of paddy, soybean and maize increased by 19.42 per cent, 13.79 per cent and 9.6 per cent, respectively after adoption of RDF based on SHC. Further the net income per acre increased from Rs.11231/- to Rs.17385/- (54.8%) in paddy, from Rs.6696/- to Rs.11228 (67.7%) in soybean and from Rs. 3380/- to Rs.8105/- (139.8%) in maize after soil testing by the farmers.

CONCLUSION

The evidence presented makes it evident that the Soil Health Card (SHC) scheme represents an innovative stride towards enhancing soil health, fostering robust crop growth, and yielding profitable agricultural outputs. The fertilizer recommendations derived from SHC have proven notably efficacious and advantageous to farmers, leading to improved crop yields, augmented income, and the enhancement of soil health, fertility, and productivity. Looking ahead, sustained adoption of soil-test-based balanced

fertilizer application is anticipated to contribute to enhanced profitability, driven by healthier soil and the principles of sustainable agriculture.

REFERENCES

Chowdary, R. K., Jayalakshmi, M., & Prasadbabu, G. (2018). Factors determining the soil health card adoption behaviour among farmers in Andhra Pradesh. An Asian J Soil Sci, 13(1), 8386.

Chouhan, R. S., Sharma, H. O., Rathi, D., & Niranjan, H. K. (2017). Impact of Soil Health Card Scheme on Farmers' Income – A Case Study of Kharif Crops in Madhya Pradesh . *Agricultural Economics Research Review*, *30*(conf), 139. https://doi.org/10.5958/0974-0279.2017.00028.3

Kumar, A., Brar, N. S., Kumar, B., & Verma, H. K. (2019). Impact of fertilizer recommendations based on soil health card on fertilizer consumption, productivity and profitability of farmers. *Journal of Experimental Biology and Agricultural Sciences*, *7*(3), 249–254. https://doi.org/10.18006/2019.7(3).249.254

Kumar, A., Singh, S., Singh, D. K., Yadav, R. N., Singh, L. B., Malik, S., & Shahi, U. P. (2021). To study the socio-economic profile of soil health card scheme beneficiaries. *Progressive Agriculture*, *21*(2), 211–215.

Singh, U., Singh, A., & Pandey, A. K. (2020). *SOIL HEALTH CARD: A SCHEME FOR SUSTAINABLE AGRICULTURE*.

Singh, B. P., Kumar, V., Chander, M., Reddy, M. B., Singh, M., Suman, R. S., & Yadav, V. (2023). Impact of Soil Health Card Scheme on Soil Fertility and Crop Production Among the Adopted Farmers. Indian Journal of Extension Education, 59(1), 122-126.

****

www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 3 ISSUE 9 SEPTEMBER, 2023

AGRICULTURAL WASTE: ENVIRONMENTAL CHALLENGES, LEAN MANUFACTURING INSIGHTS, AND RESOURCEFUL APPLICATIONS

Prakashsinh Rathava[1] Kalyansinh Chauhan[2], Ujjval solanki[3] and Arjunsinh Rathava[4]

[1]NFSM TA, District Panchayat, Chhotaudepur, Gujarat, India

[2]SRF, Department of Seed science and Technology, B.A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

[3]RA, Department of Agricultural Meteorology, C.P. College of Agriculture, ardarkrushinagar Dantiwada Agricultural University, Dantiwada, Gujarat, India

[4]Assistant Professor, Department of Plant Pathology, College of Agriculture, Jabugam, Anand Agricultural University, Jabugam, Gujarat, India

Corresponding author email: prakashrathva95@gmail.com

ABSTRACT

Agricultural waste encompasses residues from crop cultivation and processing, including fruits, vegetables, meat, and crops. The objective of waste management is to ensure environmental protection and public welfare by curbing contamination risks through efficient manure application and nutrient control. Lean manufacturing's seven wastes are analyzed in terms of their environmental impacts, emphasizing the critical importance of waste reduction, reuse, recycling, and resource recovery. Furthermore, the study delves into the multifaceted applications of agricultural waste utilization on farms, such as fertilizer application, anaerobic digestion for methane production, adsorbent use in heavy metal elimination, pyrolysis, animal feed production, and direct combustion for energy generation. These applications, while addressing waste management challenges, hold potential for sustainable agricultural practices and environmental conservation.

INTRODUCTION

Agricultural wastes encompass the residual matter resulting from the cultivation and processing of unprocessed agricultural commodities, spanning fruits, vegetables, meat, poultry, dairy products, and crops. These residues constitute the extraneous outputs of agricultural product manufacturing and processing, possessing material that holds potential utility but with economic values outweighed by the expenses incurred in collection, transport, and beneficial usage. The composition of such residues hinges on the nature of the agricultural system and activities, manifesting in various forms, including liquids, slurries, and solids. Termed as agro-waste, agricultural waste encompasses animal-derived residues such as manure and carcasses, byproducts of food processing where a significant portion of maize (80%) is left

unprocessed, crop residuals such as corn stalks, sugarcane bagasse, and surplus and discarded components from fruits and vegetables, along with hazardous and toxic elements like pesticides, insecticides, and herbicides.

Environmental Imperatives and Components of Agricultural Wastes:

The principal objective of managing agricultural waste is rooted in safeguarding the environment and public welfare, accomplished by preventing the contamination of surface and groundwater bodies through the inappropriate dissemination of manure and polluted waters. This also involves regulating the application of manure-based nutrients to cultivated lands, ensuring that their availability conforms to specific quantities, timings, and locations conducive to optimal growth conditions. Inclusive within agricultural wastes are crop residues, weeds, leaf litter, sawdust, forest waste, and the residues produced by livestock husbandry.

Waste Minimization Strategies and Resource Recovery:

Following a hierarchy that emphasizes reduction and reuse, strategies for managing agricultural waste involve the judicious employment of on-farm and off-farm recycling practices. Land application of manure and plastic recycling initiatives constitute the recycling process, either at the point of origin on the farm or external to it. Notably, the reclamation of methane gas from manure waste is a valuable resource recovery technique. Disposal of agricultural waste should only be contemplated after exhaustive consideration of the four Rs, namely reduction, reuse, recycling, and resource recovery, ensuring that waste management aligns with both environmental and economic sustainability principles.

LEAN MANUFACTURING'S SEVEN WASTES AND THEIR ENVIRONMENTAL IMPLICATIONS

1. Overproduction:

The most severe among lean manufacturing's seven wastes is overproduction, culminating in surplus inventory. Accumulating excessive stock of underutilized products results in evident costs such as storage expenses, material wastage, and capital tied up in idle inventory. Overproduction's environmental ramifications are significant and contingent on the product type. It leads to the excessive consumption of raw materials, potential product spoilage or obsolescence, further necessitating disposal. Moreover, if hazardous materials are involved, overproduction exacerbates emissions, waste disposal costs, potential worker exposure, and environmental complications stemming from the surplus waste.

2. Inventory:

Inventory waste arises from unprocessed stock and encompasses storage inefficiencies, immobilized capital, transportation waste, and the resources used for containment and lighting. This excess inventory can obscure the initial waste generated in producing it. Environmental impacts include packaging waste, deterioration of work-in-process items, additional materials required to replace obsolete inventory, and the energy expended for lighting, heating, or cooling inventory spaces.

3. Motion:

Unnecessary motion, whether by human or machine, contributes to waste that could be minimized. Superfluous motion, like unnecessary machine wear or overburdened employee health resources, carries substantial environmental costs. For instance, replacing worn machines generates waste through discarded components. Excessive employee health resource usage due to strenuous motion can be minimized through motion reduction, alleviating waste.

4. Defects:

Defects denote products deviating from design or customer expectations, leading to replacements, paperwork, labor costs, customer dissatisfaction, and wasted resources. Defects imply waste at various levels, suggesting inefficiencies in the production system. This results in environmental costs tied to resource consumption, waste generated during disposal or recycling of defective parts, and heightened energy use and space requirements for defect management.

5. Over-processing:

Over-processing involves adding unnecessary value to products, such as unneeded painting or unused features. This excessive value addition is incongruent with customer requirements. Over-processing's environmental repercussions encompass excessive utilization of parts, labor, and raw materials during production. Wasted time, energy, and emissions arise when producing redundant features. Streamlined efficiency counteracts over-processing, benefiting both the environment and the company.

6. Waiting:

Waiting waste pertains to production slowdowns or halts in a sequential process, causing inefficiencies due to differing task durations. Waiting necessitates improved efficiency, additional workforce, or coordinated workflows. Environmental impacts stem from wasted labor and energy during waiting periods. Additionally, inefficient waiting can result in material spoilage, component damage, and energy use during idle periods.

7. Transport:

Transport waste refers to non-value-adding material movement. Minimizing transport waste is crucial, involving optimal plant proximity or efficient transportation methods. The environmental costs of transport waste encompass emissions, packaging waste, potential product damage, and waste linked to transporting hazardous materials.

UTILIZATION OF AGRICULTURAL WASTE ON FARMS: DIVERSE APPLICATIONS AND ENVIRONMENTAL IMPLICATIONS

1. *Fertilizer Application:* The utilization of animal manures as fertilizer significantly influences input energy requirements at the farm level. Manure has the potential to contribute 19%, 38%, and 61% of nitrogen, phosphorus, and potassium, respectively, in comparison to chemical fertilizers. However, the adoption of manure-based fertilization from large confinement operations is accompanied by elevated energy costs for transport, distribution, storage facilities, and concerns related to odour and potential groundwater contamination.
2. *Anaerobic Digestion:* Agricultural wastes, particularly manures, can yield methane gas through anaerobic digestion. This gas serves well for heating purposes, such as in broiler operations, water heating, and grain drying. The anaerobic digestion process involves a two-step microbial fermentation. Initially, acid-forming bacteria decompose volatile solids into organic acids, subsequently utilized by methane-producing microorganisms to yield methane-rich gas.
3. *Adsorbents in Heavy Metal Elimination:* Escalating release of heavy metals into the environment due to industrial and urban activities has generated worldwide concerns. Unlike organic pollutants, heavy metal ions (e.g., copper, cadmium, mercury, zinc, chromium, lead) do not degrade into benign end products and pose significant toxicity risks to various life forms. Adsorbents offer promise in capturing these ions, mitigating environmental hazards.
4. *Pyrolysis:* Pyrolysis systems subject agricultural waste to temperatures of 400-600°C in the absence of oxygen, leading to material vaporization and char residue. This advanced technology holds potential for agricultural waste utilization. Additional techniques like hydro-gasification and hydrolysis also find application in transforming agricultural waste into chemicals and energy recovery.
5. *Animal Feed:* Many developing countries face challenges in securing adequate protein sources for animal feed. Despite efforts to identify alternative supplements, crop residues, due to their high fiber content and low protein, starch, and fat levels, often fall short. Traditional livestock production methods reliant on forage and pasture supplemented with grains and protein concentrate might not suffice to

meet future meat protein demand. However, utilizing agricultural residues for animal feed could alleviate this concern.

6. *Direct Combustion:* The rudimentary practice of burning agricultural waste as fuel, among the oldest biomass conversion methods, yields energy through complete combustion. This process entails rapid chemical reactions between biomass and oxygen, liberating energy while generating CO2 and water as end products. The energy released manifests as radiant and thermal energy, contingent on the rate of oxidation and the enthalpy of combustion of the biomass.

CONCLUSIONS

This discourse delves into the realm of agricultural waste, elucidating its multifaceted nature and environmental significance. It highlights the diverse components of agricultural residues, encompassing outputs from both cultivation and processing. The fundamental purpose of managing such waste revolves around environmental protection and the well-being of the populace, striving to prevent contamination and regulate nutrient application. The exploration of lean manufacturing's seven wastes underscores their profound environmental implications, emphasizing the need for waste reduction, reuse, recycling, and resource recovery. Additionally, the utilization of agricultural waste on farms for various purposes, such as fertilization, anaerobic digestion, heavy metal elimination, and energy recovery, demonstrates promising avenues for sustainable resource management.

REFERENCES

Timbers, G. E. and Downing, C. G. E. Agricultural Biomass Wastes: Utilization routes. Canadian Agricultural Engineering Vol. 19 No. 2, pp. 84-87. 1977.

Council for Agricultural Science and Technology Utilization of animal manures and sewage sludge in food and fiber production. Report No. 41. 1975.

Mokwunye, U. Meeting the phosphorus Needs of the soils and crops of West Africa: The Role of Indigenous Phosphate rocks. Paper presented on Balanced Nutrition Management systems for the Moist Savanna and Humid Forest Zones of Africa at a symposium organized by IITA at Ku Leuva at Cotonun, Benin Republic, October 9-12. 2000.

Gupta, V. K., Gupta, M. and Sharma, S. Process development for the removal of lead and chromium from aqueous solution using red mud – an aluminum industry waste. Water Research. 35(5): pp. 1125 – 1134. 2001.

Leng, R. A., Choo, B. S. and Arreaze, C. Practical technologies to optimize feed utilization by ruminants. In: A Speedy and P L Pugliese (Editors). Legume Trees and Other Fodder trees as Protein Sources for Livestock. FAO, Rome, Italy, pp:145- 120. 1992.

Klass, D.L., 2004. Biomass for renewable energy and fuels. In: Cleveland, C.J. (Ed.), Encyclopedia of Energy, vol. 1. Elsevier, San Diego, pp. 193–212.

****