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GOLDEN JUBILEE CELEBRATION COMMITTEE, CAET

Printed at : AB Imaging & Prints Pvt. Ltd., 62 & 63, Unit-6, Ganga Nagar, Bhubaneswar

Dr. S.C. Jamir
Governor, Odisha

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Raj Bhawan
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January 11, 2017

Message

I am glad to know that the College of Agricultural Engineering and Technology, Bhubaneswar is bringing out a commemorative Souvenir titled "Confluence" on the closing ceremony of its Golden Jubilee celebration on January 21-22, 2017.

Agricultural Engineering embraces a variety of speciality areas. As new challenges, technology and information emerges, speciality areas are transformed, new ones recreated, with many overlapping with one or more other areas. College of Agricultural Engineering and Technology, Bhubaneswar having over 50 committed years to education and research has to provide excellent educational opportunities to enable students well grounded in the theory and emphasises on understanding of concepts coupled with practical hands-on training to make them productive and adaptable under many conditions. I wish the sprit of celebration will continue to scale new heights.

I wish the celebration and publication all success.

(S.C. Jamir)

NAVEEN PATNAIK
Chief Minister, Odisha

सत्यमेव जयते

STATE SECRETARIAT
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Message

I am glad to know that the College of Agricultural Engineering and Technology, OUAT, Bhubaneswar is celebrating its Gloden Jubilee during 21-22 January, 2017 and a souvenir "Confluence" is being brought out in commemoration.

Fifty years is a landmark in the history of any institution. The students of this institute have displayed excellent skill and competence for development of machineries to promote farm mechanisation and post harvest management. Agricultural Engineers have made significant contributions in addressing the engineering challenges in the field of agriculture and make the farming sector profitable.

I extend my warm greetings to the alumni, students, and the faculty, and wish them brilliant success.

(NAVEEN PATNAIK)

SHRI PRADEEP MAHARATHY
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D.O. No...../MAF&ARD.
Bhubaneswar
Dt. 10.01.2017

Message

I am extremely happy to know that college of Agricultural Engineering and Technology, Bhubaneswar is celebrating its Golden Jubilee this year and the Souvenir "CONFLUENCE" is being published to add more colours to the celebration.

College of Agricultural Engineering and Technology, Bhubaneswar is one of the premier institute of the country in the field of Agricultural Engineering. It has made immense contribution towards mechanisation as well as modernization of Agricultural sector in our state over the last fifty years by developing new equipments and technologies. I am sure the Institute will scale new height in coming years.

On this occasion, I convey my best wishes to all the faculties, students and alumni of the college and hope for grand success of the event.

(PRADEEP MAHARATHY)

Manoj Ahuja, I.A.S
Principal Secretary to Government
Department of Agriculture &
Farmer's Empowerment
Government of Odisha, Bhubaneswar

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Message

I am extremely glad to know that College of Agricultural Engineering and Technology, Bhubaneswar is celebrating its Golden Jubilee this year and going to organize its closing ceremony in January, 2017 and also bringing out the souvenir "CONFLUENCE" to commemorate the occasion.

The College of Agricultural Engineering and Technology, established as a constituent college under OUAT, Bhubaneswar in the year 1966, has been playing a vital role in boosting agricultural production and productivity by various professional activities in the field of agricultural engineering. Agricultural engineers have a great role to play for improving the agrarian economy of the State. They have contributed immensely towards precision agriculture, mechanization, water management and value addition of farm produce.

I wish the occasion and publication of Souvenir all success.

(Manoj Ahuja)

Prof. S. Pasupalak
VICE CHANCELLOR

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ORISSA UNIVERSITY OF AGRICULTURE & TECHNOLOGY
BHUBANESWAR-751003, ODISHA

Dated the 7th January, 2017

Message

I am extremely happy to know that the College of Agricultural Engineering and Technology, Bhubaneswar is celebrating its Golden Jubilee year and bringing out a Souvenir entitled "Confluence" to mark the occasion. The College of Agricultural Engineering and Technology, Bhubaneswar is one of the leading institutes of the country in the field of Agricultural Engineering. It has made immense contribution towards teaching, research and extension in the field of farm mechanization, water management and post- harvest technology over the last five decades. I am sure the institute will serve in a greater way for overall agricultural development of the state and the country in future.

I convey my greetings and best wishes to all the Alumni of the college and wish all success to the Golden Jubilee Celebration.

(S.Pasupalak)

Tele Fax : 0674-2562360

Dr. A.K. Behera
President

CAET ALUMNI ASSOCIATION

College of Agricultural Engineering & Technology
OUAT, Bhubaneswar-751 003

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Message

I am privileged to be a part of the Golden Jubilee Celebration of my alma-mater as president of the Alumni Association. It has been a tradition to bring out a souvenir in the name and style "Confluence" during each alumni meet. This time during closing ceremony of golden jubilee celebration the publication of "Confluence" bears special significance.

Agricultural Engineers passed out from CAET during the past 50 years have played important roles in transforming India agricultural scenario in general and state of Odisha in particular through agricultural mechanization, natural resources management, agro-processing and use of renewable energy etc. The contribution of the entire fraternity of agricultural engineering has resulted in accepting agriculture as an industry in the state as well as the country. CAET in past five decades has been responsible for quality teaching, research and extension. The alumni of CAET have brought several laurels over time for their commendable services to the society in various capacities. I am hopeful that the profession will rise to a greater height in coming days through their continued dedicated service.

On this occasion, I take this opportunity to congratulate my fellow alumni and wish the Golden Jubilee ceremony a grand success.

(A.K.Behera)

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PREFACE

The beginning of agricultural engineering in the world was at Iowa State University, USA by J. Brownlee Davidson, a person from Nebraska with a dynamic vision. The American Society of Agricultural and Biological Engineers (ASABE), was founded on December 27, 1907, at the University of Wisconsin. First President of ASABE, J. B. Davidson is referred as the "Father of Agricultural Engineering" in USA. Besides the various and numerous locations that our discipline has occupied over the years, its educational programs have also been many and varied. In India, the first program in agricultural engineering education was introduced in 1942 with Bachelor of Science degree at the Allahabad Agricultural Institute, Naini, Allahabad. College of Agricultural Engineering and Technology (CAET) was established in the year 1966 under Orissa University of Agriculture and Technology (OUAT), (3rd Engg. College in the state) Bhubaneswar. Its journey of five decades has been too long and full of learning and achievements in terms of attaining academic excellence. CAET takes pride in its very strong alumni base across the globe in academics, corporate and govt. organizations. The year 2016 marks the completion of 50 years of its existence and to commemorate this milestone; special yearlong celebrations have been planned.

Agricultural Engineering in the state is becoming increasingly important to make agriculture a sustainable, profitable and competitive enterprise through engineering interventions of farm mechanization, soil and water conservation measures, value addition and energy management in production and post-harvest operations. The profession offers emerging research and new engineering solutions for food production and related activities, as a means to enhance livelihood human well-being and promote social benefits. New concerns include energy efficient methods of agricultural, livestock and forestry production while preserving precious natural resources and landscape by applying modern engineering concepts. Diverse agriculture is characteristic of Odisha. As technology is part of farming, engineering must contribute to the development of advanced and efficient agricultural practices to produce environment friendly and healthy food. Therefore, the "Confluence-2016", golden jubilee special covers a wide range of topics for initiating collaborations and for developing ideas for innovations. "Sustainability" is the buzzword today as we look to balance several conflicting needs to save the environment and to instigate practices that protect it while providing for the growing needs of the future population growth. We are agreeing on global standards and trying to redefine the parameters of what is agriculturally and ecologically sound, catering to our crop needs while not damaging it for future generations. Agricultural engineering may possibly be on the verge of another revolution as bio-tech, nano-tech and nutri-tech moves to the forefront of agricultural science.

CAET has been benefited greatly from an extremely talented and committed faculty and staff over these years. Contributions by present and previous faculty and staff are too numerous to mention. Our graduates have distinguished themselves, just as their mentors have. Agricultural Engineering at CAET can be characterized by visionary leadership, strong educational programs, cutting edge research, and exemplary public service. As we approach the 21st century, we are proud of our heritage and eager to add to the tradition. The "Confluence-2016" will serve as a reference material for Agricultural engineering professionals and students. I am privileged to appreciate the sponsors and advertisers in extending their help in bringing out this compilation. All the authors deserve appreciation for contributing valuable material. The efforts put in by the members of publication committee are also extremely commendable. We truly believe our motto to bring engineering to agriculture by making anything and everything possible.

Dr. (Ms) Kalpana Rayaguru
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Contents

Agricultural Engineering: A Key Discipline for Future Agricultural Sustainability

Dwarika Mohan Das[1], Mahamad Khalid Khan[2], M. K. Mohanty[3]

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Introduction

Many systems of food production are unsustainable. Without change, many of the current approaches will continue to degrade the environment and compromise the world's capacity to produce food in the future, as well as contributing to climate change and the destruction of biodiversity. The vision for the future of agriculture identifies sustainable crop intensification, combined with a systematic approach to deal with agricultural change in a "climate smart" way as key. Such approaches need to include technological advances based on engineering science, and the use of systems models to provide an integrated understanding of the benefits and risks associated with new practices.

Agricultural engineering is a recognised focus of engineering skills and innovation that takes strongly a multidisciplinary approach to agricultural problems. Agricultural engineers work in a variety of specialty areas: Natural Resources, Farm Power Systems & Machinery Design, Structures & Environment, Food and Bioprocess Engineering, Information & Electrical Technologies, Energy, Aquacultural Engineering, Nursery & Greenhouse Engineering, and Safety and Health. Some of the newly established advanced areas within the field of agricultural engineering are: bioinstrumentation; biomaterials; biomechanics; cellular, tissue and genetic engineering etc., where agricultural engineers in developed and developing counties are working.

Agriculture is a gruelling and laborious business, but mechanisation has reduced the drudgery, increased outputs and allowed operations to be carried out at the right time. The advances in the last 100 years in drainage and irrigation, in tractors, tillage and crop protection, and harvesting and cool chain management, all derive from agricultural engineering innovation. Now, agricultural engineering is not only associated narrowly with farm machinery, but has a much wider areas of application. It has contributed extensively to soil management, land development, mechanisation and automation of livestock farming, efficient planting, harvesting, storage, and processing of farm commodities. The future sustainable intensification of crop and livestock production systems will require a high level, precision farming approach for its delivery and agricultural engineering R&D will be pivotal to this achievement. The impact of ICT and sensors, precision farming and systems optimisation, and advanced understanding of the interactions between machines, processes, biological systems and the environment will be enormous for future agriculture.

Now, new challenges have been appeared before the world. As world population swells, more food, energy, and goods are required. But with limited natural resources

demand; we have to produce more, and higher productivity should not degrade our environment, and we have to search for new ways to use agricultural products, by-products, and wastes with the changing climate.

Agricultural engineers ensure that we have the necessities of life: safe and plentiful food to eat, pure water to drink, clean fuel and energy sources, and a safe, healthy environment in which to live. More specifically, agricultural engineering is the application of engineering principles to any process associated with agriculture and management of our natural resources. They develop solutions for responsible, alternative uses of agricultural products, by-products and wastes and of our natural resources - soil, water, air, and energy; And they do all this subjected to: the protection of people, animals, and the environment.

For students having knowledge and interest in science and mathematics; agricultural engineering offers a unique opportunity to combine those scholarly interests with the challenge of providing food and other goods for a growing world population while protecting our natural resources. Agricultural Engineering academic programs offer a unique and valuable educational experience. While other engineering students may study a single discipline, agricultural engineering programs traditionally include coursework in a variety of engineering disciplines, complemented by classes in agricultural sciences. When they reach their master level, Agricultural Engineering students then tend to choose a specialty area according to their individual interests for example, Farm Power and Machinery Systems, Food Processing and Post Harvest Management Systems, natural resources or ecological conservation and management systems, energy and alternate energy system, agricultural structures and environmental management systems, industrial management systems, agriculture systems management system, agribusiness management system, aquaculture system,. Agricultural engineer's well-rounded engineering experiences enable them to work exceptionally well on the multidisciplinary teams in today's workforce. and only Agricultural Engineers have the training and experience to understand the interrelationships between technology and the living systems.

Journey of Agricultural Engineering

First agricultural engineering department in the world was created at Iowa State University, USA by J. Brownlee Davidson, a tall man from rural Nebraska with a dynamic vision. The American Society of Agricultural and Biological Engineers (ASABE), was founded on December 27, 1907, at the University of Wisconsin. First President of ASABE, J. B. Davidson is referred as the “Father of Agricultural Engineering” in USA. In India, the first program in agricultural engineering education was introduced in 1942 with Bachelor of Science degree at the Allahabad Agricultural Institute, Naini, Allahabad, Uttar Pradesh. Mason Vaugh (June 27, 1894October 7, 1978) was an American agriculturalist who has developed the first agricultural engineering department at Allahabad Agricultural Institute and he is recognised as “Father of Agricultural Engineering” in India. The second program in agricultural engineering was established in 1952 with Bachelor of Technology (B.Tech.) degree at the Indian Institute of Technology (IIT), Kharagpur, West Bengal. IIT introduced

Master of Technology (M. Tech.) and Ph.D. degrees in agricultural engineering in 1957 and 1962, respectively. Professor Ralph C. Hay contributed a lot for development of agricultural engineering at IIT Kharagpur as a visiting professor from University of Illinois. IIT provided an engineering orientation in course curriculum. Other disciplines like agronomy, soil science and botany were added to the Department of Agricultural Engineering to support it. With the establishment of State Agricultural Universities (SAUs) during 1960's, on the pattern of Land Grant Universities in the United States, the agricultural education in India changed significantly. The first agricultural engineering program under this new pattern was started in 1962 at the Uttar Pradesh Agricultural University (now G B Pant University of Agriculture and Technology), Pantnagar. Agricultural engineering programme started at Orissa University of Agriculture and Technology (OUAT) in the year 1966. Prof. H. Panda, Prof. N. K. Ram, Prof. R. Lal and Prof. H. D. Sharma have major contributions for agricultural engineering development at CAET, OUAT, as well in Odisha.

Presently, under ICAR accreditation there are 28 SAUs offering bachelor degree programs in agricultural engineering along with master degree and 21 are offering Ph.D. degree (ICAR AIEEA Information Bulletin 2016, UG, PG and SRF-PGS). Besides these, IIT Kharagpur and some private universities have also started agricultural engineering programme with approval of All India Council of Technical Education (AICTE). In Odisha, Centurion University of Technology and Management is offering B. Tech degree in agricultural engineering at its Paralakhemundi campus.

Specialty Areas

Agricultural engineering embraces a variety of specialty areas. As new technology and information emerge, specialty areas are created, and many overlap with one or more other areas. Here are descriptions of some of the exciting specialties; one could choose to focus on as a student in agricultural engineering.

Natural Resources Engineering

Natural resources like soil, water and air are vulnerable to degradation by both natural and man-made forces. Agricultural engineers with environmental expertise work to better understand the complex mechanics of these resources, so that they can be used efficiently and without degradation. These engineers determine crop water requirements and design irrigation systems. They have sound understanding of agricultural hydrology principles, such as controlling drainage, and they implement ways to control soil erosion and study the environmental effects of sediment on stream quality. Natural resources engineers' model, design, build, operate and maintain soil-water conservation structures, channels, and flood control structures. They also work on water treatment systems, wetlands protection, and other water issues. They are also able to model plant and livestock growth and management to face the future climate change scenarios.

Farm Power Systems & Machinery Engineering

Agricultural Engineers in this specialization focus on designing advanced equipment, making it more efficient and less demanding of our natural resources. They develop equipment for precision agriculture, food processing, agricultural commodity and waste management, value addition and marketing, and landscape maintenance. This is in addition to the tractors, tillage equipment, irrigation equipment, and harvest equipment that have done so much to reduce the drudgery of farming. Their work remains challenging as technology advances, production practices change and equipment manufacturers expand globally.

Postharvest and Food Engineering

Food, is only the beginning of a list of products that are essential for sustainability of human race on earth. Food engineers combine design expertise with manufacturing methods to develop economical and responsible processing solutions for industry. The specialization include technology for post harvest, primary processing and value addition of food, feed, fiber and industrial crops, fermentation technology, controlled atmospheric packaging and low temperature storage. They are experts in pasteurization, sterilization, and irradiation, and in the packaging, transportation and storage of perishable products.

Structures & Environment Engineering

Agricultural engineers understand the importance of creating and maintaining a healthy environment for growing agricultural commodities and for the labourers who produce them. Agricultural engineers with expertise in structures and environment design animal housing, storage structures, and greenhouses, with ventilation systems, temperature and humidity controls, and structural strength appropriate for their climate and purpose.

Energy and Renewable Energy Engineering

Our high standard of living and comfort could not be maintained without energy to power the machines, devices, and systems in our homes and workplaces. But many energy sources are non-renewable and create undesirable by-products. Agricultural engineers are at the forefront of the effort to identify and develop viable alternate energy sources from- biomass, solar, wind, tide, geo-heat and water electrolysis and having an aim to produce a cleaner and more efficient energy source for future sustainability.

Aquaculture Engineering

Agricultural engineers help in designing farm systems for raising fish and shellfish, as well as ornamental and bait fish. They are specialized in water quality, biotechnology, machinery, natural resources, feeding and ventilation systems, and sanitation for better fish management. They seek ways to reduce pollution from aquaculture discharges, to reduce excess water use, and to improve farm systems. They also work with aquatic animal harvesting, sorting, and processing.

Information & Industrial Engineering

It is one of the most versatile specialty areas for agricultural engineers, because it is applied to most of the area of agriculture in the coming days, e.g., from machinery design to soil testing to food quality and safety control. Geographic information systems, global positioning systems, machine instrumentation and controls, electro-magnetics, bioinformatics, bio-robotics, machine vision, bio-sensors, spectroscopy-these are some of the exciting technology being used today and being developed in future for agricultural management.

Agriculture System Engineering

It is also an emerging field for specialization. Agricultural engineers having this specialization better understand crop modelling, soil flow and transport modelling, irrigation water quality modelling for better agriculture in the changing climate. They learn remote sensing, image processing, mathematical modelling, and biotechnology and apply this knowledge for sustainable agricultural development.

Agribusiness Management and Entrepreneurship Development

Marketing is a major concern in agriculture. Starting from agricultural commodities to big efficient machineries need to be marketed at proper time. Agricultural engineers having marketing skill have a better job opportunity in the growing economy. As, job scarcity is increasing day by day, agricultural engineers are showing their interest to develop their own enterprise. In different developed and developing countries agricultural engineers have established their farm machinery manufacturing industry, processing machinery manufacturing industry, micro irrigation companies, geo-informatics centres, dairy plants, ice cream plants, agro processing plants (e.g., Big rice, Dal, Fish processing units), solar equipment manufacturing unit, small solar power plants etc. In this specialization, a graduate agricultural engineer become more efficient in marketing and develops confidence to become an agri-entrepreneur.

Job Opportunities for Agricultural Engineers

Agricultural engineers understand the interrelationships between technology and living systems, and have a wide variety of employment options. Some examples of these areas are given below:

- Agricultural engineers having master degree or Ph.D. qualification have opportunity to be appointed as professor or scientist in different state agricultural universities, ARSs under ICAR, different AICRP projects, KVKs, NITs, IITs, MNRE and also in different foreign universities etc.

- Agricultural engineers having only bachelor degree can avail the opportunity to work in state agriculture or agricultural engineering department, water resources department, renewable energy agency, soil conservation department, horticulture department, panchayatiraj department, sate small scale industries etc.

- Agricultural engineers have job opportunities in different multinational companies and agencies e.g., different tractor companies, different food processing companies, dairy companies, micro irrigation companies, automobile companies, software companies, modelling agencies, NGOs etc.
- Agricultural engineers having management degree have opportunity in many companies because in an agriculture based economy most of the companies want to have an agricultural commodity related wing.
- In different nationalised banks there is an agriculture officer post equivalent to probationary officer, where only agriculture and allied discipline graduates can only be appointed. Agricultural engineers can avail this opportunity by clearing Institute of Banking Personnel Selection (IBPS) examination.
- Agricultural engineering is one of the major subjects in IFS and OAS like administrative services, so, agricultural engineering graduates should avail this opportunity.

Future Agricultural Engineering

The American Society of Mechanical Engineers has recognised agricultural mechanisation as their 4th most important achievement in the 20th century, after the car, Apollo and power generation (ASABE, 2006). But the vision of the future for agriculture suggests that there is not only a major opportunity but a real demand for further innovation and its translation into practice. Advances in sensing, optical recognition, robotics, data management, control engineering, mathematical modelling, nanotechnology, surface chemistry, fluid dynamics, soil physics and mechatronics will be all features for solving the global challenges. Hence, agricultural engineering traditional course curriculum needs to be changed accordingly to train the agricultural engineers for serving the future agriculture.

Conclusions

Agricultural Engineering involves finding solutions for sustainable agriculture and allied sectors on our planet. In the early twentieth century, even in industrialized countries, production of the world's food supply required the labour of at least half the population. Today, thanks in large part to advancements made by agricultural engineers; developed countries can accomplish this using only a slim 2% of their populations. And Agricultural engineering applications have not been limited to food production but applicable to fodder, fiber, timber, energy production and precious natural resources management. In future more emphasis should be given to introduce new course work in agricultural engineering to meet the future demand and also agricultural engineering should be linked to industries to produce more efficient engineers.

Rain Water Management: A New Technique

N. Sahoo[1], B.Naik[2], B C Sahoo[3]

[1]Principal TITE, [2]Retired ADA (Engg) , [3]Retired Engineer

Introduction

The scenario of current and few future alternatives of water utilisation are briefed with the following two Principles namely Surface reservoirs of various sizes (major, medium & minors as well as smaller reservoirs of assorted sizes) along with their canal distribution system and Sub-surface storage & retrieval by pumping. The former is by far the most widely accepted method of water storage & utilisation and the latter is yet to gain wide popularity for very many reasons. In this context the first thing that comes is observation of a western thinker (basically an environmentalist). He says that basically there are two views about water use. One considers it as a commodity, which thinks that the resources may be developed and sold to the users to make money and the idea was brought to India during colonial rule and later widely expanded after independence. In this concept one who happens to get water pays for it and Govt. has no responsibility towards those who do not get it. It has aptly been described by Gandhiji in the following words, "God while creating the earth has provided enough water to sustain all life forms including men, animals, micro-organisms as well as vegetation". Therefore all are entitled to get their legitimate share. For that matter he has designed a distribution system which is known as Water Cycle or Hydrological Cycle. Since the life forms need a platform with adequate water to survive, he has created a disintegrated zone to store the precipitation to see the life forms through the dry period after rain is gone.

Need for a Fresh Perspective

Now look to the part (71.93%) which is absorbed by catchments and is not utilisable for any viable flow projects. In view of the large quantum it appears unwise to leave it as such. Now that the prime minister has outlined the political will of the country in shape of PMKSY it is time for the bureaucracy and the technocrats to scratch their heads together first to develop a fresh perspective at National level so as to issue necessary guidelines to the states to mobilise their field functionaries to plan projects taking respective local factors in to consideration. National perspective, at present, largely banks upon flow irrigation systems (mostly of major and medium types). Such projects do not become viable when river flow falls below 75% dependability. They entail other problems as well such as that of area submergence and rehabilitation to name a few. Lately handling such issues have become more important than irrigation *per se*. Both major & medium projects have been vehemently resisted by people during the last 30 years mainly due to submergence & rehabilitation issues. The issue has assumed serious proportions because it essentially divides people into two groups of mutually opposite interest (one group sacrificing their facility for the benefit of the other). The argument that in spite of losses to few the net benefits to the country is

positive is no more tenable (by experience). If it is too forcefully imposed the democracy may meet a stalemate because of the political opposition taking sides to gain political advantage from the differing opinion. Fortunately for us so far only 17.25 % of precipitation has gone via flow projects leaving a balance of 82.75% for which it appears imperative that a different technology has to be identified for a new perspective to be built upon.

Conjunctive Use could be a starter

In that context Conjunctive use of ground water recharge accumulating .from canal seepage from head-end zones, (which constitute about 65% of the water released in to the canal system) could serve as an important secondary source to augment the shortage towards the tail. This could be the starting point to develop the program of ground water utilisation. This measure has so far been avoided because it entails lifting. The pumping may be resorted to either from surface drains or sub surface aquifers depending upon the nature of the commands. Apart from augmenting tail end scarcity they would serve as vertical drains as well. Water logging, which is another menace in head ends of any flow system, finds a solution in one go. In fact without such augmentation the CADA channels by themselves remain non-functional towards the tail-ends for lack of water. Lining of the channels have not been very useful for obvious reason. A study on waterlogged areas management was undertaken in Khordha district of Odisha at Biswanathpur, Balipatana Block. The command area is 397 ha and waterlogged area is 134 ha. Out of this severity in water logging in relation to crop damage is in 62 ha. In this 62 ha, nothing grows throughout the year. It is infested with Ipomea cornea and aquatic weeds. The trunk drain of irrigation department which passes through nearby does not carry adequately the surplus water in rabi as well as kharif season. The two types of solutions given to the problem are executing surface drainage system and construction of series of shallow tube well in tail end area of the command (1 tube well for 8 ha). The results showed remarkable improvement. The water level reduced from 130 cm to 55cm in extremely severe situations. The reason being the drawal of ground water in Rabi season and post kharif season in tail end area by series of tube well. The drawal of ground water made space for water to move to soil in kharif season. (Annual Report WTCER 2002)

Reason

The overall availability of water, though volumetrically large is scattered all over depending upon local hydrologic environment. If a bore well is drilled and is pumped, a hydraulic gradient towards the bore starts and media resistance being high the speed of movement of ground water is too slow (75mm /hour) That makes the system as unreliable as ever. This has given an edge to the flow system protagonists, to leave the administration wandering. Now that CADA trial has failed and PMKSY will be sitting on the head of WRD; the real solution has to be unearthed. Additional water must be found to make up deficiencies in the flow system. All the perspective plans are bound to suffer if this continues. CGWB is also finding it hard to formulate a reliable mathematical model to predict availability accurately. For example one of their recent reports says that in view of the high rainfall of Odisha, the state does not need planned

recharge. This again is the result of the inappropriate mathematical model they are using. It is totally untrue in view of our experience. Therefore a practical approach would be to take some such step as to gather the anticipated quantum sufficiently in advance and keep it in close proximity of the bores.

The Odisha Model

Fortunately the Rain Water Management model being experimented in Odisha not only ensures this but also yields information about the location and direction of movement of water to enable one to plan specific lift projects directly for farmers' use. By organising collection of differential geo-hydrological data for each planning unit (say a watershed) separately it is possible to take a view for guidance of the local planners. Incidentally we saw a report that even Cherrapunji suffers from drought in post monsoon period. Out of curiosity we visited Meghalaya to find that all that precipitates there flows down to Bangladesh. Apparently there is no room locally perceived to keep the high precipitation in conventional surface reservoirs. To make things simpler it can be said that it is much cheaper/easier to make the entire precipitation to move into a specific but easily utilisable zone of the underground by taking an appropriate measure to infiltrate rainfall at the same place as soon as rain strikes the ground. Such a plan leads to a mass recharging arrangement irrespective of quantum of precipitation. Contrary to recommendation of CGWB, our model can also be applied even on hills. For instance Odisha has a 500 year old virgin forest on Similipal hills, which boasts about 12 perennial rivers/waterfalls all fed by natural ground water recharge. If it is happening on hill top due to intensive forest cover, Nature can be imitated relatively easily on plains which, once laid out, regularly functions whenever it rains.

An artificial recharge project, executed by us, is working on Eastern Ghat region at Padmapur and Jhatikasahi villages under Mohana block of Gajapati district, Odisha. All the arable land has been covered with crop and enough water is available for Rabi and summer crops. Western Odisha has been following this model since as far back as 1824, which of course has been steadily deteriorating due to dwindling forest cover on hills. These need be compensated with appropriate alternative technology, which have already been identified. If GOI want they may ask the state govt to verify and report. A group of Agricultural Engineers have tried the method in as many as 22 locations in 20 districts.

Salvaging the annual loss via RWM technology

Left to itself the left over 71.93 % of annual precipitation moves away in all directions except getting in to the underground where there is a big void waiting (known as disintegrated zone) large enough to hold the entire 71.93% of precipitation. In order to make it move into the underground reservoir (disintegrated zone) one has to block the direction of maximum slope and keep the direction of secondary slope open and allow the runoff to move along this direction as slowly and for as long as the topography permits. This is the technique for using even a hill to develop a sub surface reservoir. The hills are full of usable voids. We make this moving arrangement because we

cannot hold precipitation at any one place unless big enough reservoirs are built first (for which the difficulties are too obvious). The real purpose is to gain as much time (at least 20 hours to infilter 1500 mm precipitation). The principle could be applied with necessary modification if needed elsewhere also. Some doubt has been raised if on hill slopes it may lead to landslides. It may lead if the soil profile is allowed to super saturate. Hill slopes can also be easily drained as well. After gravitational water is removed the unsaturated soil is very well suited to support vegetation and the roots, once established they make the soil all the more stable. Incidentally this is also the technique for preventing large scale mortality in plantations. Thus PMKSY has scope to rope in Forest Department also ultimately to sub-serve the Ground Water program. A Rain Water Management project was taken up at Badamal village, Manesar Block, Sambalpur District of Odisha under WODC, Govt. of Odisha during 2011-2013. The village depended on a small MIP, which never got filled up even during Khariff affecting cultivation. Graded guide bunds were constructed in the catchment of the MIP to promote artificial recharge and storage of water underground. The reservoir not only got filled up during 2011 rainy season but also remained full in summer 2014. (21° 16' 05?N, 84° 00' 11E)

Storage potential of disintegrated zone

Considering the disintegrated zone which occurs up to 10 m from the surface has a porosity of about 50 %. It means for every 100 ha spread on the surface we have a storage space of 500 ha-m. underneath. In Odisha conditions rain falling over 100 ha is 150 ha-m only. It means 3 years entire rainfall can be accommodated within the top 10m depth. This is the initial but one time intervention. It costs around Rs.30000 /ha under Odisha conditions but stays for a life time requiring nominal maintenance. This can be applied all over the country and store the entire surplus fall of 71.93 % BCM.Water stored in top10m slowly moves (@ 75mm/hour in the direction of the hydraulic gradient) down the slope. The fractures in the sedimentary zone below get fully charged by drawing water from the disintegrated zone. Fractures occur along drainage line which can be mapped with the help from satellite pictures. Select a confluence point on the drainage network where a well can be bored. If needed the sub-surface path can be blocked by a sub-surface diaphragm wall and the water table upstream rises substantially reducing the pumping cost while enhancing availability of usable water. This will reduce energy cost. The process is just reverse. Instead of dragging the energy to the existing water front drag the water front close to the place of use. This is cheaper and one time investment a task easier for Government to indulge in.

A project was taken up during 2007 to provide irrigation to a plantation of 650 mango trees planted on the bank of river Brahmani in village Gailo, Odapada Block, Dhenkanal district of Odisha. A Diaphragm wall / Subsurface Dyke was constructed on the adjacent drain to prevent escape of subsurface water from the orchard to the river. The water table rose from 12metres in 2008 to 4metres in 2015 eliminating any need for surface irrigation to the plants. (20° 45' 28? N, 85° 29' 43E)

An incidental opportunity to combat the effect of erratic monsoon

Incidentally to be able to store 3 years' rainfall amounts to keeping monsoon at your command one year in advance as it allows one to maintain a carryover stock. If it delays arrival, start operation in time with the carry over stock. If it stops in mid season use the stock lying below your field to give the life saving irrigation before it is late. If rain arrives at a time when standing crop is ripening; no problem, the showers will be soaked in 24 hours before they cause any damage.

Virtual control over monsoon

Since the principle is known by the engineer then movement of water in the proper direction can be adhered to. This is the new technique of The Rain Water Management. Under the MGNREGA-NRLM-CFT convergence project promoted by DoLR, Govt. of India 13 villages have taken up Guide bund construction to conserve rain water and eliminate drought in Harichandanpur block of Keonjhar district of Odisha during 2015-16. Another 20 villages of this block have also resolved to follow suit. District administration has extended this activity to several villages of adjacent Ghatagan and Patana blocks. By this people are getting wages by working in their own village at the same time their village is getting drought proof. Under IWMP, a cluster of 5150 Hectares of treatable area over nine villages under Jharbandh Block of Baragarh, Odisha is developed adopting Guide bund technology.

Objectives of Rain Water Management

- Storage of unused rainfall for deferred use: The specific place created by nature where unused rainfall can be stored is the disintegrated zone which occurs within the first 10m from earth surface. It has been calculated that 2 to 3years total rain falling directly on it can be stored. It can be filled up by diversion from elsewhere also. Intervention required is to gain 10-20 hours required for infiltration by bunding of appropriate type.
- Control of runoff: It is done via enhancement of Time of Concentration. It serves dual purpose of control runoff resulting in enhanced storage.
- Control of direct evaporation: Reduce unwanted surface storage. Reduce area lying bare by making it green. Thereby unproductive evaporation is converted into productive evapo-transpiration.

Intervention Required

In this approach concentration on conserving water in highlands is given priority. Because, conserved water in the uplands will slowly move towards lower levels inside the soil and keep the medium and low lands moist. Study shows that Drainage Line Treatment will never be required as the total run off will be managed / controlled by treating the Catchment (Both Arable & Non Arable). The time of concentration is increased by simple earthen bunds at strategic positions which are described below.

Graded Guide bund will be 1.5 meter high minimum at the ridges. The top of the bund should have longitudinal slope of 0.2 to 0.5% so that the flow path is non-silting & non-erosive. If required Loose Boulder Structures would be put up across the flow path to control the longitudinal slope. If the designer feels, surplus escapes in the form of Loose Boulder Structures may be provided at suitable intervals to allow spilling of water in excess of 1 meter depth of flow. Care should be taken that these surplus are located at ridge points on the path of the bund. Secondary Graded Bund is one meter high. It will be used to regulate the runoff generated within the cultivated upland area and the spill over from the primary bunds. Its path will be the identified field bunds which are across the primary slope of cultivated area. The longitudinal slope of this bund should be limited to 0.5%, which can be achieved by providing LBS at plot junctions, if necessary.

Existing bunds of all un-bunded and bunded high lands will be upgraded with field bunds of 60 cm height. These will be strictly along the property boundary. The spacing of the bund should be limited to 50cm vertical or 30meter horizontal interval whichever less is. If necessary, large plots may be divided following this norm. Arrangements would be such that excess water, during heavy showers, from these plots does not flow down to the plot below. Instead it is to be guided to the side plots. Application of this dyke/wall may cause perennial water logging in low lands. Hence its application should be limited to highly sloppy (10 to15%) lands like that of the Eastern Ghats. Dug wells constructed at lower middle land /low land will benefit these farmers and prompt them to go for cash crops. Shallow dug wells up to 3 meter depth and 3 to 4.5 meter diameter will be excavated and lined. These will be provided with 2.0 hp electric or 3.5 hp diesel pump set with pressure pipe delivery system.

Conclusion

In this new technique only the above 5 items are required. The Sub surface dyke is location specific and may or may not be required. Hence now with this technique major portion of runoff will be stored underground. More crop per drop of water campaign by Govt. Of India under the PMKSY will be fruitful and successful.

Combine Harvester

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Introduction

Agriculture is the oldest and largest industry of the world which provides the materials to meet the basic needs of mankind food, clothing and shelter. Countries with highly developed agriculture and industry are advanced states of the world.

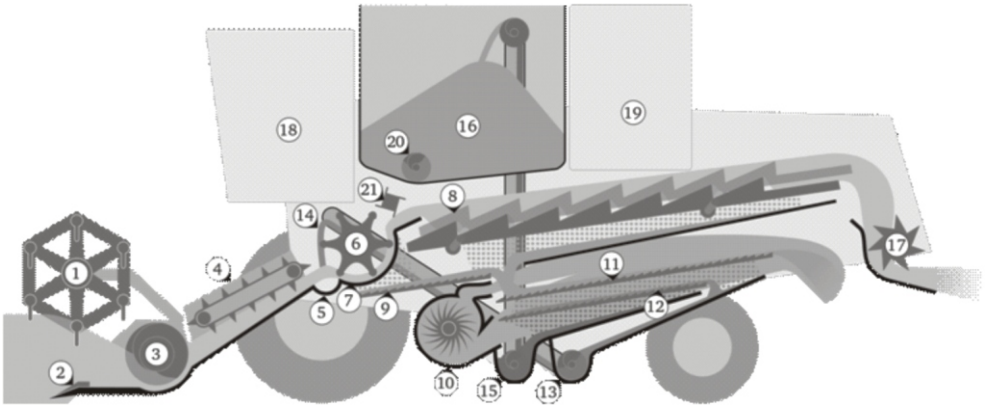
The combine harvester, or simply the combine is a machine that combines the harvesting, threshing and cleaning of grain crops such as maize, soya bean, flax, oats , wheat or rice. The waste straw left behind on the field is the remaining dried stems and leaves of the crop with limited nutrients which is either chopped and spread on the field or baled for feed and bedding for livestock. Combine harvesters are one of the most economically important labour saving inventions, significantly reducing the fraction of the population that must be engaged in agriculture.

History of Combine Harvesters

Scottish inventor Patrick Bell invented the reaper in 1826. The first combine was invented by Hiran Moore in 1834 in the USA and it took many decades for the combine to be popular. Early versions were pulled by horse, mule or ox teams. Moore built a full-scale version in 1835 and by 1839 it could successfully harvest over 20 ha of crops. The combine harvesters with a cutting width of several metres were used on American farms by 1860. The Sunshine Harvester, a commercially successful combine harvester, was produced by Australian Hugh Victor McKay in 1885. Early combines even used 16 horses to pull them where as later combines used steam engines. Tractor drawn and PTO powered combines were also used for some time followed by self propelled combines using diesel engines.

The Holt Manufacturing Company of California produced a self-propelled harvester in 1911. M/s International Harvesters started making horse-pulled combines in 1915. At the time horse powered binders and stand alone threshing machines were more common. In the 1920s Case Corporation and John Deere made combines and these were starting to be tractor pulled with a second engine aboard the combine to power its workings. The patented Sunshine Auto Header was one of the first center-feeding self-propelled harvester in 1923 in Australia. The Baldwin brothers and their Gleaner Manufacturing Company patented a self-propelled harvester in Kansas in 1923 that included several other modern improvements in grain handling. Both the Gleaner and the Sunshine used Fordson engines; early Gleaners used the entire Fordson chassis and driveline as a platform. Alfredo Rotania of Argentina patented a self-propelled harvester in 1929. The world economic collapse in the 1930s stopped farm equipment purchases thus people largely retained the older method of harvesting. A few farms did invest and used Caterpillar Tractors to move the outfits.

Tractor-drawn combines (also called pull-type combines) became common after World War II as many farms began to use tractors. An example was the All-Crop Harvester Series. These combines used a shaker to separate the grain from the chaff and straw-walkers (grates with small teeth on an eccentric shaft) to eject the straw while retaining the grain. Early tractor-drawn combines were usually powered by a separate gasoline engine, while later models were PTO-powered. These machines either put the harvested crop into bags that were then loaded onto a wagon or truck, or had a small bin that stored the grain until it was transferred to a truck or wagon with an auger.In the U.S., Allis-Chalmers, Massey-Harris, International Harvesters, Gleaner Manufacturing Company, John Deere and Minneapolis Moline are known as past or present major combine producers. A self-propelled model was perfected in 1937 by Australian-born Thomas Carroll, working for Massey-Harris in Canada and in 1940 a lighter-weight model began to be marketed widely by the company. Lyle Yost invented an auger that would lift grain out of a combine in 1947, making unloading grain much easier. In 1952 Claeys launched the first self-propelled combine harvester in Europe in 1953, the European manufacturer Claas developed a self-propelled combine harvester named "Hercules" which could harvest up to 5 tons of wheat a day. This newer kind of combine is still in use and is powered by diesel or gasoline engines. Until the self-cleaning rotary screen was invented in the mid-1960s combine engines suffered from overheating as the chaff spewed out when harvesting small grains would clog radiators, blocking the airflow needed for cooling.



Conventional Combine Harvester

1) Reel 2) Cutter bar 3) Header auger 4) Grain conveyor 5) Stone trap 6) Threshing drum 7) Concave 8) Straw walker 9) Grain pan 10) Fan 11) Top Adjustable sieve 12) Bottom sieve 13) Tailings conveyor 14) Rethreshing of tailings 15) Grain auger 16) Grain tank 17) Straw chopper 18) Driver's cab 19) Engine 20) Unloading auger 21) Impeller

A significant advance in the design of combines was the rotary design. The straw and grains were separated by a powerful fan. Axial-Flow combine harvesters were introduced by International Harvester Company during 1997.During 1980s; on-board electronic gadgets were used to measure the threshing efficiency. This new instrumentation allowed the operators to get better grain yields by optimizing ground speed and other operating parameters.

Conclusion

Odisha, one of the most progressing and promising states of India in general and of the Eastern part of the country in particular has owned laurels by continuously winning Krishi Karman Award for three times followed by International Award for agriculture development. The present need is to equally develop the industries, particularly the agro based industries to make it one of the highly developed states of our country. The farm implement and machinery industry in Odisha was limited to manufacturing and selling items worth of Rs.40 lakh in 1985 as compared to Rs.1000 lakh at present. The number of combine harvesters being used by our farmers' now stands at 1775 starting with the first one in 2002. The first self propelled combine harvester “CLAAS” was procured by OUAT under NATP Programme by the College of Agricultural Engineering & Technology. These entire combine harvesters used in our state are being manufactured in Punjab and Haryana by more than 16 manufactures. The development of combine manufacturing industry grew up in Punjab with the 200 units imported from abroad in 1972 to Punjab to overcome the labour shortage during harvesting of wheat crop. There is enough opportunity to promote combine harvester manufacturing along with power tillers, self propelled rice transplanters, power paddy reapers and other items to make Odisha agriculture developed, commercial and profitable.

Agri- Entrepreneurship Start up in Context of Farm Mechanization

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Introduction

Modernization of agriculture with the help of using improved farm machinery is a vital and essential component in sustaining and enhancing production and productivity in agriculture. Agriculture would remain important in the livelihood of a considerable section of India's population for several decades to come even with a reducing share in the country's GDP. Indian agriculture is to meet several challenges in the coming days in order to provide food, feed and fibre for the fast growing population of our country. Drudgery, natural uncertainties, low productivities, low profitability, climate change, and low societal standing of farming profession are mainly contributing to the flight of rural youth from agriculture to non-agricultural pursuits. Under these conditions, Indian agriculture is to undergo a transformation in appropriate direction. The availability of labour force in agriculture is also crucial in sustaining agricultural production. The population dynamics with regard to the agricultural workers of our state shows that their availability in the agricultural sector is declining day by day. This has led to diminishing work force in farming sector. This trend is likely to continue till wages offered in agricultural sector are comparable to other sectors. In such a case, the potential of agricultural sector to employ work force would be far less than today. Agriculture service industry has already started providing solutions/ services to stakeholder and its scope is expected to widen in coming times. Such scenario would lead to mechanization of majority of agricultural operations. Engineering interventions in agriculture have therefore become essential for reducing the cost of production and drudgery while improving the livelihood opportunities and sustainability of income and environment through appropriate mechanization, post-production technologies and energy management. Technology, skills and the policies must aim at lifting the weaker category of farm holders above the national per capita income threshold. It is in this context, greater emphasis is being given for inclusion of engineering inputs to agriculture in Odisha and for the country as a whole. Farm mechanization, land and water management approach, energy management in agriculture, protected agriculture, post-harvest loss minimization and value addition in production catchments and knowledge empowerment through IT have all been found essential individually as well as collectively for the growth of agriculture and rural sector.

Aging of farmers who support agriculture at present is advancing. As per Economic Survey, 2014, around 50 % of farmers in Odisha are over 60 years old. It is also observed that rural and unemployed youths now a day are not very much interested for engaging themselves in agricultural profession. It means 50 % of them will become

over 80 years old after 20 years and then only the rest 50 % would be engaged in agriculture. In order to compensate and managing agriculture by the remaining 50 %, we have to increase labour productivity by 2 times. The reduction of agricultural labour force has also been continuing from the beginning of the current century. Thus, agricultural labour productivity must be increased by new agricultural mechanization systems. To solve food problem around the country, development of agricultural mechanization is really necessary. For promoting agricultural mechanization, we have to undertake more research, development, production and spread of various location and need based machines from simple to complicated ones that should fit to the local requirements. At present, smart phones are spreading in each and every corner of the society. Internet facilities are also going to be connected and be used by everybody in near future. In this situation, we have to think about new types of agricultural machines, more suitable for the need and benefit of the farming community. If these become modified and simplified more, every farmer will be able to design and develop their own necessary machines by themselves and will start with business for large scale propagation of farm equipment. We all together have to think about the use of new information technology in considering the future of agricultural mechanization. Some of the specific challenges in context of agricultural mechanization in India are such as mechanization of small farm due to small size of land holdings, enhancing input use efficiency, improvement in water productivity, enhancing available energy use and reducing post harvest losses for ensuring nutritional security.

Entrepreneur friendly programmes like 'make in India' would certainly attract international manufacturers which in-turn would help creating a healthy competition and good quality standards more specifically in modernization of agriculture. The concept of business incubation for agricultural machinery would therefore become a favourable option to take up such activity as an entrepreneurship among the rural youths.

Entrepreneurship Opportunities in Agriculture

Many developing nations have succeeded in advancing economic growth and development because of entrepreneurship. Entrepreneurship has traditionally been defined as the process of designing; launching and running a new business, which typically begins as a small business, such as a startup company, offering a product, process or service for sale or hire, and the people who do so are called 'entrepreneurs'. Through this process, individuals become conscious of business ownership as an option or viable alternative, to develop ideas for business, learn the process of becoming an entrepreneur and undertake the initiation and development of a business. Rapid agricultural development needs innovating farm entrepreneurship. As urban population is growing day by day, the rural population is shrinking at a very fast pace, entrepreneurs in rural agricultural sector would be of great help and the present need of the hour. Their consolidated efforts would help to make agricultural workers stay back in village and earn a respectable living.

Entrepreneurship Option in Farm Mechanization

Agricultural work force in 2030 would largely be young which would be more receptive to modernization options. Therefore, it appears that there would be transformation of present day agriculture into more farmer-friendly, profitable, and sustainable profession. Agricultural mechanization is an important part of agricultural modernization. The principal purposes of mechanization are (i) increase in labour productivity (ii) increase in land productivity (iii) decrease in cost of production along with the additional benefits of reducing drudgery of farm work for the users. Various agricultural equipments have been developed and available in our state. However, these are not widely popularized among the farmers due to lack of awareness, inadequate sales and repair centres and non-availability of farm machinery banks for custom hiring by small and marginal farmers. Rapid agricultural mechanization therefore needs innovating farm entrepreneurship. Establishment and expansion of entrepreneurship choice for farm machinery in each and every corner of the rural areas would certainly augment generating employment, promoting incomes and earnings of people. The equipments those are available and need to be disseminated in our state through entrepreneurship option are as follow;

Power Driven Machinery

Sl No	Name of equipment	Address of Manufacturer	Cost of each unit, Rs
1	Power drum seeder	M/s Brundabanjew Enterprises, At/P.O. - Mukulishi, Dist- Balasore	75,000
2	Mini pulse reaper	M/s Andreas Stihl Pvt Ltd Gut No. 53/01, Pune- Nashik highway, Near Vijay Logistics, Behind Lear Company, Kuruli, Tal - Khed, Dist- Pune-410501	35000
3	Power-cum-manual chaff cutter	M/s Akriti, At/P.O. Bamra, Dist - Sambalpur	21455/- (with 1 hp motor) 8000 (manual)
4	Power maize sheller	M/s Akriti, At/P.O. Bamra, Dist - Sambalpur	21455/-
5	Power weeder	Developed in OUAT, Bhubaneswar	35000/-
6	Power tiller operated multi crop planter	M/s Brundabanjew Enterprises, At/P.O. - Mukulishi, Dist- Balasore	19000/-
7	Power pulse reaper	M/s Brundabanjew Enterprises, At/P.O. - Mukulishi, Dist- Balasore	95000/-
8	Mini tractor mounted multi crop planter	M/s Pragati Engineering, Madhupatna, Cuttack	32000/-
9	Power tiller operated mower	M/s Akriti, At/P.O - Bamra, Dist – Sambalpur	12,000/-
10	Power tiller operated brush cutter	M/s Akriti, At/P.O - Bamra, Dist – Sambalpur	12,000/-
11	Power tiller operated post hole digger	M/s Sahoo Agro Chemicals, Badambadi, Cuttack Dist- Cuttack, Odisha	18,000/-
12	Power tiller operated inclined plate planter	M/s Brundabanjew Enterprises, At/P.O. Mukulishi, Dist- Balasore	35,000/-
13	Self propelled pre germinated paddy seeder	M/s Annapurna Agro International Ganeswarpur Industrial Estate, Balasore Dist- Balasore	90,000/-

Manually Drawn Implements

S.N.	Name of Equipment	Address of the Manufacturer	Cost of each unit, Rs
1	Sugarcane stripper	Ms. Unicus Engg. Pvt. Ltd. 23, Madhusudan Nagar, Bhubaneswar	330/-
2	Manually operated dry land weeder	M/s Sai Shakti, Madhupatna, Cuttack	1050
3	Manually operated cycle weeder	M/s Sai Shakti, Madhupatna, Cuttack	1791
4	Manually operated wheel weeder	Recently developed	950
5	Pre-germinated paddy seeder	1. Ms. Unicus Engg. Pvt. Ltd. 23, Madhusudan Nagar, Bhubaneswar 2. M/s. Sidheswar Engineering, Bidyadharpur, Cuttack	4500/-
6	Pedal thresher with safety cover	1. Ms. Unicus Engg. Pvt. Ltd. Madhusudan Nagar, Bhubaneswar 2. M/s. Sidheswar Engineering, Bidyadharpur, Cuttack	6225/-
7	Two-row manual rice transplanter	M/s. Sidheswar Engineering, Bidyadharpur, Cuttack	6500/-
8	Coconut tree climber	Ms. Unicus Engineering Pvt. Ltd. 23, Madhusudan Nagar, Bhubaneswar	6000/-
9	Manual chaff cutter	M/s. Akriti Bamra, Dist - Sambalpur, Odisha	11,000/-
10	Coconut dehusker 2.	1. Ms. Unicus Engg. Pvt. Ltd. Madhusudan Nagar, Bhubaneswar 2. M/s. Swain Engg. Works, 1014, Nayapalli, Bhubaneswar	800/-
11	Three-row manual rice transplanter	M/s. Sidheswar Engineering, Bidyadharpur, Cuttack	8500/-
12	Ragi thresher	Ms. Unicus Engg. Pvt. Ltd. 23, Madhusudan Nagar, Bhubaneswar	10,000/-

S.N.	Name of Equipment	Address of the Manufacturer	Cost of each unit, Rs
1	OUAT mould board plough	M/s Sai Sakti Engineering, Khapuria, Cuttack	848/-
2	OUAT Puddler	M/s Brundabanjew Enterprisers At/P.O. Mukulishi, Dist- Balasore	4300/-
3	Bullock drawn single row seed-cum-fertilizer drill	M/s Brundabanjew Enterprisers At/P.O. Mukulishi, Dist- Balasore	4400/-
4	Bullock drawn 8-row pre germinated paddy drum seeder	M/s Brundabanjew Enterprisers At/P.O. Mukulishi, Dist- Balasore	13500/-

Conclusion

Entrepreneurship is the process by which individuals become conscious of business ownership as an option or viable alternative, develop ideas for business, learn the process of becoming an entrepreneur and undertake the initiation and development of a business. Entrepreneurship signifies the practical application of enterprise qualities, such as initiation, creativity, innovation and risk taking into work environment. An entrepreneur with an aim to modernize agriculture focuses on mechanization of small farms, enhancing input use efficiency, improvement in water productivity, enhancing energy use efficiency and reducing energy intensity, reducing post-harvest losses and ensuring nutritional security and appropriate strategy for technology dissemination resulting into economic development.

Combination Tillage Implement - An Efficient Equipment for Seed bed Preparation

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Intoduction

The biggest challenge before the agriculture sector of India is to meet the growing demands of food for its increasing population (expected to be 1.6 billion by the year 2050). Since the cultivated area has remained nearly constant (within 119 to 142 Mha) over the years, the only option is to increase the productivity of land. This can be achieved by increasing cropping intensity and reducing turn around time through increased mechanization. However, the mechanization level in India is quite low i.e. 2.02 kW/ha.Though mechanisation involves all forms of power sources but due to shortage of human labour, non-availability of animal power and uncertainty in supply of electrical power, the two most common power sources for carrying out farming operations are tractors and power tillers which use fossil fuel. For farmers, the cost of fuel represents a major direct expense. With respect to environmental aspects, the use of fossil fuels has a direct impact on emissions of greenhouse gases.

Approximately 20% of the energy for crop production is used for field preparation, with a majority of this energy applied in tillage operations.The primary reasons for tilling soil are incorporation of straw residues, weed control and soil loosening. The energy use for tillage in crop production is of concern to farmers and environmentalists. High energy use in carrying out tillage operations is usually associated with high machinery costs and labour inputs. Reduced tillage may therefore be favourable with respect to climate change. On the other hand, if agriculture is to serve as a producer of energy, it is important that the energy gain (output input) in crop production be kept as high as possible.

In conventional tillage practices, most of the indian farmers utilize the available tillage implements with any ranges of tractor power consequently there is improper matching of tractor and implement combinations resulting in underloading of tractor engine and hence, poor efficiency. Moreover, the conventional tillage practices are becoming increasingly expensive interms of time, fuel and equipments costs. They are also causing more soil damage and compaction to the soil due to more number of passes of heavy machinery during seed bed preparationleading to reduction in crop yield. Further, the time required by the conventional tillage practices has either limited the area of crop sown or produced a high machinery and labour requirements for short working periods, which is uneconomical.

Succesful mechanisation depends on carrying out farming operations with high energy efficient farm implements/machines requiring lesser power, time and fuel consumption. Attempts are to be made to reduce fuel consumption, time for field

preparation, compaction of soil and to better utilize the power available from the power sources. With the increase in use of tractors and power tillers in farm, energy saving tillage implements for these power sources are very much required to be developed.

In the light of the above, an attempt was made to develop a combination tillage implement for two wheel drive (2WD) tractor and its performance was evaluated at Research Farm of Agricultural & Food Engineering Department, Indian Institute of Technology, Kharagpur.

Combination tillage implement

The difficulties encountered by following conventional tillage practices as discussed in previous section can be overcome by either increasing speed of operation and width of cut of tillage implements or reducing the number of passes required for tillage operationsto prepare the seedbed without sacrificing the quality of work. As the land sizes inIndia are small, the scope for increasing the speed or width of existing implements is less feasible. Hence, reducing the number of passes by combining two or more field operations may provide better solution.

To combine two or more farming operations to be performed simultaneously by the same power source is called combination implement. Such implements will help in reducing energy required for raising crops.Several combination tillage implements comprising of rotary and passive elements were developed in America and Europe and were found to be more energy efficient than a similar single passive tillage implement when tested in actual field conditions. The combination of tillage implements could be between active and passive tillage implements or between passive and passive tillage implements. A few researchers have also conducted studies on the performance of semi-mounted and trailed type passive and passive combination tillage implements. It was reported that the use of combination tillage implements in land preparation outperformed the conventional land preparing practices in fuel consumption, time requirement and cost of operation and improved the power utilisation of the existing tractor in the field.RahemanandRoul(2013) developed a passive-passive combination tillage implement and it saved fuel consumption and time to the tune of 14-47% and 30-59%, respectively as compared to the individual passive tillage implements for field preparation.

Most of the conventional tillage implements are operated by the drawbar power which is the least efficient among all the power outlets of tractor or power tiller. Most of the implements used for carrying out tillage are passive in nature. A draft force is applied to the tillage implement, which causes the implement to move through the soil. The power required is developed by the tractor engine and is then transmitted through the soil-tyre interface and the tractor drawbar. Because of the poor efficiency of power transmission at the soil-tyre interface, tillage energy efficiencies are low. Also, considerable weight is applied on the tractors to develop required drawbar power by improving traction, which may cause detrimental soil compaction and increased power is required to overcome the wheel slip and rolling resistance of the tractor

tyres.This problem can be overcome by utilising the PTO operated implements i.e. active tillage implements for tractors and rotary tiller for power tillers. Tillage tools which utilize active elements transmit power directly to the soil rather than being drawn through the soil. These machines generally till a greater volume of soil than is required in most field crop systems and therefore, require considerable power per unit width. Purely active tillage machines return power to the tractor's drawbar by pushing the tractor. This may result in an overload of the PTO drive line and a reverse torque on the drive axle transmission. Additionally, because of the geometry of the line of action of the forward thrust (negative draft), weight transfer takes place from the rear to the front axle. This increases the rolling resistance requirement of the tractors.

A way to control this detrimental forward thrust is to combine active and passive elements, such that the rotary-powered elements produce a forward thrust counter acting the draft requirements of the passive elements. The potential benefits of combining active and passive tillage elements are: (a) power for tilling the soil can be transmitted to the tillage elements through a mechanical power train more efficiently than through the soil-tyre interface, (b) the negative draft of the active elements can be used to provide some or all of the draft of the passive elements, (c) reduced draft of tillage implements will result in less wheel slip, thus it will help in improving field productivity, (d) reduced draft of tillage implements will allow use of lighter tractors thus will reduce soil compaction and possibly it will reduce tractor cost, and (e) reduced draft of tillage machines will allow operations to be performed in more difficult traction conditions that currently require the use of extra ballast, dual tyres or assistance from the front wheels.The negative draft produced by these active tillage implements requires proper utilisation to further improve the productivity of these implements.

A few studies on development and performance evaluation of 2WD tractor drawn active passive combination tillage implements have also been conducted in India and it was reported that there was saving in fuel consumption, time for field preparation and cost of operation in the range 44-68%, 50-55% and 44-55%, respectively as compared to conventional tillage practices. Information on draft requirements and power ranges of tractor suitable for operating such combination implements are highly essential to design a suitable combination of different tillage implements for land preparation or combination of tilling and seeding equipment.

For successful design of combination tillage implements, power utilization by the conventional tillage implements is very much required. Sahu and Raheman (2008) carried out simulation studies for finding out the tractor power utilization as well as front wheel utilization factor of tractors (20 to 31 kW PTO power) for carrying out tillage operations with moldboard plow and cultivator and the results are given in Tables 1 and 2, respectively. From Table 1, it can be seen that the power utilization of all the tractors (27 and 31 kW) considered are found to be less than 84% of the tractor PTO power available including a power reserve of 20% while carrying out tillage operations at 5 km/h with moldboard plow. Hence, the tractors are underloaded. At 6 km/h, the 27 kW tractor is overloaded (power utilization is more than 100%), while 31

kW tractor is properly loaded(power utilization is around 100%). The tractors in India are usually operated around 5 km/h with two-bottom moldboard plow. Hence, to improve the power utilizationof tractors with high power range (27 kW and above), additional attachments could be provided to reduce the number of passes of conventional tillage implements.

The tractors with 20 and 27 kW PTO power are properly loaded with 9 tyne cultivator when operated at 5 and 6 km/h, respectively. However, 31 kW tractor was found to be underloaded even at 6 km/h speed of operation. The tractors in India are usually operated at 6 km/h with 9 tyne cultivator. Hence, the scope for attaching additional implements exists with tractors of higher power range (31 kW and above) while carrying out tillage operations with 9-tyne cultivator.

Development of combination tillage implement for 2WD tractor

Based on the output of the simulation study, Raheman and Roul (2013) developed a combination tillage implement (cultivator with single acting-disc harrow, C-DH) for a 31 kW tractor and is given in Fig. 1. The front passive set was selected from the tillage implements commonly used in carrying out tillage operations and available in the market. Only the rear passive set i.e. single-acting disk harrow with supporting frames were designed. The rear passive set was attached to the front passive set by means of bush bearing to act as an independent unit in terms of depth of penetration, assuming that the weight of the rear passive set was sufficient to achieve the optimum depth of penetration. The overall dimensions of the developed implement are 2.1 m × 1.4 m × 1.1 m with a total weight of 4 kN.

Field testing of developed combination tillage implement

Field testing of combination as well as individual (cultivator and disk harrow) tillage implements was carried in plots of size 50×25 m with sandy clay loam soil.

Each implement was tested with three replications using a 31 kW, 2WD tractor. Before starting the experiments, data on bulk density, moisture content and cone index were collected and their average values were given in Table 3. The performance of tractor-implement combination was evaluated on the basis of tractive and tillage performance parameters. The tractive performance parameters included measurement of draft and slip values whereas the tillage performance parameters included measurement of volume of soil handled per unit time (V_S), mean weight diameter of soil aggregates (MWD), soil inversion (Si), actual field capacity, field efficiency and fuel consumption. Measurement of tillage and tractive performance parameters were carried out following the guidelines of BIS standards (BIS: 6288-1971 and 7640 - 1975) and are summarized in Tables 3 and 4, respectively. The overall performance of tillage implements tested was expressed in terms of tillage performance index (TPI). TPI is computed as given below:

$$TPI \ \alpha \ \frac{V_s \times S_i}{MWD \times F_e} \quad (1)$$

$$TPI \ = K \frac{V_s \times S_i}{MWD \times F_e} \quad (2)$$

Where K is proportionality constant

While comparing the tillage performance of different tillage implements in same soil condition K could be absorbed in the equation.

Results and Discussion

The draft and slip values for cultivator, offset disk harrow and cultivator disk harrow (C-DH) combination are within the range of 1.18 to 5.4 kN; 1.87 to 6.08 kN; 1.57 to 6.6 kN and 3.2 to 7.7%; 3.6 to 10% and 3.6 to 9.1%, respectively for the test range of soil conditions (cone index 665-1415 kPa at an average soil moisture content of 10%), depths (5-10.5 cm) and speeds of operation (2.8-5.7 km/h).

The tillage performance data obtained from the field testing of implements are summarized in Table 4. The mean weight diameter of soil aggregates, soil inversion and volume of soil handled for the developed combination tillage implement as compared to the conventional cultivator were 15.77%lower, 23.82% higherand 3.63% higher, respectively. From this Table, it can be seen that the TPI varied from 8.64 to 12.05 for the tillage implements tested. The highest TPI was found for C-DH tillage implement, while the lowest was found for cultivator. This could be due to higher inversion and more volume of soil handled by C-DH as compared to cultivator.

Conclusions

- The developed combination tillage implement could be operated with 31 kW, 2WD tractor in sandy clay loam soil at average m.c.of 12.0%, normal depth and speed within the slip range of 15%.
- In sandy clay loam soil, the tillage practices involving combination tillage implement outperformed the tillage practices involving respective individual tillage implements in fuel consumption and for getting better tilth.
- The overall performance of different tillage implements could be expressed in terms of tillage performance index (TPI) taking into account the MWD of soil aggregates, soil inversion, volume of soil handled per unit time and fuel consumption. The TPI of combination tillage implements was found to be higher than the TPI of respective individual tillage implements.

A similar combination of different tillage implements or tillage and sowing equipment could be tried to better utilize the power source and also to get higher efficiency leading to effective mechanization.

Mahua: Lifeline of Tribal Odisha

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Introduction

Odisha is one of the poorest states in India, with an estimated 47% of its population living on less than Rs.100/- per day (Haans and Dubey, 2003). A regional and social group wise analysis of poverty in Odisha highlights the fact that the population in Scheduled Areas is comparatively much poorer than the population in non-Scheduled Areas, and that Scheduled Tribes are the poorest groups.

According to Census 2011, the total population of Odisha is 41,947,358, out of which the Scheduled Tribe (ST) population is 8,145,081. This constitutes 22.1 per cent of the total population of the State and 9.7 per cent of the total tribal population of the country. Various studies reveal that more than 1/4th of the total population of the state critically depends on forests and forest products for their subsistence and livelihood. Amongst the resource dependents, dependency of tribal community on Non Timber Forest Products (NTFPs) is extremely high. Forest produces have been supporting this population for 6-8 months in a year, both in terms of subsistence and cash benefit. More particularly, the dependency of tribal population on NTFPs is very high owing to their status of landless and marginal landholders. Amongst these NTFPs, mahua (*Madhuka indica*) is the principal commodity in the state of Odisha.

From several studies, it is revealed that, during one mahua season, which generally spreads over 3 to 4 weeks for flower collection and another 3 to 4 weeks for seed collection, on an average one family manages to collect 5-7 quintals of flower and seed and makes earnings of around Rs.5000 to 7000, which is almost 25 to 30% of their total annual income. This shows the critical role of mahua flower in addressing the issue of food security of Lakhs of poor families in the state during the lean period. Generally, mahua is overlooked for its great nutritive value. It has numerous uses besides being used in preparation of liquor. However, mahua is not intoxicant in itself as its direct consumption does not have any intoxicating effect. It becomes liquor only when it is fermented and other addition being made as in the case of some other food/fruits like rice, grapes, jackfruit, sugarcane, banana, mango etc. In this context, it must be noted that the above items are not intoxicating in its original form. More importantly, mahua flower has several other important uses. The sweet, fleshy corollas are a rich source of sugars, vitamins, calcium and essential oil and it is eaten raw or cooked/baked in the form of cakes. In fact it serves as a staple food for the tribal in periods of cereal scarcity. It is a good fodder, which is relished by cattle and is also used by cattle feed industries in large quantities. Big cattle-feed industry requires around 300 quintals of mahua per month. Besides, it also has medicinal values. They are regarded as cooling, tonic and demulcent. Outer fruit coat is eaten as a vegetable and the fleshy cotyledons are dried and ground into a meal. The mahua fruit contains 51% valuable oil known as mahua oil or butter of commerce that is used for cooking, illumination, soap and candle making. It has been noticed that traditional forest dwellers (particularly the young and educated generation) are gradually showing

disinterest in NTFP collection. This is most likely because the way the modern educational system trains the society, NTFP collection or wild collection seems to be rather a retrograde occupation, and this perception gets critical when various government-sponsored income generation schemes appear to be more securing and remunerative than the forest collection. However, NTFP collection has in itself the potential to provide a more sustainable occupation than the government schemes.

Existing Processing Chain of Mahua Flower & Intervention Required

Looking to the above facts the **AICRP on Post Harvest Engineering and Technology** project of OUAT has worked on the issue and found out some missing links and prescribed remedies thereof in the value chain of mahua as described below.

Sl. No.	Unit operations	Traditional / Local practices	Problems	Missing link/Interventions Required
1	Collection of mahua flower	Manual collection	Drudgery, Higher loss, Irregular collection, More labour requirement for watching & collection Contamination with soil & impurities – unfit for human consumption	Development of a mahua flower collection system
2	Drying of mahua flower	Sun drying on mud/cow dung plastered floor or public CC road	Longer drying time, Insect-pest attack	Optimization of drying methods, Low cost on farm dryer
3	Removal of stamen	Beating with wooden plank	Drudgery, Lower capacity, low efficiency	Development of manual/power operated stamen remover
4	Preparation of value added products	Only a few traditional products are prepared from mahua flower	Underutilization Unscientific processing	Value added products like candied flower, glazed flower, bar, cupcake, *laddu* RTS, jam, squash, etc. (These items have already been developed by the centre and few demonstration programmes have been conducted)
5	Storage	Bamboo basket, jute bags, jars	No scientific information is available Shorter shelf life More contamination	Standardization of storage condition for shelf life enhancement
6	Decortications of seed	Beating with stone/small hard object, Manual decortications over CC road	Drudgery, Low capacity, Low efficiency, More contamination	Manual and power operated mahua seed decorticator (already developed by centre and commercialized)
7	Oil extraction and refining	Local ghani or hand operated press	Poor quality, poor consumer acceptance	Study of filtration/ refining for edible purpose
8	By-products utilisation	Cattle feed	No scientific information available	Scientific utilisation of by-products like; stamen and deoiled cake
9	Demonstration of developed equipment and value added products	-	Lack of awareness	Demonstration of developed equipments and value added products
10	Entrepreneurship development		Lack of awareness, training, knowhow	Sensitization programme Entrepreneurship development, Branding & market linkage

After few years of research, it has come up with complete value chain of mahua, by developing protocols for improved post harvest practices of mahua flower and seed as well as developed some value added non alcoholic food products with different modern techniques.

Preparation Methods of Value added Products

(a) Ready-to-serve(RTS) beverage

Different value added products like RTS, Squash, and Jam, Dried and cleaned mahua flower can be prepared from mahua flower. The flowers after removing the adhered stigma were properly cleaned and thoroughly washed in tap water. After washing, were cooked in water for 10 minutes, pulped and strained to separate the solid and liquid part. The clarified mahua juice obtained was mixed with sugar syrup and citric acid. All these ingredients were properly mixed in hot condition. The scum and water vapour were separated from the syrup mixture and KMS was added to it. The mixture was boiled for some times, filled into previously sterilized glass bottles of 200 ml capacity and sealed. After sealing, the bottles were sterilized again in boiling water, labeled and stored.

(b) Squash

Dried Mahua flowers are mixed with water in 1:1 ratio (mass:volume) and cooked for 10 minutes. The cooked material is strained with a net cloth. The clarified mahua juice obtained is 800 ml per 1 kg of dried mahua flower. Sugar syrup is prepared with 0.8 kg sugar, 800 ml water and 4 g citric acid. It is mixed in hot condition. The scum which accounts to 10 g are separated from the syrup mixture. The prepared sugar syrup is mixed with the cooked clarified juice along with 2.5 g of KMS. The prepared mixture is filled into 750 ml capacity previously cleaned and sterilized bottles.

(c) Jam

Pulp is extracted from dried and cleaned mahua flower as described earlier. Sugar is added to the pulp and the mixture is concentrated using a low heat flame with continuous stirring. Recommended amount of citric acid is added. Before obtaining the end point, pectin is added to get the desired texture of jam. The end point is carefully decided. The product is packed and stored in wide mouth glass bottles. The ingredients and process parameters are standardized based on sensory acceptance.

(d) Candy

Cleaned and dried mahua flowers are thoroughly washed and blanched in 0.25% citric acid. It is steeped in 40% sugar solution for a day. Next day the concentration of the solution is increased to 60% by boiling the solution and the flower is again steeped in the same solution for a day. This process is repeated raising the strength of the solution by 5% per day up to 75%. Finally the flowers are dried under shade and packed in airtight polythene pouches for marketing.

(e) Bar

Dried and cleaned mahua flowers are thoroughly washed in tap water and cooked for 10 minutes. Pulp is prepared by grinding the cooked flower with little water. Sugar is added at the rate of 50% of the pulp and it is again cooked for few minutes so that the sugar is completely dissolved with the pulp. 3% citric acid and 5% pectin is mixed with the pulp when hot. Cooking is continued up to jelly consistency and then the material is spread on aluminum tray around 10 to 15 mm thickness and dried in a tray dryer at 60^0C.

(f) Cake

Dried and cleaned mahua flowers are thoroughly washed in tap water and soaked for 10 minutes. Then it is steamed in a pressure cooker for 10 minutes and pulp is prepared by grinding the cooked flower with little water. It is blended to a paste with refined wheat flour, baking powder, powdered sugar and refined oil or ghee. The paste is half filled with paper cups and kept in a preheated oven of 180-200^{0}C for 15 to 20 minutes.

Scope for Entrepreneurship

Value added products from mahua flower have been displayed in different exhibitions, like State Level Agriculture Fair, Adivasi Mela, MSME, ORMAS, in different KVKs, and on the occasion of Foundation Day of OUAT etc. The response has been encouraging and the need of the hour is to establish small scale enterprise on value addition of mahua for creating employment for tribal and rural youths. A cottage scale industry on mahua products like, RTS, squash, jam, bar, cup cake, could be initiated with an investment of around Rs.1.00-2.00 lakh for the machinery and a profit of 25-30% could be earned.

Conclusion

Traditionally, the mahua flowers collected are dried under the Sun up to 18-20% moisture content and sold to the middlemen at a throw away price of Rs. 10-12 / kg, which is mainly used for distillation of country liquor. Traditional products like roasted mahua flower, mahua *pitha* mixed with rice flour, mahua laddu, etc are prepared by tribal people. Value added products like candied flower, glazed flower, bar, ready to serve beverages, cup cakes, squash, jam etc. can be prepared form mahua flower and oil extracted from mahua seed can be marketed. These products are well appreciated by the consumers and can generate income and employment opportunity for poor tribes of the state.

Prospects of Small Farm Mechanization Boosting Tribal Agriculture

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Introduction

The agricultural production and productivity of the state of Odisha has been stimulated considerably with the growth of farm mechanization during the last decade even though the national level is far ahead. However, the agrarian scenario in different agro-climatic zones depicts hugely variable situations with respect to cropping system, farm labour availability and obviously the level of mechanization. Of late, the use of tractors, power tillers and high end machineries like transplanters, combines etc has increased many folds. The launching of various Government sponsored programmes and their implementation of course hold the key to the socio-economic development of the state. Since there has been sharp increase in shifting of agricultural labour force to the non-agricultural sector, the labour cost has increased abnormally and availability of farm labour during peak hours has been the serious concern. Incidentally, the small and marginal holdings constitute 83.82 % of total holdings possessing 53.11 % of cultivable land. The problem of fragmentation of land holdings will further aggravate with increase in population which needs serious attention for overall agricultural development. Thus, the use of human and animal power for different agricultural field operations will also continue to dominate in the agrarian sector of the state to take care of small holdings.

Incidentally, as per 2001 Census, the Scheduled Tribe (ST) population of the State of Orissa constitutes 22.1 percent of the total population of the State and 9.7 per cent of the total tribal population of the country. The Scheduled Tribe population in the State is overwhelmingly rural, with 94.5 per cent residing in villages and involving themselves mostly in agriculture and wage activities. Tribal farmers are characterized by small and fragmented land holdings, low productivity of crops and livestock, disguised unemployment, poor income and low risk bearing ability. Thus the agrarian scenario of the state which is largely dominated by small and marginal holdings almost reflects in similar fashion with the agricultural status of the tribal people.

Status of Mechanisation in Tribal Area

In Odisha, most of the tribal farmers continue to use indigenous tools and implements as it is considered to be cheaper, economical and easily available in the local market. Furthermore, the agro-climatic situation of lands belonging to tribal people in the state is just tough, mostly lying in hilly areas, undulated patches or under-developed corners of the state without much of irrigation facility. In some cases, lack of adequate communication facility coupled with low level of education further add to the problem of the tribal people who are commonly unaware of much of the advanced techniques.

Traditional farm tools and implements for self-subsistence have been developed and modified through experience over generations to meet emerging socio-economic and

farming challenges. Almost all farming communities have common traditional agricultural implements like Sickle, Plough, Spade, Winnower, Khurpa, Bamboo sieve, Weeder and Axe etc. These tools and implements were economical in terms of labour, money and time saving. Also, they are operated easily without any special skills. Each of these tools and implements are usually used in connection with specific operation in the sequence of agricultural operations; land preparation, sowing, weeding, irrigation, harvesting, post-harvest operations and transportation. Under such a typical scenario of farm mechanization in tribal areas of the state, it may be more appropriate to suggest technologies, in a rather selective manner without jeopardising their existing set-up which certainly has the essence of organic agriculture and conservation agriculture. The tribal people mostly use manually or animal operated tools; which are considered to be extremely slow moving system; but efficient in their terms. There exists huge scope for improvement over the conventional methods which are location specific, crop specific and in some cases carry socio-religious tags. Considering the need based problems of these tribal people, many research initiatives have been undertaken through government and non-government organizations. Gradually, the attitude of tribal people is changing as they realise the benefits of new technologies which of course solve their age-old problems to certain extent.

Benefits of Animal Energy

Apart from their personal labour in various agricultural operations, the tribal farmers mostly depend on animal energy and with available bullock drawn implements they manage to accomplish the different field operations like primary tillage, secondary tillage, weeding, ridging etc. Nevertheless the animal energy seems to be the only feasible source of energy for agricultural work in hilly areas which has further advantages like low investment, non-requirement of skilled labourers, crop waste and by-product utilization. The animal energy system facilitates organic farming and avoids soil compaction which is just essential for conservation agriculture. Now-a days, the animal energy is considered as renewable source of energy and also regarded sustainable farm power sources. From socio-religious point of view,

the attachment of tribal people to cattle in general has been phenomenal for which this age old practice still prevails in many parts of the state, country as well. The modern equipments developed over the years such as tractors, transplanters, combines, etc are yet to be adopted by the tribal farmers for the above reasons apart from higher initial cost and smaller size lands. The scientists working under All India Coordinated Research Project on Utilization of Animal Energy, OUAT through sincere and dedicated research are trying out with many new animal drawn implements to improve the efficiency of this system.

Usually, the tribal small farmers and farm owners of scattered lands are unable to use tractors and in that case bullock drawn ploughs are highly preferred. The basic components of the plough are a shoe, a body, a handle and a beam. This implement can be used with a pair of bullock or he-buffaloes to till fields before planting. It has a

single bottom *desi* plough and the average depth of ploughing is 8-10 cm. It has a provision for adjustment of the hitching point which can be adjusted according to height of oxen and the working depth. Tillage depth can be adjusted by applying manual force on the handle. Generally, a triangular furrow is made during tilling by this deshi plough; thus some portion of the land below the top surface remain unploughed resulting in ineffective tillage and poor yield. The bullock drawn mould board ploughs developed through All India Coordinated Research Project on Utilization of Animal Energy are found quite useful because of the trapezoidal furrow, which results in uniform and higher depth of cut leaving no un-cut land below surface. The bullock drawn disc harrow is very effective for secondary tillage operation under dry land situation and facilitates the use of seed-cum-fertilizer drills.

The conventional method of manual broadcasting small seeds after two passes of ploughing often reduces yield due to improper plant stand and the manual weeding cost increases cost of operation. Later through intercultural operation such as beusaning in case of paddy or manual thinning of mustard plants is done to control the plant population. Manual hill dropping of bold seeds such as groundnut, maize etc in furrow, behind the bullock drawn deshi plough is a common practice where huge labour, time and cost is involved. The bullock drawn single row seed-cum-fertilizer drill, being attached to a narrow wooden deshi plough ensures proper seed and fertilizer rate with less labour, time and cost. While the plough is used to open the furrow, the metering mechanism gets the drive from a drive wheel attached to the seed and fertilizer box. The inclined plate in the metering mechanism is changed according to the type and size of seeds.

The three row bullock drawn seed-cum-fertilizer drill, developed from Central Institute of Agricultural Engineering, Bhopal with inclined plate metering mechanism has been more effective. Performance of the bullock drawn five row multi crop seed-cum-fertilizer drill with roller and cup type metering mechanism has been found satisfactory in different agro climatic zones of the state through the AICRP on UAE. The use of these seed-cum-fertilizer drills reduces the cost of operation, labour requirement, seed and fertilizer requirement and of course drudgery of working besides facilitating the use of mechanical weeders.

Improved Manual/Animal Drawn Machinery

In conventional wet land paddy cultivation, the field is ploughed twice by deshi plough, allowed to decompose under saturated condition. After one week, the field is ploughed twice or thrice, called puddling to facilitate manual transplanting. Performance of the bullock drawn puddler, developed through the AICRP on UAE has been found effective in tribal districts of the state which reduces the labour, time and cost to almost one third. The bullock drawn puddler or Rotary blade puddler has been developed which basically got an iron frame with a seat on it for the operator, an axle with the puddling elements being mounted on the frame with two bearings and a beam for hitching arrangement. The rectangular blades or the puddling elements are mounted on mild steel rings which are fitted to the axle and the blades are placed at

angle of 15^0- 45^0. The operator controls the movement of the puddler, riding on a seat provided with this puddler, therefore, reducing the drudgery of walking in mud as it happens in conventional method.

The paddy transplanting operation under wet land condition is a labour consuming activity and involves huge drudgery. Self propelled mechanical transplanters both riding type and walk behind type have been made available and mat type seedlings are used in these machines. The raising of these mat type seedling and field preparation for use of transplanters need certain expertise for which this technology is not picking up in tribal areas of the state. After puddling and levelling operation, sometimes farmers go for broadcasting of pre-germinated paddy seeds. Of late, a manually operated eight row drum seeder has been developed, where the operator pulls it to cover eight rows with row to row spacing of 20 cm. Under this situation, the field is left with some patches of minor depressions with water logged condition due to improper levelling and some patches of major depressions created due to foot marks of the operator who pulls the drum seeder; thus some seeds get buried resulting in improper plant population. For this purpose bullock drawn drum seeders have been developed which makes raised beds over which the pre-germinated paddy seeds are allowed to fall. The capacity of these drum seeders are around 0.2 ha/h. Under controlled conditions this method can reduce huge labour, time and cost as compared to transplanting.

Harvesting and threshing operations are crucial for farmers to finally get the return for their effort throughout the season. Traditionally, farmers use local sickles of different shape and size for harvesting paddy crop. The improved sickle available in the market has got a bend from the grip of the sickle which helps to protect the hand from injury. Furthermore these improved sickles have got self sharpening edge; thus the farmers need not require making edge before every season. For threshing paddy crop, the tribal farmers go for manual hand beating on a stone or bamboo/ wooden bench. The bullock treading is also in practice in many areas of the state. The pedal and power operated hold-on type paddy threshers are available in the market where harvested and dried paddy bundles are held on to the moving threshing cylinder, having wire-loop elements, mounted on the slats of the cylinder. The output of these threshers is higher and threshing can be taken up indoors in case of unfavourable weather conditions. Thus, the time, labour and cost involved in threshing are reduced. Research work under AICRP on UAE is going on use of animal energy in rotary mode for operating post harvest gadgets during the period when animals are otherwise free i.e. after transplanting till harvesting of paddy. The bullock operated rotary system can be established on community basis in a village to carry out different operations such as threshing & winnowing of paddy, threshing and decortications of groundnut etc. This system can be utilized to lift water and even generate electricity for lighting during evening hours in the remote parts of the state where un-interrupted electric supply is a nightmare. Research on utilizing this bullock operated rotary system for many post harvest operations of various crops are under way to utilize the bullock power. The farmers having bullocks are facing an uphill task to maintain the bullocks as the annual use is hardly within 100 hours. With development of the bullock drawn implements as

well as the bullock operated rotary system; the annual use of the bullocks may touch 300 hours annually which will make the bullock farming system cost effective. The issues of conservation agriculture, organic production and self sufficiency can thus be resolved as the tribal farmers will continue to utilize the animal energy to the maximum possibility.

Conclusion

The technologies suitable for tribal farmers, residing in hilly areas with small pieces of lands need to be demonstrated in the tribal dominated districts with more number of capacity building programmes to create further awareness. Thus, the agricultural development of the tribal people can happen and thereby the overall agrarian sector of the state can see a positive change. The animal energy of late has been referred as "clean energy" or "green energy" which is categorized further as renewable source of energy. Even with the advancement of agriculture with regard to mechanization, there remains huge scope for small farm mechanization in accordance with proper utilization of animal energy.

Stabilized Mud Block Technology- An Eco-friendly Alternative to Bricks for Low Cost Housing

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Introduction

Stabilized mud block technology is a special technology of making walls with bricks. These bricks are different from the conventional red bricks that are made by burning clay. These are made by compressing a combination of earthen materials with added stabilizers. Stabilized mud block (SMB) is an eco-friendly, cost effective, energy efficient and low carbon emission alternative for wall construction. Manufacture of clay bricks is perhaps the oldest industry in the history of mankind. It is reported that hand moulded, sundried mud bricks were made and used during the pre-pottery Neolithic Period as far back as 10,000 B.C. Use of mould box shaped, sundried and fired bricks started only around 3000 B.C.

The long lasting and excellent thermal insulating property of the brick has earned it an enviable and indispensable position among today's building materials. Like cement, i.e. ordinary Portland cement no alternative material has yet been able to threaten burnt clay bricks seriously as technical as well as commercial grounds.

Conventional building technologies like burnt bricks, steel and cement are high in cost, utilize large amount of non-renewable natural resources like energy, minerals, top soil, forest cover etc. Cement, steel and bricks are conventional energy intensive building materials. Around 1.5 billion bricks are produced annually by small & medium size processing units consuming annually about 3 million cubic meters of top soil. Most of it fertile soil. The burning of bricks in the vicinity of fields damages plant life and digging of soil for brick making causes collection of water in pools creating unhygienic conditions and erosion of good agricultural soil. The thermal efficiency of kilns leads to environmental pollution.

Cost effective, labor intensive and energy efficient traditional building materials and techniques like mud wall, thatch roofs etc. are available but these require frequent repairs. Use of conventional materials to satisfy the demand for new buildings can drain the available energy resources and cause environmental degradation/pollution. Also, energy intensive building materials are expensive. Building materials amount for 70-75% of the total cost of construction. Due to large scale construction programs in the country the demand for conventional building materials like cement, steel, bricks and timber has outstripped their supply. The exponential population growth and the existing housing shortage have made the situation even more alarming. It is thus quite evident that present available stock of building materials in the country is not in a position to meet the overgrowing demand of housing. These materials are scarce but the rising demand is leading to depletion of the resources. This clearly indicates the need for energy efficient environmental friendly, economical alternative building materials and technology. Fortunately, new building materials have been developed

by the institutes and bodies involved in building materials research and development. Some of the institutes are laboratories of Council of Scientific and Industrial Research (CSIR), Central Building Research Institute Centre (CBRI), Roorkee, Structural Engineer's Research Centre (SERC), Chennai, ASTRA, Bangalore, COSFORD, Thrissur, Kerala, and other state level institutes in India.

Stabilized Mud Block Technology

Stabilized Mud Block Technology is a simple, cost effective, environmental friendly technology developed by Centre for Science and Technology, Indian Institute of Science, Bangalore. It utilizes local materials and reduced energy consumption and thus reduces the cost.

Advantages

- Energy efficient-70% savings when compared to burnt bricks
- Economical (20-40%), when compared to brick masonry). The net financial advantage in terms of labour per block is Rs.1.50, whereas in conventional methods is 30-40p
- Plastering of walls can be eliminated
- Highly decentralized production
- Better block finish
- Aesthetically pleasing
- Lower amount of mortar required for wall construction

Production of Stabilized Mud Blocks

- The process of production involves
- Sieving the soil
- Mixing the soil with sand and stabilizer such as cement and lime
- Mixing of optimum quantity of water
- Pressing the wet mixture into a dense solid block using a simple manually operated machine
- Curing the block for a period of 3-4 weeks by sprinkling moisture

Soils containing predominantly non expansive clay minerals are suited for cement stabilized blocks. Most of the red loamy soils are suitable with minor modifications. Expansive soil such as black cotton soil requires addition of lime and the process of making SMB is cumbersome using black cotton soil. Highly silt soils also pose problems of green strength and compaction. Soil with 10-15% clay and more than

65% sand is ideal for SMB production using cement as a stabilizer. If some soils contain more clay fraction, then it is advisable to bring down the clay fraction by addition of sand or inert materials like stone quarry dust.

Compacted natural soil can have good insulation and fire resistant properties. Walls constructed out of well compacted soil, have adequate compressive strength under dry conditions, however they will loose their strength under adverse moisture content. Soil properties can also be improved by

i) Choosing the distribution of grain size, gradation control

ii) Compacting the soil

iii) Adding stabilizers or chemicals

iv) Mixing all of the above

Soils can be improved and used as a building material for various types of structures by adding stabilizers, the result is stabilized soil. Commonly used stabilizers are i) cement, ii) lime, iii) combination of lime and cement, iv) asphalt etc.

Types of Pressing Machines

The Stabilized Mud Blocks production machines are available in mechanized as well as manually operated form. The machine weighs 170-200 kg depending upon the different moulds. Manually operated machines are ideal in rural areas for decentralized production. Madini soil block press is one such manually operated machine. A team of 6-7 persons can produce 200-500 numbers of blocks per day from a single machine depending upon their professional efficiency. Two tons of soil and sand along with 275 kg of cement is required for the production of 500 blocks. The cost of the machine is Rs. 45, 000/- approximately. One simple machine can generate employment for 6-7 persons.

Block sizes and strength

Two block sizes (305x143x100mm and 230x190x100 mm) have been standardized. These two sizes can be used to construct walls of thickness 305mm, 230mm, 190mm, 143mm or 100mm. These blocks are 2.5 to 2.8times bigger in volume when compared with conventional bricks.

Compressive strength of the block greatly depends upon the soil composition, density of the block and percentage of stabilizer (cement/lime). Sandy soils with 7% cement can yield blocks having wet compressive strength of 3-4 MPa.

Cost of Stabilized Mud Blocks

The cost of SMB depends on a number of factors such as

- Machine Depreciation Cost
- Cost of soil and sand
- Cost of cement
- Labor cost

230x190x100 mm (2.5 to 2.8 times brick volume) will be in the range of Rs.3 to Rs.7 depending upon the above factors. Cost can be drastically reduced by the use of local materials and self help labor. Cost of the mud block is independent of the scale of production.

Seasonality

Production activities can be carried out throughout the year. During rainy season the production activities can be carried out without any difficulties provided that the raw materials are protected from rain and procured before the rainy season.

Other benefits

Stabilized Mud Block technology is a low cost alternative for bricks, which can be used for any type of soil except black cotton soil with cement as stabilizer. If the block is prepared properly, it will not disintegrate in water. Plastering and pointing can be avoided to SMB walls. The blocks are not fired or burnt. These are energy efficient and eco-friendly. The production will be done in a tiny scale, nearer to the construction site, which is ideal for rural buildings. It can be done in a low capital investment. Strong, durable and aesthetically pleasing walls can be prepared using SMB technology.

Conclusion

The rapid increase in population and the consequent increased construction activities are causing significant damage to the environment on account of the removal of fertile top soil for brick manufacture, mining and quarrying activities, unscrupulous extraction of precious sand and silt from the river beds, indiscriminate lumbering and the use of the scarce forest resources. Further the production process for conventional building materials are also energy intensive, besides contributing to global warming due to emission of green house gases. Hence, SMBs can be popularized to replace the bricks as a substitute for construction works. These are characterized by moderate compressive strength (5.5 N/mm^2), low thermal conductivity, high water absorption, high fire resistance and good sound absorption. These are extensively used in low cost building constructions. Fly ash, iron ore tailings and red mud from Aluminum plants can be used for SMB production, thereby eliminating environmental problems associated with disposal of such waste products.

Entrepreneurship as a Driving Force for Rural Development

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Introduction

To ease the immense population pressure on the economy and the high rate of unemployment, engaging and supporting a potential mass of 95m plus youth in entrepreneurial activities may be the only solution. The small and medium enterprises are a good source of low-cost employment creation. Agro-based industry, dairy and livestock and horticulture have great potential to attract the young breed of potential entrepreneurs, if necessary support is provided to start small enterprises in their own regions/areas. This will discourage youth migrating to urban areas in search of jobs. Businesses with potentials in rural areas based on their indigenous resource must be prioritised and supported. During the past few years, those following rural development trends and strategies have probably heard a lot about the need to encourage entrepreneurial activity in rural communities. Many leading researchers in the rural development field have expressed this need, and as policymakers and rural development practitioners strive to develop strategies to sustain rural economies, increasing entrepreneurship has risen to the top of the list. According to researchers, while rural communities need entrepreneurs in order to revitalize their economies, entrepreneurs are dependent on the community for access to capital and other professional services. Entrepreneurs and communities are interdependent; the challenge for both lies in their ability to recognize the other's unique needs. As rural economies change, new strategies for sustaining rural communities, such as encouraging entrepreneurship, must be explored. Entrepreneurship has the potential to boost local economies by tapping local talent and resources and to help keep rural populations from declining even further. Through entrepreneurial growth, rural economies can diversify and become less dependent on the economic pendulum swings affecting agriculture and other rural industries. In short, entrepreneurs can ensure that rural communities will survive.entrepreneurship refers to the creation or expansion of new businesses and industries, often by individuals who perceive a new market niche or opportunity and assume the risk of the venture.

Challenges currently affecting rural areas, which have implications for entrepreneurship

- A culture that does not support entrepreneurship.
- Distance to market and services
- Gap in capital availability
- Threshold of demand to justify location of support services
- Absence of other entrepreneurs
- Absence of industry clusters

Declining employment opportunities in primary industries (mainly agriculture), as a result of structural change, intensified by changes in policy resulting from reviews. This emphasises the need to take steps to stimulate economic activity with employment-generating potential in rural areas. An aging population, associated with an outmigration of young people and an in-migration of retired people, in some cases, which in combination affects the supply of potential entrepreneurs. Difficulties in maintaining a critical mass of facilities to support economic development, including a range of business services is a major drawback of the programme..

New opportunities

Increased demand for rural amenities, Sources of economic success, such as dynamic SME clusters; and Development of diversified agro-industries and rural tourism.In addition, developments in communications technology offer potential opportunities to businesses in peripheral rural areas, in particular, to overcome some of the barrier effects of distance. Other positive attributes include evidence that shows the adaptive capability of some small firms in rural localities to overcome external environmental constraints and opportunities related to products that project traditions of quality and craftsmanship, connectedness with nature and a sense of place and culture.

The heterogeneity of rural environments

In identifying policy issues and challenges facing rural areas, it is important to recognise the heterogeneity of such areas, both internationally and within the same country. Some of this heterogeneity reflects variations in the locational characteristics of rural regions within their national economies (e.g. central or peripheral), while others are related to national and regional differences and the implications for rural development paths. Peripheral rural areas are characterised by remoteness from major markets; depopulation; infrastructural deficiencies; and high dependence on land-based activities. Accessible or more central rural areas, by contrast, typically have higher population densities; closer proximity to markets; less dependency on agriculture; and a more diversified economic base. Policy and challenges facing entrepreneurship development in rural areas and Rural distinctiveness are issues.

Characteristics of the business environment in rural areas

- Small size of local markets
- Rural labour market characteristics
- Availability of business premises
- Transport and communications infrastructure
- Access to information, advice and business services
- Access to finance
- Institutional environment

Characteristics of rural populations

- Entrepreneurial culture and attitudes
- Social capital:interaction between individuals in formal and informal networks &social trust and sometimes a cultural dimension, reflected in higher levels of engagement in voluntary activities by people in rural than in urban areas.

Characteristics of rural enterprises and the economic structure of rural areas

- Farm and land-based initiatives, such as farm diversification schemes, local sustainable development programmes; and the activities of Farm Business Advisers, in seeking to integrate business support for farmers into mainstream programmes;
- Other rural sector initiatives, focusing on non-land based activities, such as a Village Shop Scheme and tourism initiatives;
- General business advice/training programmes targeted at small firms, such as rural outreach for start-ups;
- Initiatives targeted at minority or disadvantaged groups in rural areas, such as the longterm unemployed or women; and,
- Strategic initiatives for rural regeneration, in which enterprise support was part of a wider economic regeneration programme.

Recurrent and interrelated practice features of rural enterprises

An integrated approach, in which enterprise support is, integrated into a wider rural development strategy, such as for inward investment, housing, transport and social issues, emphasising the interdependencies within the rural economy; Partnership, which can help to mobilise scarce resources, avoid duplication and increase the utilisation of the existing rural infrastructure. Contribution to capacity building, which helps to ensure there are long-term benefits from the intervention and increased social capital to act as a future resource for development. A bottom-up approach, involving some initial research on the part of the community, which helps to encourage community ownership and a grounded approach to rural development, with benefits in terms of adding to social capital. A proactive approach to delivery, since experience over a number of years has emphasised the need for outreach activity and peripatetic advisors to deliver business support in rural areas, particularly since many rural enterprises (e.g. farms and micro enterprises) have been outside the target groups of mainstream business support agencies in the recent past. There is a effective co-ordination of sector specific support with generic business support services. Encouraging co-operation and networking between enterprises, which can reduce purchasing costs, involve joint marketing to boost sales and share knowledge; and, „One stop shops?, involving a common entry point through which all initial enquiries for assistance from entrepreneurs are channelled. This reduces fragmentation and facilitates more effective service delivery.

Key recommendations

- Actively promote entrepreneurship as a career option to young people
- Provide support to enable teachers to receive specialist training in entrepreneurship education
- Prioritise the establishment of support programmes in rural areas to facilitate new business startup, that incorporate pre-start up as well as post start-up support
- Take steps to actively promote successful rural entrepreneurs in the various regional media
- Establish a portfolio of enterprise awards for successful entrepreneurs, and aspiring entrepreneurs from rural regions

Constraints in the development of rural enterprise:

a) The issue of transport and accessibility in general, and of remoteness.

b) The low skill base of many rural areas emerged as important.

c) The lack of sufficient funding continues to be perceived as a major constraint.

d) The low enterprise base in many rural areas is seen as a key issue,

e) The absence of facilities and services both for enterprises and for their workforces emerged as important.

Conclusion

The objective of the GOI - to make its large populace a human resource - would be through the enterprise development which would turn the tide in favor of India. DA has been a pioneer in micro-enterprise development programmes and believes firmly in creating many entrepreneurs through training on EDP (Enterprise Development Programme). EDSS (Enterprise Development Support Services) do hand holding for some time and give necessary linkages for their development. From making a business plan to learning to have a strong market linkage are the highlights of these training programs. Micro-credit and micro-enterprise development are some of the training programs to be conducted.

Ozone Applications in Food Industries

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Introduction

Disinfecting agents have widespread applications to assure safety and quality in the food industry. Commonly used disinfectant agents in food industries are chlorine, hydrogen peroxide, sulpher dioxide, chlorine dioxide, hypochlorites, hypochlorous acid etc. Disinfecting agents should be effective in inactivation of common and emerging pathogens, removing toxic contaminants, leading to less loss in product quality, adaptable to food processes and environmental friendly. However, some of these agents, such as chlorine, are inefficient against some organisms, particularly at high pH or against spore-forming microbes. Furthermore, chlorine can react to form trihalomethanes, which are of concern for both human dietary safety and as environmental pollutants. Therefore, the food industry is in search of applications of new disinfecting agents which can target the amount of disinfection of microorganisms, removal of micotoxin as well as environmentally pollution free. Ozone treatment has the potential to meet these criteria and gives encouraging results for some problems of the food industry. Ozonation has been used for years to disinfect water for drinking purposes. An expert panel in 1997 declareds that ozone was a GRAS (generally recognized as safe) substance when used in accordance with good manufacturing practices. It has now been approved for use as a disinfectant or sanitizer in food processing in the US. However, any regulations for usage of ozone in the food industry have not been established in developing countries like India and others.

Ozone (O_3) Basics

Ozone is a strong, naturally-occurring oxidizing agent with a long history of safe use in disinfection of municipal water, process water, bottled drinking water, and swimming pools. More recent applications include treatment of wastewater, dairy and swine effluent, cooling towers, hospital water systems and equipments and others. In clean, potable water, ozone is a highly effective sanitizer at concentrations of 0.5 to 2 ppm. There are numerous application areas of ozone in the food industry such as food surface hygiene, sanitation of food plant equipment, reuse of waste water, treatment and lowering biological oxygen demand (BOD) and chemical oxygen demand (COD) of food plant waste. Treating fruits and vegetables with ozone has been found to increase shelf-life of the products. Notably, when ozone is applied to food, it leaves no residues since it decomposes quickly.

Ozone is almost insoluble in water (0.00003g/100mL at 20°C and effective dispersal is essential for antimicrobial activity. Ozone's disinfectant activity is unaffected at a water pH from 6 to 8.5. Ozone is also highly unstable in water and decomposes to oxygen in a very short time (less than half the activity remains after 20 minutes). In

process water with suspended soil and organic matter, the half-life of ozone activity may be less than one minute. Lower water temperatures extend the half-life of ozone.

In nature, ozone is formed by UV irradiation (185 nm) from the sun and during lightening discharge. Commercially, UV-based generators pass ambient air (20% O_2) across an UV light source, typically less than 210 nm. These systems have a lower cost but also have a more limited output than corona discharge systems. Corona discharge generators pass dry O_2 enriched air across a high electric voltage (>5,000 V) or corona; similar to a spark plug. Excess O_3 not dispersed in water must be captured and destroyed to prevent corrosion and personal injury. One method of destruction is by UV light at a longer wavelength, 254 nm, combined with the use of a catalytic agent. The ozone generator supply line interfaces with the process water supply or return line at a Venturi-type injection disperser unit. Adequate mixing and sensitive process monitoring are essential for uniform treatment with the low concentrations applied to water for postharvest uses.

Effectiveness of Ozone as Disinfectant

Ozone is reported to have 1.5 times the oxidizing potential of chlorine and 3,000 times the potential of hypochlorous acid (HOCl). Contact times for antimicrobial action are typically 4-5 times less than chlorine. Ozone rapidly attacks bacterial cell walls and is more effective against the thick-walled spores of plant pathogens and animal parasites than chlorine, at practical and safe concentrations.

Scope of Ozone Applications in Food Industries

Microbial food pathogens cause an estimated 6.5 to 33 million cases of human illness and up to 9000 deaths each yearjust in the US. Microbial load of raw material, improper handling and storage, use of contaminated wash water, processing equipment, and transportation facilities, as well as cross-contamination from other products contribute to the microbial hazards. Ozone destroys microorganisms by the progressive oxidation of vital cellular components. The bacterial cell surface has been suggested as the primary target of ozonation. Chlorine, the most common used disinfecting agent, selectively destroys certain intracellular enzyme systems, whereas ozone causes widespread oxidation of internal cellular proteins causing rapid cell death.

Numerous studies investigated the inactivation of toxigenic *A. flavus* and *A. parasiticus* by ozone. D-values (the time required to kill 90% of the conidia) of *A. flavus* were 1.72 and 1.54 minutes at pH 5.5 and 7.0, respectively; D-values of *A. parasiticus* were 2.08 and 1.71 minutes, respectively. Several studies reported treatment of fruits and vegetables with ozonated water helped in reducing greater than 90% of total bacterial counts. Exposure of bacteria to ozone at 2.5 ppm for 40 s caused 5 to 6 log decrease in count. Resistance of tested bacteria to ozone followed this descending order: *E. coli* O157:H7, *P. fluorescens, L. mesenteroides*, and *L. monocytogenes.* Treatment of Chinese cabbages with ozonated water (2.3 mg/L) for 60 minutes reduced total baceterial load to less than 90%. The poultry processing industry has been approved the use of ozonation for washing of poultry carcasses

(provided that the ozone did not come into direct contact with the product). Studies reported that a processing combination of screening, diatomaceous earth filtration and ozonation yielded the highest quality of water with total microbial loads (total coliforms, *E. coli* and *salmonella)* reduced by 99%. Ozone at low dosages (0.1 mg/g fruit) for 20 min. reduces the levels of fungi yeasts and bacteria on grapes. This application is important not only for being a microbial inactivation but also for inactivation of fungi capable of producing mycotoxins. Mycotoxins constitute a serious problem for numerous kinds of foods including fruits and vegetables. Besides microbial inactivation, ozonation has also been applied for the purpose of mycotoxin degradation in food products.

Mycotoxins, secondary metabolites of some species of molds in many processed and nonprocessed food and feed, threaten human and animal health. They are mainly produced by the species of *Aspergillus*, *Penicillium* and *Fusarium*. Mycotoxin contamination was the most incident hazard type in food products after analysis of consignments imported to European Union countries. It is estimated that 25% of the world's crop are lost due to aflatoxin contamination. Preventing mold contamination and toxin production seems to be the logical solution to mycotoxin problem in food. But measures to achieve that goal are usually impractical. In addition, precautions cannot be taken or they do not give effective results due to high humidity, moderate temperature and sudden rains at production areas of agricultural products. For these reasons, several methods have been used in the past to detoxify/degrade mycotoxins such as physical removal of contaminated raw material, heat treatment, adsorbents, adding chemicals or vitamins and irradiation. Heating the contaminated product usually does not result in effective degradation ratios because of heat stability of most mycotoxins. The effectiveness of ozonation has been evaluated in degradation mycotoxins in a number of foods. Reports suggested that that aflatoxin B1 and G1 were rapidly degraded using 2% ozone, while aflatoxin B2 and G2 were more resistant to oxidation and required higher levels of ozone for rapid degradation. This difference in degradation rates of different kinds of aflatoxins was attributed to the C8-C9 double bond, which is present in aflatoxin B1 and G1, but not in aflatoxin B2 and G2. It was found that 33 mg/l and 66 mg/l of ozone treatment for 60 minutes destroyed 80% and 93% of toxin, respectively. Several studies reported that significant levels of toxins were removed by ozonation in peanuts and corns. Moreover, the results of embryo assays and feeding experiments with various kinds of animals showed that many deleterious effects of toxins were prevented by ozone treatments. Hence, application of ozone on mycotoxin contaminated food crops seems to be a promising treatment.

The misuse of pesticides causes residue accumulation on agricultural products. This presents severe risks to human health because pesticides are toxic even at low concentrations. Ecological effects of pesticide residues and their fates in the environment are also important issues. Ozonation is considered as one of the most promising variations of chemical oxidation and has a long history of investigation for aqueous pesticide degradation. Dipping apples into ozonated water (0.25 ppm) resulted in reducing levels of azinophos-methyl, captan and formetanate hydrochloride on the surface of apples in the ratio of 75%, 72%, and 46%, respectively.

Moreover, a significant reduction was reported for the three pesticides in the ozonated water wash treatment as compared to the simple water wash. The reduction of the three pesticides ranged between 29 to 42%. Mancozeb, a registered fungicide, is a polymeric complex of ethylene bisdithiocarbamate (EBDC), manganese and zinc salt. Mancozeb residues were reported to be decreased by 5697% with ozone treatment (110 ppm). In addition to ozonation, various ozone-based advanced oxidation processes, which utilize hydroxyl radicals for oxidation, were recently evaluated for the degradation of aqueous organic pollutants including pesticides. Applications of ozone + hydrogen peroxide, ozone + ultraviolet irradiation and ozone + hydrogen peroxide + ultraviolet irradiation are the examples of advanced oxidation processes.

Effect of Ozone Treatment on Physiology and Quality of Foods

Ozone can be safely applied in gaseous and aqueous form to enhance the shelf-life and safety of food products. It has a strong microbicidal action against bacteria, fungi, parasites and viruses when these microorganisms are present in low ozone-demand media. Food products specially the fruits and vegetables are very perishable in nature, being susceptible to mechanical injury, physiological deterioration, water loss, etc. The effects of ozone exposure on the quality and physiology of various kinds of food products have been evaluated.

The respiratory activity of fresh-cut lettuce was controlled by treatment with ozonated water, despite its strong oxidizing activity. Respiration rate of fresh-cut celery was inhibited by ozone treatment. Peach respiration and ethylene production were also not affected by 3 weeks exposure to 0.3 ppm ozone. It has been suggested that ozone could reduce the level of ethylene in the air in a cold storage room, so that ethylene-sensitive and ethylene-producing commodities could be shipped or stored together for longer time. Ozone treated fruits show less weight loss than the non-treated samples in cold storage. The effect of ozonation in aqueous solution (O_3 concentration=1 mg/l, time of ozonation: 60 and 90 min) enhanced the shelf life of vacuum-packaged mussels, stored under refrigeration for a period of 12 days as compared to a shelf-life of 9 days for the control sample (Non-ozonated).

The application of O_3 in a cyclic manner (4 ± 0.5 mL L^{-1} of O_3 for 30 min every 3 h) to Thomson tomatoes, initially stimulated the respiration rate, although after 2 days, the metabolic activity decreased to a rate lower than that of control (air flow) when stored at 5°C for 15 days . In O_3-treated whole and sliced tomatoes a higher sugar (fructose and glucose) and organic acid (ascorbic and fumaric) content was found. The kind of cut (whole or slices) did not affect the sensitivity of tomato to O_3. In whole tomatoes, O_3 maintained the tissue firmer than in control fruit while no influence was found on slices. The O_3 treated fruit retained a good appearance and overall quality in slices but experienced a reduced aroma.

Enzymatic browning causes color change of fruits and vegetables, which result from the action of polyphenol oxidases enzymes, are also inhibited by ozone treatment (e.g.fresh-cut celery, lettuce etc). Red color of intact, whole berry fruit was the best in 0.3 ppm ozone treated samples during storage. It was also reported that the undesirable

color change from green to yellow in broccoli was significantly less pronounced for ozone treated samples. Antioxidant compounds such as flavonoids, polyphenols, vitamins A and C are important constituents of foods. They may serve as natural substrates for oxidative enzymes such as polyphenol oxidase. Reports suggested that there was no significant change or little change in vitamin C contents of samples treated and non-treated with ozonated water. Moreover, increase of ascorbic acid levels in spinach, pumpkin leaves and strawberries was reported in response to ozone exposure. In some cases, it has been reported that ozone decreases ascorbic acid viz. in broccoli florets. Ozone treatments were reported to have minor effects on anthocyanin contents in strawberries and blackberries. Anthocyanin content in blackberries stored in air and at 0.1 ppm ozone, remained stable while fluctuated in the 0.3 ppm ozone treated samples during storage. No phytotoxic injuries of fruit tissues were observed in ozonated atmosphere treatments of peaches, grapes and citrus fruits. Treating carrots and celery with ozonated water did not adversely affect sensorial quality of the final product. The effects of ozone on physiology and quality of fruits and vegetables vary according to chemical composition of food, ozone dose, and application type and time. If used in proper conditions, ozone may prevent microbial spoilage and some diseases, with a minimum amount of physiological damage to fruits and vegetables. These conditions must be determined by trials of ozone application to all kinds of products.

Ozone plays an effective fumigant for insect killing, mycotoxin destruction and microbial inactivation on stored grain. Studies have demonstrated that ozone which is a natural agent, may offer unique advantages for grain processing along with addressing growing concerns over the use of harmful pesticides. The effect of ozone treatment on controlling deterioration of high-moisture maize under extreme and moderate environmental conditions experienced decreased dry matter loss compared to the control.

Hazards about Ozone Application

Ozone is very effective against microbial disinfectant and other deleterious effects, but at the same time it is highly corrosive to equipment and lethal to humans with prolonged exposure at concentrations above 4 ppm. Ozone is readily detectable by human smell at 0.01 to 0.04 ppm. OSHA limits of exposure specify a 0.1ppm threshold for continuous exposure during an 8-hr period and 0.3ppm for a 15-min period. At 1 ppm ozone has a pungent disagreeable odor and is irritating to eyes and throat. Effective but safe concentrations are difficult to maintain and often difficult to evaluate and reproduce due to uncertainty of reported concentrations of delivered ozone in the experimental or commercial system. Newer electrode probes that measure oxidation reduction potential (ORP) of the water or colorimetric kits are being used to monitor ozone concentrations more accurately but problems in practical application still exists.

Conclusions

Ozone seems to be an effective sanitizer with great potential applications in the food industry. It decomposes into simple oxygen with no safety concerns about consumption of residual by-product. Due to its high oxidation capacity and microbial inactivation potential, ozone has prevented various kinds of microbial spoilages usually encountered in fruits and vegetables. Decontamination of products by ozone depends on number and kind of contaminating microorganisms, physiology of the product, ozone application system, temperature, pH, and other factors. If improperly used, ozone can cause some deleterious effects on physiology and quality of products such as losses in sensory quality. For effective and safe use in food processing, optimum ozone concentration, contact time and other treatment conditions should be defined for all products. Though, ozonation is an emerging new technique, the subject must be well evaluated and to be used more effectively before going for pilot scale commercialization in near future. Also, advances in ozone generation and application technologies must be explored to make the process more reliable and economical.

Sustainable Production of Biofuels: Potential and Prospect

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Introduction

Concerns about shortage of fossil fuels, increasing crude oil price, energy security and accelerated global warming have led to growing worldwide interests in renewable energy sources such as bio-fuels. An increasing number of developed and rapidly developing nations see bio-fuels as a key to reducing reliance on foreign oil, lowering emissions of greenhouse gases (GHG), mainly carbon dioxide (CO_2) and methane (CH_4), and meeting rural development goals.

Biofuels are referred to solid, liquid or gaseous fuels derived from organic matter. They are generally divided into primary and secondary biofuels (Fig. 1). While primary biofuels such as fuel wood are used in an unprocessed form primarily for heating, cooking or electricity production, secondary biofuels such as bioethanol and biodiesel are produced by processing biomass and are able to be used in vehicles and various industrial processes. The secondary biofuels can be categorized into three generations: first, second and third generation biofuels on the basis of different parameters, such as the type of processing technology, type of feedstock or their level of development.

Utilizing of Biofuel or Biomass Energy

The four methods in which biomass energy is generally utilized are:

Direct combustion

Production of liquid fuels from crop seeds

Cellulosic conversion of crop residues to produce liquid fuel

Methane production from animal manures

Conversion of Biomass to Fuel

This publication provides information about biofuels for use in helping to understand technology-related implications of biofuels development. It seeks to (a) provide some context for understanding the limitations of first-generation biofuels; (b) provide meaningful descriptions accessible to non- experts of second-generation biofuel technologies; (c) present salient energy,carbon, and economic comparisons between first and second-generation biofuels; and (d) finally, to speculate on the implications for trade and development of future expansion in global production and use of biofuels.

First Generation Biofuels

'First-generation' or conventional biofuels are biofuels made from sugar, starch, and vegetable oil. Biologically produced alcohols, most commonly ethanol, and less

commonly propanol and butanol, are produced by the action of microorganisms and enzymes through the fermentation of sugars or starches (easiest), or cellulose (which is more difficult).

Straight unmodified edible vegetable oil is generally not used as fuel, but lower quality oil can and has been used for this purpose. Used vegetable oil is increasingly being processed into biodiesel, or (more rarely) cleaned of water and particulates and used as a fuel. Biodiesel is the most common biofuel in Europe. It is produced from oils or fats using transesterification and is a liquid similar in composition to fossil/mineral diesel. Chemically, it consists mostly of fatty acid methyl (or ethyl) esters. Feedstocks for biodiesel include animal fats, vegetable oils, soy, rapeseed, jatropha, mahua, mustard, flax, sunflower, palm oil, hemp, field pennycress, pongamia pinnata and algae. Pure biodiesel (B100) is the lowest emission diesel fuel. Although liquefied petroleum gas and hydrogen have cleaner combustion, they are used to fuel much less efficient petrol engines and are not as widely available

Green diesel, also known as renewable diesel, is a form of diesel fuel which is derived from renewable feedstock rather than the fossil feedstock used in most diesel fuels. Green diesel feedstock can be sourced from a variety of oils including canola, algae, jatropha. Green diesel uses traditional fractional distillation to process the oils, not to be confused with biodiesel which is chemically quite different and processed using transesterification.

Bio ethers (also referred to as fuel ethers or oxygenated fuels) are cost-effective compounds. They also enhance engine performance, whilst significantly reducing engine wear and toxic exhaust emissions. Greatly reducing the amount of ground-level ozone, they contribute to the quality of the air we breathe.

Biogas is methane produced by the process of anaerobic digestion of organic material by anaerobes. It can be produced either from biodegradable waste materials or by the use of energy crops fed into anaerobic digesters to supplement gas yields. The solid byproduct, digestate, can be used as a biofuel or a fertilizer. Syngas, a mixture of carbon monoxide and hydrogen, is produced by partial combustion of biomass, that is, combustion with an amount of oxygen that is not sufficient to convert the biomass completely to carbon dioxide and water. Before partial combustion the biomass is dried, and sometimes pyrolysed. The resulting gas mixture, syngas, is more efficient than direct combustion of the original biofuel; more of the energy contained in the fuel is extracted. Examples include wood, sawdust, grass cuttings, domestic refuse, charcoal, agricultural waste, non-food energy crops and dried manure.

Second Generation Bio-Fuels

Global biofuel production has been increasing rapidly over the last decade, but the expanding biofuel industry has recently raised important concerns. In particular, the sustainability of many first-generation biofuels which are produced primarily from food crops such as grains, sugar cane and vegetable oils, has been increasingly questioned over concerns such as reported displacement of food-crops, effects on the environment and climate change. In general, there is growing consensus that if

significant emission reductions in the transport sector are to be achieved, biofuel technologies must become more efficient in terms of net lifecycle greenhouse gas (GHG) emission reductions while at the same time socially and environmentally sustainable. It is increasingly understood that most first-generation biofuels, with the exception of sugar cane ethanol, will likely have a limited role in the future transport fuel mix.

The increasing criticism of the sustainability of many first-generation biofuels has raised attention to the potential of so-called second-generation biofuels. Depending on the feedstock choice and the cultivation technique, second-generation biofuel production has the potential to provide benefits such as consuming waste residues and making use of abandoned land. In this way, the new fuels could offer considerable potential to promote rural development and improve economic conditions in emerging and developing regions. However, while second-generation biofuel crops and production technologies are more efficient, their production could become unsustainable if they compete with food crops for available land. Thus, their sustainability will depend on whether producers comply with criteria like minimum lifecycle green house gas reductions, including land use change, and social standards.

Second-generation biofuels are not yet produced commercially, but a considerable number of pilot and demonstration plants have been announced or set up in recent years, with research activities. To produce second-generation, considerable amounts of biomass have to be provided, which will require an analysis of existing and potential biomass sources well before the start-up of large-scale production. In recent studies, bioenergy potentials differ considerably among different regions; the main factor for large biomass potentials is the availability of surplus agricultural land, which could be made available through more intensive agriculture.

So far, no experience with commercial production of second-generation biofuels yet exists. In particular, in developing countries it will be a challenge to balance large-scale industrial development with small-scale local value chains, which would be required to ensure environmental, economical and social sustainability.

The large biomass demand (up to 600 000 T/yr) for a commercial second-generation biofuel plant requires complex logistics systems and good infrastructure to provide biomass at economically competitive costs. This is a particular challenge in the rural areas of the studied countries where poor infrastructure, as well as complex land property structure and the predominance of small land holdings increase the complexity of feedstock logistics. The assessment of opportunity costs for residues from the agricultural and forestry sector is difficult due to the absence of established markets for these material flows. Data accuracy on costs is generally better when residues are used commercially (*e.g.* bagsse that is burned for heat and electricity production) than if they are used in the informal sector (*e.g.* as domestic cooking fuel, organic fertiliser or animal fodder). In cases where feedstock costs were indicated by local experts in the studied countries, they were often reasonably small compared to dedicated energy crops. Thus, residues are an economically attractive feedstock for second-generation biofuel production.

Overall, production of second-generation biofuels based on agricultural residues could be beneficial to farmers, since it would add value to these by-products. This could reduce the necessity to support farmers and smallholders in countries where the agricultural sector is struggling and investment is urgently needed. However, in India, there is limited financing possibilities, poor infrastructure and a lack of skilled labour which are currently constraining establishment of a second-generation biofuel industry.

Job creation and regional growth will probably be the most important drivers for the implementation of second-generation biofuel projects in major economies and developing countries. The potential for creation of jobs along the value-chain varies depending on the feedstock choice. Use of dedicated energy crops will create jobs in the cultivation of the feedstock, whereas the use of residues will have limited potential to create jobs since existing farm labour could be used. A large constraint regarding the social impact of feedstock production is the occupation of arable land for energy crop cultivation and thus competition with current agricultural production.

The use of second-generation biofuels to provide energy access in rural areas seems currently unlikely due to high production costs and the need for large-scale production facilities. Other bioenergy options like electricity production are technically less demanding and require less capital investment, and could thus be more effective in promoting rural development, as has been successfully demonstrated for instance in India.

The environmental impact of second-generation biofuel production varies considerably depending on the conversion route as well as the feedstock and site-specific conditions (climate, soil type, crop management, etc.). An important driver for biofuel promotion is the potential to reduce lifecycle CO2 emissions by replacing fossil fuels.

Feedstock plantations for second-generation biofuels are usually perennial tree or grass species, the cultivation of which can have a number of positive impacts:

- The year-round cover provided by perennial tree or grass species can increase the water retention capacity of the soil.
- Perennial plantations can also considerably reduce the impact of erosion through wind and water, which is a considerable benefit compared to annual feedstocks.
- Soil carbon stock can be increased through both roots and leaf litter.

The use of residues is bound by different constraints, since biomass is taken away from the site rather than added. Using secondary residues as feedstock is expected to have only little negative impact on the environment, since these residues are usually not returned to the field. The use of primary residues, however, could lead to nutrient extraction that has to be balanced with synthetic fertilizers to avoid decreasing productivity.

Third Generation Bio-fuels

Algae fuel, also called oilgae or third generation biofuel, is a biofuel from algae. Algae are low-input, high-yield feed stocks to produce biofuels based on laboratory experiments, it is claimed that algae can produce up to 30 times more energy per acre than land crops such as soybeans, but these yields have yet to be produced commercially. With the higher prices of fossil fuels (petroleum), there is much interest in algaculture (farming algae). One advantage of many biofuels over most other fuel types is that they are biodegradable, and so relatively harmless to the environment if spilled. Algae fuel still has its difficulties though, for instance to produce algae fuels it must be mixed uniformly, which, if done by agitation, could affect biomass growth.

Conclusion

India is a tropical country blessed with abundant sunshine and rains, thus offering an ideal environment for Biomass production. Further, the vast agricultural produce, also makes available large quantities of agro-residues which can be used to meet energy needs. With an estimated production of about 350 million tonnes of agricultural waste every year, residual biomass is capable of mitigation of GHG emissions to the extent of 300 million tonnes / annum. Taking advantage of their favourable natural climates and low labour costs for growing biomass, a more attractive evolution would be their becoming producers, users and exporters of finished biofuels, thereby retaining domestically more of the considerable added value involved in the conversion of the feed stocks to finished fuels.

Hydroponic- A Viable Technique for Urban Agriculture

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Introduction

Human being requires food, water, and living space in order to survive. These things do not exist in endless abundance and are derived both from abiotic and biotic sources, making people inherently dependent upon the optimization of land area and the preservation of biodiversity. The human population is increasing, and is predicted to expand again rapidly.

The intensified harvesting of resources from the environment affects biodiversity negatively, as it contributes to climate change and habitat fragmentation, degradation, and reduction. Habitat loss is the leading cause of biodiversity loss, and today, about 38 percent of global land is devoted to agriculture. An alternative to combat the present situation of land scarcity in the urban areas is the hydroponics.

The word 'hydroponics' is derived from two Greek words: '*hydro'* meaning water, and '*ponos'* meaning labour. It also means working water. Simply put, it is the art of growing plants without soil. All the nutrients are dissolved in the irrigation water and are supplied at a regular basis to plants. Thus hydroponics is a system of agriculture that utilizes nutrient-laden water rather than soil for plant nourishment. Hydroponic systems do not require pesticides; require less water and space than traditional agricultural systems. This makes them optimal for use in cities, where space is particularly limited and populations are dependent on high-self-sustaining city-based food systems. Hydroponics becomes an excellent choice for all types of growers.

Both hydroponic fertilizers and those intended for use in soil contain the three major nutrients, nitrogen, phosphorus and potassium. The major difference in hydroponic fertilizers is that they contain the proper amounts of all the essential micro-nutrients which fertilizers intended for use with soil do not. Hydroponic fertilizers are usually in a more refined form with fewer impurities making them both more stable and soluble for better absorption. Virtually any plant at any time of the year can be grown. The simple, effective hydroponic systems now available, coupled with modern horticultural lighting, have transformed the trend to grow one's favourite plants where and when one chooses.

Generally, there are 6 basic types of hydroponic systems like wick system, water culture, Ebb & flow - (flood and drain), drip system, N.F.T. (Nutrient Film Technique) and aeroponic. The wick system is the simplest type of passive hydroponic system, where there are no moving parts. The nutrient solution is drawn into the growing medium from the reservoir with a wick. This system can use a variety of growing medium like perlite, vermiculite, pro-mix and coconut fiber.

Water culture system is an active system with moving parts. An air pump supplies air to the air stone that bubbles the nutrient solution and supplies oxygen to the roots of the plants, which are totally immersed in the water.EBB & FLOW hydroponic system works by temporarily flooding the grow tray. The nutrient solution from a reservoir surrounds the roots before draining back. This action is usually automated with a water pump on a timer. Dip systems are a widely used hydroponic method. A timer will control a water pump, which pumps water and the Growth Technology nutrient solutions through a network of elevated water jets. A recovery system will collect excess nutrient solution back into the reservoir. N.F.T. systems have a constant flow of nutrient solution so no timer required for the submersible pump. The nutrient solution is pumped into the growing tray (usually a tube) and flows over the roots of the plants, and then drains back into the reservoir. The aeroponic system is probably the most high-tech type of hydroponic gardening. The roots hang in the air and are misted with nutrient solution. The mistings are usually done every few minutes.

Advantages of hydroponic system

- Increased rate of growth. With the proper setup, plants will mature up to 25% faster and produce up to 30% more than the same plants grown in soil.
- Hydroponically produced vegetables can be of high quality and need little washing.
- It is possible to produce very high yields of vegetables on a small area. All the nutrients and water that the plants need are available at all times.
- It uses only 1/20th of water compared to traditional gardening and water is used efficiently.
- Plants are irrigated automatically. The system water can be reused
- Hydroponic fertilizer formulations contain a balanced nutrient content
- Through hydroponic gardening; plants can be grown anywhere as long as their growth requirements are met.
- It provides a sterile environment for plant production.
- It needs 20% of less space in comparison to soil based gardens, as plants with small roots can be grown closer to each other.
- Hydroponics involves less labour. Upkeep is also minimal.
- Plants grown through this technique are healthy and have better nutritional value. It has been proved that vitamin content is 50% more in hydroponically grown plants as compared to conventional ones.
- It is easy to harvest in this type of gardening.

- There are no worries about the changing seasons, as crops can be grown all year round.
- This technology can be combined with green house technology to get better results.

Disadvantages of hydroponics

- Hydroponic production is management, capital and labour intensive.
- A high level of expertise is required for growing plants through hydroponics.
- Daily attention is necessary.
- Specially formulated, soluble nutrients must always be used. Pests and diseases remain a big risk .Micro-organisms that are water-based can creep in rather easily.
- Finding a market can be a problem.
- Pump failure can kill off plants within hours depending on the size of the system.

Using hydroponics, anything, including most house plants, flowering plants, vegetables, several different kinds of fruits and different kind of herbs for seasoning or health purposes can be grown. Hydroponic gardening indoors can provide a year-round supply of fresh fruits, vegetables, and herbs. Flowers or foliage of own choice can be grown to decorate home, no matter what the season or weather. Among the vegetables that can be grown using hydroponics are: artichokes, asparagus, beans, beets, cabbages, carrots, cauliflowers, celery, cucumber, eggplants, leeks, lettuce, onions, peas, potatoes, radishes, squash, tomatoes and yams. Tomatoes are one of the most popular plants grown hydroponically and can ripen as much as eight weeks earlier and produce more fruit than when grown in soil. Water-loving fruits make a good choice for hydroponic garden. These include watermelon, cantaloupe, tomatoes (technically a fruit), strawberries, blueberries, blackberries, raspberries and grapes. Many hydroponic gardeners also successfully grow other, more exotic fruit species even pineapples. Surprisingly, there are some trees that can be grown in a hydroponic manner. Banana trees are one, and dwarf citrus trees, such as lemons are another. Some of the most popular herbs to grow are: rugula, basil, chervil, chives, coriander, dill, lemon balm, mache, majoram, oregano, rosemary, spear and peppermint, sage, tarragon, thyme and more.

All the nutrients plants need are dissolved in water and they are supplied to plants every day. Macro elements (N; P; K; S; Ca) are needed in substantial amounts, whereas plants need very small amounts of micro elements (Fe; Zn; Mn; Mg; Cu; Co, Mg). It is necessary to use the specially formulated fertilizers. Fertilizers used for hydroponics are more pure than other fertilizers to prevent precipitation and blockages of the system.

Generally seedlings can be purchased at nurseries, or can be produced by the hydroponic growers. Different crops are planted at different spacing. Small plants can be planted close to each other. Large plants need more space to grow and must be spaced further apart. Water flow must be checked every day and adjusted when necessary. If plants turn yellow, it is normally a symptom of nutrient deficiency, too little light or a disease. Inspection is needed every day for disease symptoms and insects.

Conclusion

The practice of hydroponics can yield excellent results in short span of time with proper knowledge and techniques. Presently, hydroponics is being practiced by some of the floriculturists in Gujarat, Maharashtra and Karnataka state. In Bihar, Himachal Pradesh, Kerala and some other states it is finding the place. The awareness regarding this method has to be spread for its popularity. Various environmental concerns, reduction in arable land, and scarcity of water can be easily addressed with the use of hydroponics. It is extremely beneficial for commercial farmers and home gardeners alike. More particularly, in the urban agriculture there is tremendous scope of hydroponics, which can increase the production and meet their daily food requirement to a great extent. This method of food production is much needed to support our growing population.

A Food Technologist in India

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Introduction

"Cooking is an art, Food Technology is a science" cannot remember the number of times I had to repeat this quote to people who would tell - "you studied Food Technology does that mean you are a good cook?". I completed my Master's in Food Technology from C.F.T.R.I. (Central Food Technological Research Institute), Mysore in 1995 - a time when packaged foods formed a very small part of our daily diet and food technology as a stream was known to very few in India.

Two decades and the entire scenario has changed the internet, youngsters with high disposable income, nuclear families all of this demanding convenience, saving time in the kitchen - ready to prepare and ready to eat foods, products offering long lost grandmother recipes etc. Packaged food and the convenience it brings along is here to stay.

Present Scenario

In India, the packaged food market has taken a slightly different shape as compared to most developed markets where ready to eat products form a large share of the packaged food market. In India, the products are geared towards making the life of every day cook more convenient raw materials like spice powders, masala powders, cleaned and cut fruits, vegetables, meat and sea food, ready to prepare products like Idli mix, Dhokla mix, Gulabjamun mix and to a smaller extent ready to eat curries and other products like paneer makhani, chole etc.

While the consumption of these products has increased, not many people are aware of the role a "food technologist" plays behind the scenes. A Food Technologist is trained to contribute at various places during the manufacture of food Procurement, Product development, Manufacture and Quality Control. Procurement ensuring that the right type of raw material, consistent in quality and meeting the desired specification is sourced. Product development, designing includes the product and process to ensure a tasty and safe product for the consumer, scaling up the process in the factory to ensure consistent product quality, deciding the content on product label. Manufacture designing the process for manufacture of consistent and good quality products. Quality control ensuring consistent quality of the bulk manufactured products. Apart from that Food Technologists also enjoy technical sales roles in food ingredient companies.

Till a decade ago, most of the packaged food products were western products where the process was established and well known, the trend is different now, a lot of manufacturers are innovating and identifying ways to package products that we Indians are far more familiar with like Bhujia, mixture, Roti, Sweets, Idli batter etc.

Also, health and wellness is another trend that is catching up since the application of food technology is moving from side dishes (products which are consumed in smaller quantities) to products in the "center of the plate" (products which are consumed in larger quantities as part of our daily diet).

Conclusion

The market in future needs Food Technologists who have a sound knowledge of the core skills of food processing coupled with additional skills in different areas like post-harvest technology, machine design, nutrition, entrepreneurship, sales and marketing etc. So, all in all while there is no guarantee that a Food Technologist can cook well, he/she can definitely ensure consistent, safeand nutritious food material and make the art of cooking and eating delightful for the consumer.

Carbon Sequestration to Mitigate Climate Change

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Introduction

The term "Carbon sequestration" is used to describe both natural and deliberate processes by which CO_2 is either removed from the atmosphere or diverted from emission sources and stored in the ocean, terrestrial environments (vegetation, soils and sediments) and geologic formations. Human activities, especially the burning of fossil fuels such as coal, oil and gas have caused a substantial increase in the concentration of carbon dioxide (CO_2) in the atmosphere. The increase in atmospheric CO_2 from about 280 to more than 380 ppm over the last 250-years is causing most of global warming. Potential adverse impacts include sea-level rise, increased frequency and intensity of wild fires, floods, droughts and tropical storms, changes in the distribution, frequency and volume of rainfall, snow and runoff, and disturbance of coastal marine and other ecosystems. Before human caused CO_2 emissions began, the natural processes that make up the global carbon cycle maintained a near balance between the uptake of CO_2 and its release back to the atmosphere. However, existing CO_2 uptake mechanisms are insufficient to offset the accelerating pace of emissions related to human activities.

Carbon sequestration describes long term storage of CO_2 or other forms of carbon to either mitigate or defer global warming and avoid dangerous climate change. It is the capacity of CO_2 produced by burning fossil fuels and storing it safely away from the atmosphere. It has been proposed as a way to slow the atmospheric and marine accumulation of green house gases, which are released by burning coal and fossil fuels. Carbon dioxide is naturally captured from the atmosphere through biological, chemical or physical processes. CO_2 may be captured as a pure by-product in processes related to petroleum refining or from flue gases from power generation.CO_2 sequestration includes the storage part of carbon capture and storage, which refers to large-scale, permanent artificial capture and sequestration of industrially produced CO_2 using subsurface saline aquifers, reservoirs, ocean water, aging oil fields, or other carbon sinks. There are two separate operations, Carbon Capture and Sequestration (CCS) the "capturing" process whereby carbon emissions are prevented from being released into the air, and the "sequestration" or "storage" of the captured carbon. "Capturing" carbon means separating out the CO_2 from all of the other gases and particulates often found in fossil fuel exhaust. Sequestration occurs naturally, i.e. oceans and plants are already absorbing much of what we emit. CO_2 sequestration may be done by surface methods, by sub surface storage and by recovery of energy fuels and minerals. If the source and the underground fixation sites are not near to each other, transport of CO_2 in liquid form over longer distances is required.

Problems of CO_2

CO_2 is a greenhouse gas which is increasing its atmospheric concentration due to human activities. Only the increase in CO_2 is presently deemed to have contributed about 70% of the enhanced greenhouse effect. The IPCC has concluded that developed countries need to reduce emissions by 25-40% below 1990 levels by 2020 to avoid exceeding the 450 ppm atmospheric concentration of CO_2 equivalent that are likely to be required to stay within the temperature rise limit of 2^0 C. Similarly the developing countries need to reduce emissions by 15-30% relative to business as usual by 2020. The total amount of CO_2 entering into the atmosphere due to human activities like burning of fossil fuels, change in land use and deforestation amount to 7.5 Gt (Giga tonnes) per year. Evidence is mounting that carbon dioxide's heat-trapping power has already started to boost average global temperatures. If CO_2 levels continue upward, further warming could have dire consequences, resulting from rising sea levels, agriculture disruptions, and stronger storms (e.g. hurricanes) striking more often. But choking off the stream of CO_2 entering the atmosphere does not have a simple solution. Fossil fuels, which provide about 85 percent of the world's energy, are made of hydrocarbons, and burning them releases huge quantities of CO_2. Even as renewable energy sources emerge, fossil-fuel burning will remain substantial. And the fossil fuel in greatest supply, coal is the worst CO_2 emitter per unit of energy produced. A grand challenge for the scientists will be to develop systems for capturing the CO_2 produced by burning fossil fuels and sequestering it safely away from the atmosphere. The following table shows CO_2 emissions by different countries in the world. India has historically not been responsible for the emissions, has per capita emissions of 1.8 tons/person and ranks 135^{th}-standing along with most of the least developed countries. But with total CO_2 emissions of 2.34 billion tons, it is currently the 3^{rd} biggest emitter after U.S and China. On per capita basis, an Indian emits four times less than a Chinese and nine times less than an American. This is because we are still lagging behind them in industrial development. India has enormous reserves of coal and other fossil fuels. But, so far we have not been able to exploit its full potential, which has come as a boon for the environment as that would have contributed to increasing greenhouse gas emissions.

CO_2 Capture

Methods already exist for key parts of the sequestration process. A chemical system for capturing CO_2 is already used at some facilities for commercial purposes, such as beverage carbonation and dry ice manufacture. The same approach could be adapted for coal-burning electric power plants, where smoke stacks could be replaced with absorption towers. One tower would contain chemicals that isolate CO_2 from the other gases (nitrogen and water vapor) that escape into the air and absorb it. A second tower would separate the CO_2 from the absorbing chemicals, allowing them to be returned to the first tower for reuse.

A variation to this approach would alter the combustion process at the outset, burning coal in pure oxygen rather than ordinary air. That would make separating the CO_2 from the exhaust much easier, as it would be mixed only with water vapor, and not with nitrogen. It's relatively simple to condense the water vapor, leaving pure CO_2 gas that can be piped away for storage. In this case, though, a different separation problem emerges the initial need for pure oxygen, which is created by separating it from nitrogen and other trace gases in the air. If that process can be made economical, it would be feasible to retrofit existing power plants with a pure oxygen combustion system, simplifying and reducing the cost of CO_2 capture.

Advanced methods for generating power from coal might also provide opportunities for capturing CO_2. In coal-gasification units, an emerging technology, coal is burned to produce a synthetic gas, typically containing hydrogen and carbon monoxide. Adding steam, along with a catalyst, to the synthetic gas converts the carbon monoxide into additional hydrogen and CO_2 that can be filtered out of the system. The hydrogen can be used in a gas turbine (similar to a jet engine) to produce electric power.

Carbon Storage: Geologic Sequestration

Once CO_2 has been captured, compressed, and transported to a sequestration site, it can be pumped deep underground and injected into a variety of geologic formations for storage. Characteristics to consider in evaluating sequestration sites include:

- Depth of the formation
- Porosity of the surrounding material
- Presence of potential vents, such as old oil wells
- Nearness to freshwater aquifers
- Potential volume for CO_2 storage
- Proximity to sources of CO_2

The expected storage time for direct sequestration is on the order of millennia. Large-scale, long-term sequestration tests have not yet been conducted to have a solid understanding of the potential for leaks after injection, though research is ongoing. Because of the long time period involved, even an annual leak rate of less than one percent could make the sequestration ineffective for climate change mitigation. Few environmental impacts of geologic sequestration have been identified, but studies are ongoing. In particular, the effects of CO_2 sequestration on groundwater are not yet well documented and the subject of research projects. Types of geologic formations that have been considered, and in some cases tested, for carbon sequestration include:

Oil and gas fields

The oil industry has been using a process called Enhanced Oil Recovery (EOR) for several decades wherein they inject CO_2 into depleted oil fields to increase their yields. The CO_2 in an oil well can either be in miscible or in immiscible phase. In the miscible

phase, injected CO_2 mixes with the viscous crude causing it to swell. It reduces its viscosity in the reservoir causing a flow to produce more oil. In the immiscible phase CO_2 does not dissolve in the crude. It raises the pressure and helps to sweep the oil towards the production well. Actually, both the conditions occur and the oil displacement depends on various parameters like oil swelling, viscosity reduction, miscibility, and reduction in oil saturation.

Submarine sediments

A potential benefit of injecting CO_2 into rocks beneath the seafloor is that injected CO_2 may be more stable in these submarine sediments than terrestrial formations. Though the capacity for submarine geologic sequestration is extremely vast, transportation of the CO_2 from capture sites is likely to be the main constraint.

a) Saline aquifers

Sometimes large, deep formations of porous rock (such as sandstone and limestone) contain large amounts of briny water in their pore space. These formations are known as saline aquifers, and the water they contain can be displaced by CO_2, providing a storage site. CO_2 fixation in deep saline aquifers, both on shore and offshore and are expected to provide the largest storage capacity at below 800m depth. At this depth, CO_2 is in liquid or super critical state and has density less than water. In saline formations, estimates of potential storage volume are low up to 30% of the total rock volume. Some model predictions indicate that saline aquifers are a viable option for geologic CO_2 sequestration.

b) *Unmineable coal seams*

Coal beds have absorption capacity for CO_2 which is two to three times that of methane. Like oil fields, an unmineable coal seam can also prove to be a potential reservoir for Enhanced Coal Bed Methane Recovery (ECBM). CO_2 can be sequestered by pumping it into unmineable coal seams, where it adsorbs to the internal surface and micro pores of the coal replacing methane. A major benefit of this method is that the injected CO_2 will displace methane that was adsorbed to the coal, and this methane can be collected at the surface and sold, offsetting some of the costs of sequestration.CO_2 storage in coal beds takes place at shallower depth than in saline and oil reservoirs.

Carbon Storage: Indirect Sequestration

Carbon can be sequestered indirectly by inducing the marine or terrestrial biosphere to take up more CO_2. One of the main challenges of indirect sequestration is the limited degree of control over the biologic systems being manipulated. Indirect sequestration projects are expected to provide less permanent carbon storage than direct sequestration, on the order of decades or at most centuries, because of the relatively rapid turnover time of the systems.

Marine Sequestration

Marine indirect sequestration, often known as ocean fertilization, entails spurring the growth of marine phytoplankton (algae and other organisms) in the ocean surface. When phytoplankton growth increases, more CO_2 is drawn out of the atmosphere, and the hope is that a significant fraction of it will sink to the ocean floor -- effectively sequestering CO_2. However, much of the CO_2 drawn out of the atmosphere will be returned in a matter of days to years as the phytoplankton die, decompose, or are ingested by other near-surface organisms, leaving only a fraction to sink to the ocean floor. Inducing large blooms of phytoplankton could have ecological consequences that are not yet well understood, such as the growth of algal species and the depletion of oxygen.

The world's oceans are the primary long term sink for human caused CO_2 emissions, currently accounting for a global net uptake of about 2 giga tons of carbon annually. This uptake occurs naturally through chemical reactions between sea water and CO_2 in the atmosphere. Hence seawater becomes more acidic. Many marine organisms and ecosystems depend on the formation of carbonate skeletons and sediments that are vulnerable to dissolution in acidic waters. CO_2 can be injected into sea water at different depths. Dispersal at shallow depths of less than 300m may however release it back to the atmosphere by surface plumes. Injecting it to a depth of 1000m or so is likely to delay the process of atmospheric release, but this may endanger the survival of marine species. Liquid carbon injected at a depth of 3000m would confine it to form a permanent lake, being denser than water, is safer. Other options are disposal of frozen CO_2 in thermohyline zones, CO_2 fixation in marine cynobacteria- and use of iron filings on the upper surface of oceans to catalyze production of phytoplankton as well as marine food.

Terrestrial Sequestration

Methods of indirect sequestration in the terrestrial biospheres work on the concept of inducing enhanced uptake of CO_2 by increasing the growth of land plants through planting trees, mitigating deforestation, or adjusting forest management practices. There is little concern about adverse ecological effects of planting trees, reintroducing wetlands, and preventing deforestation. However, most terrestrial sequestration methods are relatively short-lived compared to direct geologic sequestration. This approach is having significant potential which includes, plant & soil sequestration, microbial and micro algae fixation to stabilize atmospheric concentration of CO_2. Plants absorb CO_2 in the photosynthesis process. Carbon assimilation occurs in forests, trees, crops and soil and these are CO_2 sinks. Agro-forestry, cultivation of advanced crop species will increase the uptake of CO_2 through an enhanced photosynthesis rate. Decisions about terrestrial carbon sequestration require careful consideration of priorities and tradeoffs among multiple resources. For example, converting farm lands to forests or wetlands may increase carbon sequestration, enhance wild life habitat and water quality, and increase flood storage and recreational potential- but the loss of farm lands will decease crop production. Converting existing conservation

lands to intensive cultivation will produce valuable crops, but diminish wild life habitat, reduce water quality and supply and increase CO_2 emissions. Lot of research is going on to assess the effects of climate and land use change on potential carbon sequestration and ecosystem benefits and to provide information about these effects for use in resource planning.

The primary ways that carbon is stored in plants or in the soil as soil organic matter, which is a complex mixture of carbon compounds, consisting of decomposed plant and animal tissue, microbes (protozoa, nematodes, fungi, and bacteria) and carbon associated with soil minerals. Soils contain three times more carbon than the amount stored in living plants and animals.

Conclusion

The CO_2 sequestration is a large scale infrastructure intensive emerging energy technology for mitigation of climate change. All the above methods are based on site specific research and need to be evaluated on case to case basis. Global field experimentation is going on to find out the efficacy of carbon sequestration. To achieve a carbon balance in the atmosphere in an enhanced CO_2 captures processes and materials as well as site specific models for its fixation. Computer models of future CO_2 emissions and controls on atmosphere have been developed and summarized by the U.S. Climate Change Science Programme (CCSP). The CCSP models illustrate that sequestration is necessary but insufficient to control atmospheric CO_2 For stabilizing this we require substantial changes in energy sources and use as well as carbon management. Many of these changes will likely have significant, long lasting impacts on land, water and ecosystem resources.

Impact of Food Waste on Greenhouse Gas Emissions

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Introduction

Agriculture is the major driver of climate change accounting for more than 20% of overall global greenhouse gas emissions. FAO estimates that each year, approximately one-third of all food produced for human consumption in the world is lost or wasted. This not only means a missed opportunity for the economy and food security, but also a waste of all the natural resources used for growing, processing, packaging, transporting and marketing food. Although today there is a wide recognition of the major environmental implications of food production, no study has yet analysed the impacts of global food wastage from an environmental perspective. The global volume of food wastage is estimated to be 1.6 Gtonnes of "primary product equivalents" while the total wastage for the edible part of food is 1.3 Gtonnes. This amount can be weighed against total agricultural production (for food and non-food uses), which is about 6 Gtonnes. The loss of land, water and biodiversity, as well as the negative impacts of climate change, represent huge costs to society that are yet to be quantified. The direct economic cost of food wastage of agricultural products, shows that a reduction of food wastage at global, regional, and national scales would have a substantial positive effect on natural and societal resources.

Food Waste and Agri-supply Chain

Food production, consumption and disposal have a significant role in causing climate change, and it is estimated that the food cycle contributes 15% to 30% of total emissions, although this proportion varies greatly with food type. The components such as food transport and processing account for a much smaller fraction. A significant contributor to GHG emissions is waste biomass generated throughout the food supply chain. It is estimated that 30% of food grown ends up as waste and in some cases can be as high as 75%. With advance of time, the agri-food chain is targeting for the production of high quality food across a number of parameters. Many foods (fresh fruit and vegetables) are discarded on the basis of appearance and physical characteristics rather than nutritional quality. Some major commodities create very large amounts of waste co-products i.e. brewers' spent grain, peels of fruits and vegetables etc. These are usually disposed of locally as animal feed, composted or added to landfill. A large proportion ends up in landfill sites, where it produces methane which is a more potent GHG than CO_2. Probably the most significant impact of food on GHG emissions is wastage in households and the commercial sector like

hospitals, institutions and social functions. This is rarely considered in life cycle analysis of foods as it is difficult to monitor and quantify. Most food waste is collected by local authorities and the remainder is composted, fed to animals or disposed to sink. Statistics says the household food waste is composed of 19% of unavoidable waste (e.g. vegetable peelings, meat carcasses etc.), 20% is possibly avoidable (e.g. bread crusts and potato peelings that are eaten by some people and not by others) while the remainder (61%) could be eaten if managed more appropriately. One important element of agri-supply chain is the confusion amongst consumers on expiry date in packed food and some food waste is generated due to this.

The environmental assessment for all commodities is based on a life cycle approach that encompasses the entire "food cycle", including agricultural production, post-harvest handling and storage, food processing, distribution, consumption and end-of-life (i.e. disposal). Food wastage along the food supply chain (FSC) has a variety of causes, such as spillage or breakage, degradation during handling or transportation, and waste occurring during the distribution phase. Along the food supply chain Agricultural production, at 33 percent, is responsible for the greatest amount of total food wastage volumes. Upstream wastage volumes including production, post-harvest handling and storage, represent 54 percent of total wastage, while downstream wastage volumes including processing, distribution and consumption is 46 percent. Thus, on an average food wastage is balanced between the upstream and downstream of the supply chain. An analysis of the food supply chain phases by regions reveals that upstream losses occurring at agricultural production phase appear homogenous across regions where as downstream wastage occurring at consumption level is much more variable, with wastage in middle and high-income regions at 3139 percent, but much lower in low-income regions, at 416 percent. Food wastage arises at all stages of the food supply chains for a variety of reasons that are very much dependent on the local conditions within each country. At global level, a pattern is visible. In high-income regions, volumes of lost and wasted food are higher in downstream phases of the food chain, but just the opposite in low-income regions where more food is lost and wasted in upstream phases. In developing countries, there are indeed significant post-harvest losses in the early stages of the supply chain, mostly because of the financial and structural limitations in harvest techniques, storage and transport infrastructures, combined with climatic conditions favourable to food spoilage.

Role of Food groups and Phase of FSC on Carbon footprint

All foodstuffs share a common characteristic: emissions of biogenic GHG such as methane (CH_4) and nitrous oxide (N_2O) play an important role in their carbon

footprints. CH_4 and N_2O are very powerful GHGs having high global warming potential. A product's carbon footprint is the total amount of greenhouse gases (GHGs) it emits throughout its life cycle, expressed in kilograms of CO_2 equivalents. Emissions of biogenic GHG occurs through all stages of the food chain i.e. **a**griculture, food manufacturing, distribution and retail, consumption and end-of-life treatment. GHG emissions of the production phase (including all agricultural inputs, machinery, livestock, and soils) and successive phases (such as processing, transportation, preparation of food, waste disposal) are all included in this calculation. Thus, one kg of wheat, or one kg of beef have different carbon footprints, since their life cycles are different, emitting specific types and varying amount of greenhouse gases.

On top of the pyramid, beef and dairy products are some examples of carbon intensive food products, Pork and fish are less intensive. The major contributors to the carbon footprint of food wastage are cereals (34 percent of total), followed by meat (21 percent). Products of animal origin account altogether for about 33 percent of total carbon footprint, whereas their contribution to food wastage volumes is only 15 percent. Despite meat being a relatively low contributor to global food wastage in terms of volumes (less than 5% of total food wastage) it has a significant impact on climate change, contributing to over 20% of the carbon footprint of total food waste. Thus, efforts to reduce GHG related to food wastage should focus on major climate hotspots commodities, such as meat and cereals. The highest carbon footprint of wastage occurs at the consumption phase because when food wastage occurs along the FSC, impacts of all the phases that the product has gone through (e.g. processing, transport), are added to the initial agricultural impact and the final end-of-life impact. "So when we're going to reduce waste, we need to prioritize." In low income countries, the lack of infrastructure and lack of knowledge on proper storage and food handling, combined with unfavourable climatic conditions, favour food spoilage. In higher income countries, aesthetic preferences and arbitrary sell-by dates are factors that contribute to food waste.

Key Environmental Issues for the Food Industry

The food industry is now facing increasing pressure to ensure that their company's activities are environmentally sensitive, but there is also increased internal pressure to maintain or increase profitability in the competitive market. Key resources used by the food-processing industry include the water, raw materials and energy. Traditionally, the food-processing industry has been a large water user. Water is used as an ingredient, an initial and intermediate cleaning source, an efficient transportation conveyor of raw materials, and the principal agent used in sanitizing plant machinery and areas. Although water use will always be a part of the food-processing industry, the solid waste has become the principal target for pollution prevention. Primary issues of

concern include both organic and packaging waste. Organic waste, that is, the rinds, seeds, skin, and bones from raw materials, results from processing operations. Inorganic wastes typically include excessive packaging items that are, plastic, glass, and metal. Organic wastes are finding ever-increasing markets for resale, and companies are slowly switching to more biodegradable and recyclable products for packaging. Excessive packaging has been reduced and recyclable products such as aluminum, glass, and high-density polyethylene (HDPE) are being used where applicable. The food processing factories should follow the major technological innovations in the industry. The clean technologies include wastewater treatment practices, improved sensors and process control to reduce wastes and increase productivity. There are several ongoing trends of research and development activities within the food-processing community in the areas of pollution prevention and clean technology implementation. The industry needs to continue to implement advanced innovative techniques to lessen the environmental impact of food processing by-products.

Food Waste Management Practices

Major technological innovations in the industry are clean technologies that include advanced wastewater treatment practices like membrane applications, disinfection, charge separation and other separation practices. Use of less excessive and more environment friendly packaging products, improved sensors and process control and use of radiation to kill microorganisms are other alternative options. Food-processing facilities are looking for reduction or total elimination of effluent from the manufacturing process or to have pretreatment options that can help in reducing the amount of waste product. Recycling food waste and turning it into compost has many environmental benefits. Food waste can also be turned into renewable energy and a soil amendment through anaerobic digestion. One can divert food from landfills by preventing food waste before it is created, donating fresh, wholesome food to those in need, feeding safe, fresh food scraps to animals like pig farms, rendering fats, oils, and grease and turning it into products or biofuel and turning food waste into a valuable soil amendment. Turning food waste into renewable energy and a valuable soil amendment since there are no regulations that force companies or individuals to reduce their emissions yet, But not only does food waste make a sizable contribution to global warming it's also a lot of money.

Once food has been thrown away GHG emissions are produced in transporting this food to waste processing facility if exists. A huge source of GHG emissions associated with food is those associated with food packaging. However, with the use of proper post-harvest practices, packaging may help to protect food and prevent food waste. Reductions in packaging quantities and/or changes in materials to ensure that they are

re-usable or recyclable may be beneficial. Where food is thrown away, there can be a number of initiatives to reduce its associated GHG emissions. These are of critical importance because landfilling, the most common disposal method produces methane, a more potent GHG than CO_2. Till date much focus has been placed on non-food biodegradable sources of waste such as paper and textiles. However, as 2020 approaches increased processing of residual waste through techniques such as home and centralized composting, mechanical biological treatment, anaerobic digestion and energy from waste need to be developed. A fraction of this may be recovered and burnt through methane recovery systems. In addition, such techniques have the potential to generate electricity and heat which displace GHG from being produced in other sectors (e.g. electricity generation).

Conclusion

It is widely argued that cutting food waste and distributing the world's surplus food where it is needed could help tackle hunger in places that do not have enough land to expand farming. The best way is to create awareness about the need to avoid wastage of food at all levels. But that alone will not solve the problem. There is a need to penalise people who are responsible for failure to preserve and protect the precious edible resources of the country as is done in Germany. Though our people rarely waste much food in restaurants, we as a nation waste a lot of food during marriages, festivals and other occasions without caring about the large percentage of our people that go hungry each day. Food wastage reduction would not only avoid pressure on scarce natural resources but also decrease the need to raise food production by 60 percent in order to meet the 2050 population demand.

Entrepreneurship Opportunities in Solar Energy Sector

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Introduction

In the rising industry of solar power generation, job prospects are on the rise too. To accomplish the 20000 MW installed capacity targets under Jawaharlal Nehru National Solar Mission (JNNSM), solar energy business will need a projected requirement of about 4, 00,000 people by 2022. There are options in production and development implementation and JNNSM is a real prospect for start-ups. Once the Government steps up the scope of the domestic solar manufacturing business, we will see an increase in the industrial sector. There is possibility of undertaking various field works for the growth of the sector. It has more to do with linking systems like solar panels, batteries, charge controllers, inverters and the consignment in fixing up power plants. In the absence of universal electricity access across the country, the dream of digital India, e-commerce, e-governance, smart cities and developed economy shall remain a farce and impossible to realize. Government of India has therefore recognized the importance of solar energy as one of the sustainable sources of energy under National Action Plan for Climate Change (NAPCC). NAPCC aims to derive 15% of its energy requirements from renewable energy sources by the year 2020. Various policy measures, such as preferential tariff or fixed tariff or feed-in tariff, excise duty exemption, and soft loan, have been implemented to achieve the above-mentioned target. The growth in the solar power generating industry represents many new opportunities for the entrepreneurs. One does not have to obtain an engineering degree or some other technical background to seize upon these opportunities in this industry. They can spread the entire value chain from PV cell production manufacturing to management of the national energy grid system. The opportunities include original equipment manufacturing, PV manufacturing, PV product testing and delivery, PV cell installation and servicing, new energy storage devices, mobile solar energy based appliances, management of the solar energy supply to the national grid system, development of alternative materials to produce wafers or semiconductors, energy usage monitoring devices, development of heating and cooling systems, development of new hot fluids for cogeneration or electrical turbines systems, and many others. All of the opportunities can be categorized into three major categories associated with the energy generation value chain such as to reduce the cost of power generation, improve the speed and reliability of power generation, and expand the opportunities to apply renewable, sustainable energy technology to new applications across the value chain. Each area of the value chain offers business venture opportunities that can create value using one or more of the three major categories and enhance universal electricity access for all as electricity is essential for human comfort, efficiency and basic needs like lighting, cooking food, cooling homes, earning a living and utilizing health and education services etc. Due to the continuous increment in electricity demand day-by-day, Indian power sector is interfacing some challenges to maintain the balance between the power generation and demand with suffering from supply constraints and

shortages in power. For maintaining the ratio of generation and demand of power, moving from conventional sources to non-conventional sources is not only an option, it is a necessity. The importance of using solar as energy source in India's perspectives in not only to increase power generation, but also to expand energy reliability with considering the environmental, social, independent and financial benefits properties.

Entrepreneurship Opportunities

Entrepreneurship' is one of the principal mechanisms for the mitigation of unemployment and under-employment amongst educated youth. For success, the prospective engineer entrepreneur must coordinate knowledge and skills and keep abreast of the technologies, business market, skill requirement and fiscal policy issues related to the solar energy business. In addition, the engineer entrepreneur needs to do lots of homework for site selection, check proximity of the enterprise to transport facilities and power evacuation for establishing a micro-grid enterprise. Attention must be paid on the cost, durability, effectiveness and the design of the important components, such as the solar inverter, transmission and distribution equipment and supporting switchgear and equipment which ought to be geared up as per demand and the local market. The entrepreneur should vigorously survey the human resource requirement and keep a database of the organizations willing to provide financial and technological assistance to the prospective entrepreneurs on convenient terms. The prospective entrepreneur must try to be partner with reputed companies and institutions to develop mechanisms and maintain profitability and human resource development for entrepreneurial operations. Suggestion for the solar - based enterprises is made, especially due to the availability of solar energy in abundance all over the country by virtue of its advantageous geographical location. India lies on the equatorial belt of the earth bestowing 250 to 300 clear sunny days in a year with annual global solar radiation from 1600 to 2200 kWh/m^2 and equivalent energy potential of about 6, 000 million GWh per year. Energy from the sun can alone suffice more than the electricity needs of this country. Solar energy is a clean, emission free, renewable and environment friendly energy resource, abundantly available in India. The more it is harnessed to produce electricity, the better it shall be for larger electricity access on a countrywide scale. The country must gradually prepare itself to bid a good bye to the use of fossil fuels for electricity due to escalating costs of the imported fuel and the environmental degradation caused by the GHG and NOx emission generated by the fuels which has become a burning issue for the country's climate and sustainability. Optimal harnessing of solar energy for electricity can make this country the world leader in energy and bring this nation on the map of developed economies which all Indians should continuously strive for.

Rebates and Concessions to Prospective Entrepreneurs under the National Solar Mission

A lot of opportunities exist for young engineer entrepreneurs to avail special incentives, subsidies and tax benefits from the Government side as MSMEs and Energy entrepreneurs to make them active partners in developing country's economy by enhancing electricity access in rural areas. The Jawaharlal Nehru National Solar

Mission (JNNSM), offers a 10-year tax holiday for photovoltaic (PV) and thermal solar plants getting completed before 2020, reduced customs duty and zero excise duty on specific capital equipments, critical materials and project imports in addition to the grant of loans at cheap interest rates. These concessions and subsidies are meant to meet the challenges of ecologically sustainable growth, energy security and for fulfillment of the target of solar energy in villages and grid connected power by the National Thermal Power Corporation fixed at 100, 000 MW and 15, 000 MW respectively by the year 2022. The young engineer entrepreneurs must carefully understand the perspective, policies and incentives and its implications for deriving optimum benefits in order to make their ventures business oriented and profitable.

Existing Skill Gaps in Solar PV and Thermal Systems

Solar PV and Solar Thermal based renewable energy generation in India currently contributes significantly to the employment opportunities in the renewable energy sector. Considering the JNNSM targets, there would be a multi-fold increase in employment opportunities in this sector. Employment opportunities in solar PV and solar thermal based RE systems require qualified mechanical and electrical engineers, semi-skilled and non-skilled workers for installation and commissioning, technical staff for the operation and maintenance. Entrepreneurs are to take challenge to abridge the gaps in creating avenues to become a part to the growth of solar industry.

Conclusion

The solar PV on-grid sub-sector is now at the growing stage in India. With the Jawaharlal Nehru National Solar Mission (JNNSM), a scheme of the Government of India, the installed capacity is estimated to reach 20 GW by the year 2022. This would create enormous employment opportunities in the country. During last five to ten years, India is facing a big problem with the shortage of electricity. Government of India predicted that the total power demand will expand to 400,000 MW at the end of 2020. It needs enormous additions in capacity of electrical generation to meet the demand and to maintain the progress in the electricity market economy of the country. Considering the large potential, easy availability and other inherent characteristics of solar power, Government of India has given more emphasis on promotion of solar power in Indian power scenario. Currently India is in the top ten ranked countries in the world for investment, capacities addition and creation of job opportunities in solar power. Solar power can also provide a better economical scenario after successful implementation of solar mission for all states of India, especially for some underdeveloped states, where the potential of solar power generation is very good but not utilized till date. From the above discussion, it is concluding that the solar power takes an important role in the future power development in India due to the major initiatives and dedication at Government level.

Biodiesel from Algae

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Introduction

Diminishing fossil fuel resources and their adverse environmental impacts have called for development of techniques and policies to enhance uses and production of renewable energy sources. Increasing concerns about sustainability and the environment have led to a common practice to reduce carbon dioxide emissions and thus global warming, resulting from human activities. Biofuels, produced from biomass, are one of the most feasible, renewable and alternate energy resources to deal with the above issues. The benefits include sustainability, reduced environmental impact and greater energy security. There are many different types of biofuels, produced from biomass, such as vegetable oils, biodiesel, bio-ethanol, bio-syngas, bio-oil, and bio-hydrogen.

India consumes seven times more diesel than gasoline, and biodiesel being the best candidate for diesel fuels, has thus attracted much attention as a blending component or a direct replacement for diesel fuel for transportation. Biodiesel, being renewable and environmentally friendly fuel, has recently been considered as one of the best alternative resources of fossil fuels.

From an environmental perspective, benefits of biodiesel include reduction of carbon monoxide, carbon dioxide and sulfur emissions into the atmosphere. Moreover, it is nontoxic and biodegradable. It has similar energy content, chemical and physical properties as that of conventional diesel fuel, and can be used either on its own or mixed with conventional diesel in any diesel engine, without having to modify either the ignition system or the fuel injector. Canola oil, soybean oil, palm oil, sun flower oil, cotton-seed oil, waste vegetable oil is a few widely used edible and non-edible oils for biodiesel production. Few reasons which have not led to the commercial production of biodiesel include collection difficulty and high raw material cost and adverse impact on food supplies, which necessitate the need for a new feedstock for biodiesel production. Microalgae use sunlight more efficiently, than other crop plants, to produce oil. Their oil production capacity is almost one or two times higher than any other energy crop. There are different conversion processes by which microalgae can be converted into different forms of energy; which mainly include thermo-chemical and bio-chemical processes. They can be used to produce a number of different biofuels including vegetable oils, biodiesel, bio-ethanol, syngas, bio-oil, and bio-hydrogen etc. However, the current article is mostly focused on biodiesel production from algae.

Algae as Biodiesel

Algae are unique eukaryotic microorganisms, which convert sunlight, water and CO_2 to biomass resource with the process called photosynthesis. Microalgae are the

fastest-growing photosynthesizing organisms and can be used to generate a wide range of energy products. Many algae are exceedingly rich in oil or lipids which can be converted to biodiesel. Under suitable culture conditions, some algal species are able to accumulate up to 50% to 70% of oil/lipid per dry weight. Advantages of microalgae over terrestrial biodiesel feedstock include, short multiplication cycle due to which it can be harvested round-year, and can be cultured in wastewater, thus reducing the fertilizer requirement. They use carbon dioxide as carbon source for growth and produce non-toxic and highly degradable biodiesel, thus help in mitigating environmental concerns.

Utilization of microalgae as a source of biodiesel production has both environmental and economic benefits. However, there are a number of technical hurdles which have rendered algal biofuel industry economically unfit. Fast growing strains with high oil yield are the most important requirement for effective biofuel production from algae. Oil extraction methods and conversion technologies also need to be developed and optimized. Looking at the potential of microalgae as a third generation biofuel feedstock, this article collates and presents an overview of current harvesting, oil extraction and biofuels production technologies from algae.

Algae Harvesting Technologies

After lipid synthesis, for further processing of algal biomass to biofuels requires water removal from the algal culture. Harvesting alone, accounts for 20%30% of the total production cost. Therefore, for mass biodiesel production, efficient harvesting method is very essential. Selection of the appropriate harvesting method is of great importance to the economics of biofuels production. The appropriate harvesting method strongly depends upon the characteristics of the algae chosen, viz. the density and size, as well as the nature of the desired product. An optimal harvesting method should be species independent, should use less chemicals and energy, and if possible, also release intracellular materials. Dewatering small sized and initial dilute cultures of microalgae is one of the major challenges obstructing the emergence of algae based fuels. Many harvesting strategies like, centrifugation, sedimentation, flocculation, floatation, electrophoresis and micro- filtration, can be used to harvest algae. Microalgae harvesting can generally be divided into a two-step process. In that, the initial step is bulk harvesting during which algal biomass is separated from the bulk culture. This step concentrates biomass to 2% to 7% dry weight. The second step, called thickening which further concentrates the algal slurry. Thickening is more energy intensive than bulk harvesting.

Oil Extraction

Lipid extraction is done by the physical methods and chemical methods in the form of solvent extractions, or a combination of the two. Method used for extraction should be fast, easily scalable, effective and should not damage the extracted lipids. Depending on the type of biomass, sometimes before oil extraction, pre-treatment of biomass may be required. Cell disruption is one such pre-treatments method. Various cell disruption methods are microwave application, bead beating, autoclaving, grinding, osmotic

shock, homogenization, freeze drying and 10% (w/v) NaCl addition. In solvent extraction method, algal oil is derived with the use of solvents. Soxhlet extraction and Bligh and Dyer's method are the two typically used methods for extraction of lipids from algal biomass. The Soxhlet method uses hexane and the Bligh and Dyer's method uses mixture of chloroform and methanol as solvents to extract lipids. Supercritical carbon dioxide (SC-CO2) extraction is one of the promising green technology methods, which has the potential to displace the traditional organic solvent lipid extraction methods.

Biodiesel Production

Presently, the common method of microalgae based biodiesel preparation entails the following steps: lipid extraction from microalgae, followed by removal of excess solvent, and conversion of lipid to biodiesel. Transesteri?cation is the most usual method to convert oil into biodiesel and is the best choice as fatty acid methyl esters (biodiesel), produced by this process have their physical characteristics very close to those of diesel fuel. Transesteri?cation converts raw and viscous algal lipid to lower molecular weight fatty acid alkyl esters. It is a reaction between the parent oil (triglyceride) and a short chain alcohol, in the presence of a catalyst. Fatty acid methyl esters (FAME) and glycerol are the products of the reaction. The reaction rate and yield can be improved by use of a suitable catalyst. Lipid extracted algal Biomass residues are rich in carbohydrates (polysaccharides), proteins and pigments. They can further be processed to produce a wide range of biofuels like bio-methane, bio-ethanol, bio-hydrogen and bio-butanol etc.

Conclusion

Algae, due to several advantages such as high oil content and high growth rate, are a potential source of renewable energy and an ideal biofuel candidate. They can be used to generate energy in several ways. There is no single best method of harvesting algae and the choice of preferable harvesting technology depends on algae species, size, density and desired end product. Moreover, harvesting and drying of algal biomass highly increases the overall operational cost of biofuel production. Therefore, in order to produce biofuels from algae economically, more research and development is required to recommend commercially viable harvesting technology. Research for few of them is still in very early stages and moreover currently, biofuel production from algae is still very expensive to be commercially viable. Considering the early stage of research and high cost, it can be said that there is still a long way to go to perfect the process of optimizing the algae biofuel manufacturing process. Therefore, based on the current research inputs, it appears that apart from identifying the most optimal methods to cultivate algae, one also needs to identify the most optimal method for efficient biodiesel manufacturing from them. A lot of work is already being done in these aspects, and it is hoped that there will be many more to come soon.

Prospects of Jute and Allied Fibres for Manufacturing of diversified products

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Introduction

India with about 1.25 billion people is the second populous country in the world after China. It is predominantly an agricultural economy and about 65-70% of its population earns their livelihood through agriculture. Jute and allied fibre crops play a significant role in the country's economy, particularly, for the Eastern and North-Eastern States. The importance of these crops is felt in generating employment opportunities in the rural areas as well as in industrial and related sectors, earning foreign exchange, providing fuel requirements in the jute growing areas, fitting well in crop rotation, etc. Jute, the most important of these fibres was introduced for commercial cultivation, mainly as a source of raw material, for the packaging industries nearly 200 years back and, thereafter, it was witnessed ups and downs, particularly, in the post partition years. Once considered as the “golden fibre” for its National importance, Jute faced large problems with the inroad of synthetics.

However, being environment-friendly and annually renewable, it has greater advantage over the costly man-made fibres as well as costly plant species for the same purpose, particularly in the textile and paper industries. Along with jute and mesta, importance of other allied fibre crops like flax, sisal, pineapple leaf fibre, banana pseudo-stem fibre, oil-palm fibre, ramie fibre, coir fibre, bamboo fibre etc. is also being increasingly felt in the textiles and allied sectors. People are now getting more concerned about the environment pollution and thus prefer to use natural products which are not only bio-degradable but also eco-friendly. Consequently, diversification of jute and allied fibres is vital in the changing global scenario.

Status of Traditional Products from Jute & Allied Fibres

The specifications and standards of classic jute products have remained unchanged for decades. First comes sacking, which is used for making heavy bags for food grains and other commodities. Generally each sack weighs about one kilo net and is used to transport or store fifty kilos of produce. This item represents about half of the industry's output. In the last decade an improved 'food grade' sack have been developed, produced and marketed. This sack is physically very similar to the conventional one but does not contain any mineral oil. The use of 'food grade' bags is specified by importers of Cocoa and Coffee beans.

Next is 'Hessian,' which is a cloth, made from finer yarns and which generally weighs half as much per square metre as sacking. Some Hessian is used to make finer sacks and bags and the rest is used in a wide variety of applications from wrapping plants or collecting grass cuttings to furniture and as a support cloth for linoleum flooring. Hessian cloth represents a little less than twenty percent of the total output of the world jute industry.

Yarn and twine are also major traditional products. The yarns are primarily exported to carpet weavers in Europe and the Middle East where they are woven into the back of the carpet to provide bulk and stability. Jute sold in the form of yarns for carpet or twines represents close to twenty percent of total industrial output.

Wide Hessian cloth, known as carpet backing cloth is used on the back of tufted carpets. At one time it was used for both, primary and secondary backing but has been phased out of primary backing altogether. This application once consumed far larger volumes of jute than it does today when it accounts for less than two percent of output and a very minor part of the market.

The remaining ten percent or so of output is taken up by a wide range of small amounts of specialist products. Among these one can mention 'soil saver' an open weave construction using very heavy yarns used for geo-textiles which are laid on the ground. Jute woven matting or carpets are used as household floor coverings. Shopping bags are made from the better qualities of Hessian cloth. Furnishing fabrics, and rope soled shoes are also produced from jute and are finding consumer acceptance.

Flax fibre is mainly used for making linen. Flax fibre like cotton is a cellulosic polymer, however compared to cotton, it is stronger, crisper and stiffer to handle. It can also absorb and release water quickly, making linen comfortable to wear in hot weather. About 70% of the linen manufactured is used in the textile industry, which includes fabrics and high quality household textiles. Lower grade fibres are also used as reinforcement and filler in thermoplastic composites. Fine and regular long flax fibres are spun into yarns for linen textiles. Linen fabric maintains a strong traditional niche among high quality household textiles - bed linen, furnishing fabrics, and interior decoration accessories. Shorter flax fibres produce heavier yarns suitable for kitchen towels, sails, tents and canvas. Lower fibre grades are used as reinforcement and filler in thermoplastic composites and thermoset resins used in automotive interior substrates, furniture and other consumer products.

Sisal fibre is used for making Cordage (rope, twine and yarn), Composite materials (automobile components, construction roofing and paneling materials), Woven materials i.e. carpets, bags and buffing cloth etc. It has the ability to carry loads and can, therefore, be attractive for the reinforcement.

Pineapple leaf fibre finds different uses across the various parts of the world. It has no separate spinning system of its own and is, therefore, twisted instead into rope. It is used for making cloth and is also at times combined with silk or polyester to create textile fabrics. Pineapple fibre is also used for table linens, bags, mats and other clothing items.

Banana fibre extracted from its pseudo-stem is used for a wide range of products including bags, baskets, wall hangings, floor mats, home furnishings, etc. The fibre extracted by mechanical process is of superior quality and is extensively used for making high quality special paper and decorative papers. Banana fiber is used to manufacture handicrafts, home decorative, door mats, table mats, pooja and meditation mats.

The oil palm fibre are of high quality and used to make various fibre composites such as furniture, infrastructures, mattress, erosion control, paper production and also landscaping. Oil palm fiber is hard and tough, which shows similarity to coir fibers and its porous surface morphology is useful for better mechanical interlocking with matrix resin for composite fabrication. It has been used in combination with various polymeric matrices including natural rubber (NR), polypropylene (PP), polyvinyl chloride (PVC), phenol formaldehyde (PF), polyurethane (PU), epoxy, polyester, etc. to form bio-composites.

Ramie fibre is one of the strongest natural fibres, is white in color, with a silky luster, has low elasticity and dyes easily. The ramie plant is grown for fibre mainly in China, Brazil, the Lao PDR and the Philippines. The yarn produced from ramie fibre is suitable for a wide range of garments. It is usually blended with other textile fibres. It is also suitable for making twine, rope and nets. Coir is extracted from the tissues surrounding the seed of the coconut palm (*Cocos nucifera*) and is of two types, white coir and brown coir. Coir has a high concentration of lignin, making it stronger but less flexible than cotton and unsuitable for dyeing. It has good resistance to microbial action and salt water damage. White coir is used in the manufacture of rope and used to make fishing nets, while brown coir is used in sacking, brushes, doormats, rugs, mattresses, insulation panels and packaging.

Bamboo fibre is a cellulose fibre produced from bamboo pulp processed from bamboo culms. Bamboo fibre resembles cotton in its un-spun form and is thinner than hair. It is strong, flexible, can be softer than silk when spun into yarn and also has natural anti-bacterial properties. Bamboo fibre has numerous applications, which includes clothing, non-woven fabric (used in hygiene materials), home furnishing and medical textiles.

Future Scope for the Diversified Products

If jute and allied fibres can be used in textile applications other than packaging, there

will be an immediate value jump for these fibres. With the help of modern finishing, blending, printing and laminating techniques, fine quality fabrics can be produced. These fabrics can be used for manufacturing products such as shopping bags, soft luggage, upholstery cloth, carpets, blankets etc. The response of jute shopping bag both in domestic and international market is tremendous. Similarly there is tremendous scope for other diversified products from jute and allied fibres specially; floor coverings, wall hanging, apparels etc.

Non-wovens used in automobiles are much diversified and their consumption would increase with the increase of the production of cars. It can be used in various applications such as headliners, trimliners, moulded floors, door trims etc. Jute and allied fibres have great scope in the development of blended products both for automobile and general applications.

Beautiful and extremely appealing high fashion handbags, made of jute have found a lot of buyers in the domestic as well as international market. The bags might have a very foreign look but there will certainly be ethnic value to it. The techniques and value addition, which are India's strength that are going to the foreign market include bead/sequence work with trims like shells, wooden beads, hand embroideries & machine embroideries, patch/appliqué works different prints patched together and embellished with decorative work and sequence. Printed products are being used to make evening bags & casual bags with both durability and strength. The promotional bag market is the fastest growing market in the promotional product market today, where the qualities are very demanding though the prices are very competitive.

The application of natural fibre based composites in the building industry is gradually gaining importance. The composite is a combination of reinforcing fibre held together by an adhesive. There may be two types of composites; price driven for which costs dictate the market and the other performance driven for which the properties dictate the market. Jute and allied fibres can be effectively used in making high production, high performance composites for various applications.

Geo-textiles literally means textile material suited for earth. At present, mostly geotextile out of synthetics fibre is being used. Natural fibre based geotextile because of their bio-degradability, drapability and cheapness, would be the preferred material over synthetics for applications in embankments, cutting slopes, river bank, step erodible mine spoils in hilly areas, road constructions etc.

Jute needle punched nonwovens can be used (a) for agricultural mulching, (b) irrigation mats for nurseries, (c) pots for seedlings for mail order packaging and as seed bags etc.

Needle punched jute/jute blended nonwoven fabric can be successfully used in the area of floor covering and carpets. Jute blended nonwovens employing sandwich

blending technique combine both the aesthetic and the functional properties required in such materials and are substantially cheaper than woolen materials which is the main advantage though performance-wise jute products are slightly inferior to woolen products. In such cases, woven sacking or hessian fabric is used at the backside for reinforcement and coarse denier polypropylene/ acrylic fibre is used on top for aesthetic appeal and smooth appearance, keeping thick layer of jute fibre in between for resiliency.

Noise control and reduction are considered essential for human physiological health and in this context noise absorbing materials have a unique role. They absorb unwanted sound by dissipating sound wave energy when it passes through and also by converting some of the energy into heat, making them very useful for control of noise. Although conventionally glass fibre or mineral fibre materials are used as sound absorbers, jute and other allied fibres are suitable for this purpose due to their light weight and cost.

Recently a revival of interest is seen in utilizing natural fibres and their biomass & by products as antibacterial agents against pathogenic bacteria, possibly due to problems faced by over use of antibiotics. Jute and other allied fibres can effectively be used in these applications in view of their antibacterial attributers, be it in packaging, medicinal applications or as barriers from infections.

Recent years have seen the growth of research concerning use of cellulosic materials for the removal heavy metal ions from dilute aqueous solutions. These studies assume significance due to well known toxicity of heavy metal ions. Jute and other natural fibres with their multi component nature of biomass (cellulose, hemicelluloses, lignin and other incrusting materials) are more suitable for removal of a range of pollutants simultaneously. Jute nonwoven may be a cheaper substitute for costly woolen felts used in sizing. It can be used as interlining and inner part of the warm garments. It can be also used as interlining of the shoe.

Proper designing of jute needle punched nonwoven can be used as filter media . Such nonwovens are suitable for coarse and medium filtration application and suitable for textile, tobacco dust, wood flour, paper shreds etc. Jute and allied fibre based hand-made paper is making inroad in Indian market in various applications. Disposable bags, greetings cards, archive papers etc. have enormous potential both in domestic and international market

Efforts needed for Diversification

- The emerging environmental considerations and consumer preferences need to be taken advantage of for promoting new and diversified products from Jute & Allied fibres. Among these products furnishing fabrics, natural fibre floor

coverings, ropes and chords, non-wovens, composites, pulp and paper, building and insulation materials are the key items.

- Products like geo-textiles; agro-textiles etc. which have a large potential, have to receive focus both in terms of product development and market promotion.
- The cost-competitiveness of Jute and Allied fibre products needs to be improved to compete with cheaper synthetics products.
- The levels of technology at the processing and manufacturing stage of Jute and Allied fibres need to be improved considerably.
- It is observed that there exists market but attempts may be made to expand the market for the diversified products. With increasing awareness about the positive attributes of Jute and Allied fibres, market is likely to expand.

Conclusion

It is now evident that, in the era of changing global environment, efficient utilization and product diversification in Jute and Allied fibres is the need of the hour. Natural fibres will play a major role in the economic growth of the country by improving the livelihood of the rural poor and employment generation in rural and semi-urban sectors. The high technology pathways developed, can play as a catalyst for accomplishment of this mission.

Getting Started with Ubuntu: Open Source Operating System

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Introduction

Open-source Operating System is free to use, distribute, and modify. It has lower costs, and in most cases this is only a fraction of the cost of their proprietary counterparts. It is more secured as the code is accessible to everyone. Anyone can fix bugs as they are found, and users do not have to wait for the next release. The fact that is continuously analyzed by a large community produces secure and stable code.Lastly, the companies using open-source operating system do not have to think about complex licensing models and do not need anti-piracy measures like product activation or serial number. In this article a guide of Open source Operating System Ubuntu is given for students.

Ubuntu is a Debian-based Linux Operating System for personal computers, tablets and smartphones, and also runs network servers. It is published by Canonical Ltd, who offer commercial support. It is based on free software and named after the Southern African philosophy of *ubuntu* (literally, 'human-ness'), which Canonical Ltd. suggests can be loosely translated as "humanity to others" or "I am what I am because of who we all are". It uses Unity as its default user interface for the desktop. It is the most popular operating system running in hosted environments, socalled "clouds". As it is the most popular server Linux distribution.Development of Ubuntu is led by UK-based Canonical Ltd., a company of South African entrepreneur Mark Shuttleworth. Canonical generates revenue through the sale of technical support and other services related to Ubuntu. The Ubuntu project is publicly committed to the principles of open-source software development; people are encouraged to use free software.

Features

A default installation of Ubuntu contains a wide range of software that includes LibreOffice, Firefox, Thunderbird, Transmission, and several lightweight games such as Sudoku and chess. Many additional software packages are accessible from the built in Ubuntu Software Center as well as any other APT-based package management tool. Many additional software packages, such as Evolution, GIMP, Pidgin, and Synaptic that are no longer installed by default are still accessible in the repositories, installable with the built in Ubuntu Software Center; or by any other APT-based package management tool.Ubuntu operates under the GNU General Public License (GPL) and all of the application software installed by default is free software. In addition, Ubuntu installs some hardware drivers that are available only in binary format, but such packages are clearly marked in the restricted component.

Security

Ubuntu's goal is to be secure "out-of-the box". By default, the user's programs run with low privileges and cannot corrupt the operating system or other users' files. For increased security, the sudo tool is used to assign temporary privileges for performing administrative tasks, which allows the root account to remain locked and helps prevent inexperienced users from inadvertently making catastrophic system changes or opening security holes. PolicyKit is also being widely implemented into the desktop to further harden the system. Most network ports are closed by default to prevent hacking.A built-in firewall allows end-users who install network servers to control access. A GUI (GUI for Uncomplicated Firewall) is available to configure it. Ubuntu compiles its packages using GCC features such as PIE and buffer overflow protection to harden its software. These extra features greatly increase security at the performance expense of 1% in 32-bit and 0.01% in 64-bit.Ubuntu also supports full disk encryption as well as encryption of the home and Private directories

Installation

The system requirements vary among Ubuntu products. For the Ubuntu desktop release 16.04 LTS, a PC with at least 2 GHz dual core processor, 2 GB of RAM and 25 GB of free disk space is recommended. For less powerful computers, there are other Ubuntu distributions such as Lubuntu and Xubuntu

Releases

Each Ubuntu release has a version number that consists of the year and month number of the release. For example, the first release was Ubuntu 4.10 as it was released on 20 October 2004. Version numbers for future versions are provisional; if the release is delayed the version number changes accordingly.

Use of Self Propelled Eight Row Rice Transplanter in Odisha

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Introduction

Rice is the major *Kharif* crop of India covering 42.8 million ha amounting to 85.7 million tonnes of production (india.gov.in, 2012). Odisha contributes more than 4 million ha area under rice cultivation. The demand of cereals to meet the food requirements of the burgeoning population is increasing while on the other hand most vital inputs of agriculture *viz*. water and labour are depleting in the area. The conventional system of rice production in this region is basically water, labour and energy intensive, adversely affecting the environment. The area under transplanted paddy in Odisha is 1.66 million hectare as compared to 2.24 million hectares under broadcasted paddy (2012-13). Due to severe weed problem and grazing in lean season, farmers prefer transplanting than direct sowing of seeds. It is a labour intensive operation which requires 300-350 man-h/ha. Before being transplanted, seedlings of improved varieties are grown for 20 25 days of time in the nursery. Transplanting of rice seedlings into puddled fields is widely practiced in India, primarily for better control of weeds. Rice seedlings are transplanted randomly without definite distance or space between plants. Manual transplanting requires less seed but much more labor, and the crop takes longer to mature because of the transplanting shock. Planting in straight rows will make it easier to control weed or apply fertilizers, herbicides, or insecticides. The increase in labour cost and scarcity of labourer for transplanting paddy has made it necessary to mechanize this operation. It is, therefore, essential to adopt mechanical methods so that the timeliness in transplanting operation could be ensured and the cost of cultivation is minimized to increase the profitability as well as productivity and production in the farm.

Traditional Practices and Necessity for Introduction of Transplanter

Transplanting of paddy in Odisha is usually done manually by hired female labour. This operation is highly labour consuming and strenuous for the agricultural labours. During the transplanting season farmers adopt contract transplanting on area basis which results in low plant density leading to lower yield. Timely transplanting is affected by scarcity of labour during peak season. Delay in transplanting results in decrease in yield. Labour requirement for manual transplanting of paddy requires 300 350 man-hours per hectare, which is roughly 25 % of total labour requirement of rice production. Mechanical weeding by weeders is also not possible due to random placement of seedlings in manual transplanting. Plant population is an important parameter of yield maximization. Transplanting of seedlings is the most arduous and expensive operation in rice cultivation. The uprooted seedlings are to be put in puddled soil. A person puts 2-3 seedlings per hill in the puddled soil at a depth of 3-5 cm. The person moves in back ward direction in bending posture in puddled soil. On an average, a worker dips fingers 1,40,000 times to transplant one acre of land and can

transplant only 0.016 ha/day (Swain, 1997). To overcome this difficulty and to increase the work output a front line demonstration on 8 row self-propelled riding type transplanters was conducted by AICRP on Farm Implements and Machinery, OUAT, Bhubaneswar, Orissa. The objective of this study was to evaluate the performance of rice transplanter in the farmers' field and to get their feedback on the performance of the transplanter for necessary modification and mass adoption.

Salient Features of the Machine

It is a single wheel driven machine fitted with a 3.94 kW single cylinder air cooled diesel engine. The machine is riding type and it transplants seedlings from mat type nursery in eight rows in a single pass. The drive wheel receives power from the engine through V-belt, cone clutch and gear box. A propeller shaft from the gear box provides power to the transplanting mechanism mounted over the float. The float facilitates the transplanter to slide over the puddle surface. The tray containing mat type nursery for 8 rows is moved sideways by a scroll shaft mechanism, which converts rotary motion received from the engine through belt-pulley, gear and universal joint shaft into linear motion of a rod connected to the seedling tray having provision to reverse the direction of movement of tray after it reaches the extreme position at one end. Fixed fork with knockout lever type planting fingers are moved by a four bar linkage to give the designed locus to the tip of the planting finger. The planting mechanism is operated by a separate crank shaft and connecting rod system with seedling pusher. The machine uses mat type seedlings and it can transplant 0.14 to 0.2 ha/h with the help of 5 persons by working at speed of 1.2 to 1.5 km/h. The row spacing is 238 mm. Hill to hill spacing is adjustable and varies from 140 mm to 170 mm. The detailed specification of the transplanter is presented in Table 1.

Field Evaluation of Self Propelled Transplanter

Mat type seedlings were raised in the field on polythene sheets using a pre-fabricated frame of required tray size (Figs. 2 and 3). The germinated seeds were uniformly spread on the prepared soil mats and a thin layer of soil was spread over the sprouted seeds. Seed rate of 40 kg/ha was taken for preparation of mat type seedlings as compared to 70-80 kg/ha in case of manual transplanting. The growth of seedlings was monitored in the nursery for next 20-22 days till they become suitable for mechanical transplanting. Seedling height at the time of transplanting was more in case of manual transplanting because the seedlings were raised directly in the field.

The performance of the self-propelled eight rows rice transplanter was compared with traditional method of manual transplanting of root wash seedlings (Fig. 4).The standing water at the time of transplanting was less than 20 mm. The field capacity of the transplanter was 0.16 ha/h with a field efficiency of 62%. The cost of operation of the transplanter was Rs 3800/- per ha as compared to Rs 9000 per ha in manual transplanting. The saving in seed requirement was 30-40 kg/ha.

Economics of Self-propelled Rice Transplanter

It was observed that the adoption of machine resulted in net saving in cost of transplanting of Rs. 5200/ha to machine owning farmers and about Rs. 4610/ha to

farmers who got the work done on custom hiring basis (Table 3). The average payback period of the machine was worked out as 208 h. Thus, machine owners got back their investment in one year after use of 200 h annually. There was a net return of Rs. 38,150/ha to farmers in machine transplanted field as compared to Rs.23,625/ha in manual transplanted field. The higher return of Rs.14,525/ha was due to the increase in yield and savings in total labour and seed requirement.

Farmers Feedback

During the demonstration of self-propelled rice transplanters, the farmers appreciated riding type seat arrangement, maintenance free operation, ease in adjustments, high effective field capacity, savings in labour, seedlings and cost of operation (Fig. 5). The improved nursery preparation technique was also appreciated by women due to less requirement of nursery area and seeds quantity. The farmers were also getting accustomed to the technique of raising mat type seedlings. The machine is getting popular in coastal districts of Odisha where there is an acute shortage of labour during rice transplanting. Farmers reported an increase in yield of 10-12% with the use of self-propelled rice transplanter due to uniform plant population and healthy crop environment in line planted crop. No specific problem was reported by farmers in operation of the machine after initial training on its operation in participatory mode. Farmers reported that the planting fingers need replacement every year.

Status of Technology

The large scale frontline demonstrations of 8 row self-propelled rice transplanters were carried out at farmer's fields in a total area of 96 ha during 2004-2013 in different villages of Khurda, Puri, Balasore, Cuttack, Bhadrak and Sonepur districts of Odisha state. The machine was demonstrated at Hirakud command area during 2008-12 and an area of 68 ha was covered. The machine was widely accepted by the farmers of Odisha state as more than 1900 transplanters were sold during 2013-14 to 2015-16. Presently, about two thousand self-propelled rice transplanters are in use in Odisha state. The state govt. is giving subsidy up to 75% on purchase price of transplanter to the farmers.

Water Resources

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Introduction

Water resources are sources of water that are potentially useful. Uses of water include agricultural, industrial, household, recreational and environmental activities. The majority of human uses require fresh water. 97% of the water on the Earth is salt water and only three percent is fresh water; slightly over two thirds of this is frozen in glaciers and polar ice caps. The remaining unfrozen fresh water is found mainly as groundwater, with only a small fraction present above ground or in the air. Fresh water is a renewable resource, yet the world's supply of groundwater is steadily decreasing, with depletion occurring most prominently in Asia and North America, although it is still unclear how much natural renewal balances this usage, and whether ecosystems are threatened. The framework for allocating water resources to water users (where such a framework exists) is known as water rights.

Surface Water Resources

Surface water is water in a river, lake or fresh water wetland. Surface water is naturally replenished by precipitation and naturally lost through discharge to the oceans, evaporation, evapo-transpiration and groundwater recharge. Although the only natural input to any surface water system is precipitation within its watershed, the total quantity of water in that system at any given time is also dependent on many other factors. These factors include storage capacity in lakes, wetlands and artificial reservoirs, the permeability of the soil beneath these storage bodies, the runoff characteristics of the land in the watershed, the timing of the precipitation and local evaporation rates. All of these factors also affect the proportions of water loss. Human activities can have a large and sometimes devastating impact on these factors. Humans often increase storage capacity by constructing reservoirs and decrease it by draining wetlands. Humans often increase runoff quantities and velocities by paving areas and channelizing stream flow. The total quantity of water available at any given time is an important consideration. Some human water users have an intermittent need for water. For example, many farms require large quantities of water in the spring, and no water at all in the winter. To supply such a farm with water, a surface water system may require a large storage capacity to collect water throughout the year and release it in a short period of time. Other users have a continuous need for water, such as a power plant that requires water for cooling. To supply such a power plant with water, a surface water system only needs enough storage capacity to fill in when average stream flow is below the power plant's need. Nevertheless, over the long term the average rate of precipitation within a watershed is the upper bound for average consumption of natural surface water from that watershed.

Natural surface water can be augmented by importing surface water from another watershed through a canal or pipeline. It can also be artificially augmented from any

of the other sources listed here; however in practice the quantities are negligible. Humans can also cause surface water to be "lost" (i.e. become unusable) through pollution. Brazil is the country estimated to have the largest supply of fresh water in the world, followed by Russia and Canada.

Under River Flow

Throughout the course of a river, the total volume of water transported downstream will often be a combination of the visible free water flow together with a substantial contribution flowing through rocks and sediments that underlie the river and its floodplain called the hyporheic zone. For many rivers in large valleys, this unseen component of flow may greatly exceed the visible flow. The hyporheic zone often forms a dynamic interface between surface water and groundwater from aquifers, exchanging flow between rivers and aquifers that may be fully charged or depleted. This is especially significant in karst areas where pot-holes and underground rivers are common.

Ground Water Resources

Ground water is a precious and most widely distributed resource of the earth and unlike any other mineral resources; it gets annual replenishment from the precipitation. The world's total water resources are estimated at $1.37X10^8$ million ha-m. of these global water resources about 97.2% is salt water mainly in oceans and only 2.87% is available as fresh water at any time on the planet earth. Out of this 2.8% fresh water, about 2.2% is available as surface water and 0.6% as ground water. Even out of this 2.2% of surface water 2.15 % is fresh water in glaciers and ice caps and only of the order of 0.01% ($1.36X10^4$ M ha-m) is available in lakes and reservoirs, and 0.0001 % in streams, the remaining being in other forms -0.001% as water vapor in atmosphere, and 0.002 % as soil moisture in the top 0.6m, out of 0.6% of stored ground water, only about 0.3% ($41.1X\ 10^4$ M ha-m) can be economically extracted with the present drilling technology, the remaining being unavailable as it is situated below a depth of 800m.

Thus ground water is the largest source of fresh water on the planet excluding the polar ice caps and glaciers. The amount of ground water within 800m from the ground surface is over 30 times the amount in all fresh water and reservoirs and about 3,000 times the amount in stream channels, at any time.

At present nearly one fifth of all the water used in the world is obtained from ground water resources. Agriculture is the greatest user of water accounting for 80% of all consumption. It takes roughly speaking, 1000 tons of water to grow one ton of grain and 2000 tons to grow one ton of rice. Some 15% of world's crop land is irrigated. The present irrigated area in India is 60 million ha (M ha) of which about 40% is from ground water.

Resolution of Moral Hazard in Democracy: Unanimously Agreeable Fundamentally Fair Rational System of Governance

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Introduction

This is a significant revision of my rejoinder, dated May 7, 2016, to U.S. President Barack Obama's proclamation that there exists no unanimously agreeable "better" alternative system of governance to the currently practiced democracy. President Obama did not spell how the term “better” should be measured. The only unanimously agreeable goal of every individual is freedom. The only unanimously agreeable measure of whether a system of governance is better than another is, therefore, less costly way (e.g., without violent wars) of attaining freedom. Moral hazard (blackmailing) is antithetic of freedom. The current system of corporate as well as public governance is based on a presumption that moral hazard cannot be resolved efficiently. This presumption is a mistake at best and self-serving for blackmailers at worst.

What is Moral Hazard in Corporate Governance?

The term "moral hazard" is an academic euphesim for the commonly understood term "blackmailing." The academy of economics and finance presumes, for example, that the chief executive officer (called the agent) is privileged by his monopoly over the valuable information of running a company. The CEO uses this privilege to arrogate first-best status (pays and perquisites) by subjecting the true owners (principals) of the company to second-best sustenance, e.g., by paying significantly lower dividends than that feasible without such monopoly. The academic literature presumes that the principals have no better alternative than granting such monopoly to the CEO. The blackmailing of principals by the CEO of a company is, thus, ordained by the extant academic literature.

This blackmailing problem in corporate governance can, however, be efficiently resolved if the principals (i) choose the directors on the BOD (board of directors), each with a skills and capability to replace the current CEO and each allowed to share all valuable information (now being monopolized by the CEO), (ii) disallow the CEO to nominate/appoint any BOD member, and (iii) recruit each BOD member as diligently as hiring of the CEO. The principals can, thus, maintain a virtual rivalry among the CEO and every BOD member. The Principals must monitor such rivalry with corporate accomplishments through periodic general body meetings. This way, the principals can avert being blackmailed by the current corporate system of a monopolising CEO with a crony BOD.

Moral Hazard in the Current Democracy

Democratically elected leaders are wont to spreading a myth that the existing democratic system is the only form of governance of *We the People* with a propaganda that nothing better exists to attain individual freedom efficiently. The democratically elected leaders sermonize *We the People* that no better unanimously agreeable form of governance exists. By indoctrinating *We the People* with such sermons, democratically elected leaders have arrogated power to enact significant rules and policies to facilitate legalized systemic robbery of enterprising wealth creators. This democratic system so financially eviscerates the vast majority robbed of their wealth and wherewithal that they cannot easily contest against the established democratically elected leaders. This has resulted in inefficiency (decay in national competitiveness), social instability and fundamental unfairness (unconstitutionality). This is moral hazard (blackmailing) of *We the People* by democratically elected leaders.

President Obama, for example, proclaimed at Howard University on May 7, 2016 that no better alternative to the exisying system of democracy. Churchill said it (House of Commons, 11 November 1947)but he was quoting an unknown predecessor. From *Churchill by Himself*, page 574: Many forms of Government have been tried, and will be tried in this world of sin and woe. Indeed it has been said that democracy is the worst form of Government except for all those other forms that have been tried from time to time. President Obama and other democratically elected leaders including Churchill have obviously meant that there is no unanimously agreeable better alternative to the currently practiced democracy. They have all seriously erred. Here is a unanimously agreeable better alternative (to the currently practiced system of democracy) which is necessary for civilized coexistence of humanity with social stability, economic efficiency (national competitiveness) and fundamental fairness:

Unanimously Agreeable and Fundamentally Fair Democracy. It is democracy with a *new constitutional preamble* that explicitly proscribes enactment (by elected leaders) of any rule or policy to facilitate legalized robbery of individual or common wealth, even surreptitiously. This alternative system of governance is fundamentally fair and unanimously agreeable because even the robbers (including, e.g., the democratically elected leaders that turn selfish and greedy to vote for laws for legalizing systemic robbery) do not like to be robbed of their power and wealth (e.g., by people eventually turning conscious of systemic robbery and revolting against such democratically elected leaders). This alternative system of governance has evolved over decades of research within dynamic microeconomics models of general equilibrium in which individuals, households and corporations maximize their net-worth with the government operating not-for-profit and efficiently and with the markets pricing and trading securities without government-ordained intervention.

Democracy is, theoretically, unnecessary to attain a fundamentally fair system with efficiency and stability for individual freedom. The theoretical Walrasian central planner - who can allocate resources for everyone efficiently- is sufficient. But practically all nations that tried the Walrasian central planning system (in the name of socialism and communism) have failed. Countries like China and India had to amend, if not completely disband, their central planning systems.

Systemic robbery has, in the real world, created rampant subsidies, quotas and privileges funded by (or bonding) the robbed enterprising wealth creators. Stifling freedom of enterprising wealth creators has unmotivated them to slog their best for the indolent usurpers. This has resulted in economic inefficiency (eroding national competitiveness), deterioration in innovation and productivity and lethargy among usurpers. This real-world experience shows that democracy per se is insufficient to beget individual freedom. The unique common cause of failure of all the existing systems of governance in providing individual freedom is, thus, systemic robbery of enterprising wealth creators by either the democratically elected leaders and their allies in industry and academy or by the self-anointed authoritarian leaders.

The *Unanimously Agreeable Fundamentally Fair Democracy* is a unique system of governance available for *We the People* worldwide to attain individual freedom with efficiency (survival with limited resources), stability (without social internecine) and civilized coexistence. This path naturally begets individual freedom by proscribing moral hazard (blackmailing of *We the People*) in the currently practiced system of democracy. Proscription of moral hazard (blackmailing) is essential for individual freedom. Moral hazard has bonded enterprising people everywhere in the world. *Unanimously Agreeable Fundamentally Fair* rules could sans democracy is sufficient to beget individual freedom, but a democractic system with freedom of expression can facilitate even an apolitical individual (such as this author) to challenge any potential deviation from such rules.

This discovery has, therefore, virtually *crucified* its sole author with: (i) credible threats of unemployment, (ii) actual collusion to block publication of his research discoveries with steps taken to purge him from the academy (which no longer is a fountain of epistemic truth), (iii) raids of his research center (perhaps to plant evidence for prosecution as a criminal), (iv) decimating his income to a paltry one-fifth of the pay of the vanquished antithetic pundits of systemic robbery (which ironically proves penultimate efficiency of the author), etc. Despite such threats from the colluding established powerful interests everywhere, the author and his philosophy of Unanimously Agreeable Fundamentally Fair Democracy have *triumphed*. I can rationally vouch for every step that I have taken since 1991 for such triumph. One may still question how, despite all the odds stacked against me, I could take such steps on time. One can irrationally avoid this question by terming it as providential. Rationally, however, I see this as mutation of the human gene fighting for survival to produce eventually someone to undo a system turning rampantly destructive. This has happened, historically, since the ancient humanity struggled and cultured to devise a system of governance for survival which was first written as Gita in 3500 B.C.

If we proclaim the existing form of governance - democracy with systemic robbery of people on the left, right and center - as the ultimate system for civilized coexistence, the human species may be destroyed, just like the powerful dinosaurs died on earth. The triumph of a single individual over very powerful mega vested interests of systemic robbery, however, indicates that the human gene can survive eternally through Unanimously Agreeable Fundamentally Fair Democracy.

Scope and Opportunities in Mechanization of Jute and Allied Fibre Crops

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Introduction

Farm mechanization implies use of various implements and machines in crop production and post-harvest operation. The fibres from jute and allied fibre crops are not obtained during crop harvest, unlike cotton. These fibres in their original state are usually tightly bound in the stems of plants (leaf in case of sisal) and must be separated from the woody and gummy substances that bind them together. Until the harvest, the potential to obtain good quality fibre is the same for any two farmers using the same variety and the management skill; but method of fibre extraction precise or faulty may provoke wide differences in the quality of fibre produced. Fibre extraction has to be carried out with much care in order to obtain the best yield and quality of fibre. Manual labour involvement in fibre extraction is more and its reduction through introduction of mechanization is essential in order to reduce the cost and improve the quality of fibre. Considering the socio-economic situations and production problems of these fibres, the research efforts are made at CRIJAF in the development of appropriate technologies for production and extraction of these fibres. The cultivation of jute and allied fibres involves six major operations viz. land preparation, sowing, weeding & thinning, plant protection operation, crop harvesting and fibre extraction. The operations like weeding & thinning, harvesting, retting and fibre extraction are labour intensive.

CRIJAF 4-row Jute Seed drill

Manually operated multi-row (4 rows) seed drill has been developed to sow jute seed in line. Seeder is operated by a man/women and sowing capacity is similar to conventional broadcast about 5-6 h/ha. Line sowing (spacing- row to row 25 cm, plant to plant 5-7 cm) by the machine of capacity 0.2 ha/h is more economical and profitable, as the seed requirement reduces by more than 50 per cent i.e. 3-4 kg/ha, besides ensures uniform germination and proper crop stand and also facilitates other post-sowing operations. Due to evenly plant population, uniform distribution of soil moisture, plant nutrients and solar energy in line sown jute, the overall fibre yield increases about 10-15 per cent with overall reduction in cost of cultivation of about Rs. 6000/- per ha in comparison to broadcast sowing.

Weeding equipment

Weeding after 30-40 days of sowing is most important operation in jute cultivation. Weeding of jute field by manual labour using traditional weeding tools like khunti, khurpi etc. leads to more time and more expenditure. Manual weeding requires 90-

160 labourers/ha and about 30 per cent of total production cost. For delivering economic advantages out of line sowing, high speed mechanical weeding is essential.

CRIJAF Nail weeder developed at ICAR-CRIJAF helps to weed out young composite weed flora including germinating ones from line sown crop since 3 - 4 days of crop sowing. It is used at 5 days interval (5-30 days of crop age) in between lines and controlled about 80 - 85 per cent weeds. It requires 7-10 labours/ha against 90-160 labourers/ha (2-3 weeding) in broadcast sowing and there is a saving of about Rs. 15000/ha in weeding and thinning operation in line sown jute crop.

A more efficient "CRIJAF single wheel jute weeder" has been developed at ICAR-CRIJAF to cater the mechanical weeding of jute and similar line sown crops. The weeder consists of body frame, wheel, tyne attachment frame (hoe type and scraper) and handle. The body frame was made with M S flat (180 x 5 mm) for its durability. The weeder operates on a cycle wheel (compact) of diameter 40 cm for its easy operation in the field with less rolling resistance. The overall dimensions of the weeder including handle are 40 x 157 x 99 cm (W x L x H) from the ground and it weighs 9 kg. The handle grip is made of 22 mm G.I. pipe and elbow flex- on angle is kept at 1000 to reduce the drudgery of operator. The weeding capacity/ field capacity of weeder is 0.026-0.028 ha/h i.e. 35 man-hours/ha. It is used 15-30 days of crop age in between lines and controlled about 80 - 85 per cent weeds. There is saving of more than 60% of weeding time and saves about Rs.14000-15000/- per ha over manual weeding operation.

Fibre Extraction

The improved technology involves mechanical extraction of ribbon with the help of machine followed by retting of ribbon in water is termed mechanical-cum-retting method. Fibre extraction is carried out in two phases i.e. first separation from the wood by machine and later from the gummy substances by retting. Machines were developed for the extraction of ribbon of the harvested plants and also developed technique for retting ribbon by steeping vertically. This method is applicable to bastfibre crop i.e. jute, mesta, sunnhemp and ramie. Details of the developed machines are given below.

CRIJAF Jute Extractor

Manually operated portable machine was developed to extract green ribbon (keeping stick intact) from the harvested jute plants. It is light in weight (about 50 kg), feasible to operate in field condition by a man/women. Freshly harvested jute plants (about 5 nos.) are fed by the tip end upto 15 cm length in to the machine.After activating ribbon separation unit by pressing foot and pulling the canes back manually, green ribbon remains in the hand of the operator while unbroken stick is ejected forward. Green ribbon extraction capacity is equivalent to about 18-20 kg dry fibre/hour.

CRIJAF Bast Fibre Extractor

Power operated portable machine was developed to extract green ribbon of jute,

Mesta, Sun hemp and Ramie plants by breaking the stick into small pieces. The machine works on the principle of beating the canes progressively down its length and scrapping when the operator pulls out the canes. The machine is powered by 1 hp electric motor and weight about 125 kg. About 5-6 normal canes can be fed into the machine at a time by a person and ribbon extraction capacity equivalent to dry fibre is about 22, 15, 8 and 10 kg per hour for Jute, Mesta, Sun hemp and Ramie, respectively.

Retting of Ribbon

An improved method of vertical steeping of ribbon in captive low-volume water has been developed to get fibre of improved quality in lesser time. The green ribbon extracted by the machine is held vertically in the water (pit/pond) with the help of bamboo or bamboo grid for retting which is completed in about 7-9 days for jute and mesta and 3 days for sunnhemp and ramie. The retted fibre is washed, preferably in clear water and the resultant fibre is bright in colour, clear, uniform, root-less and strong, which are attributes quality of fibre. Vertical ribbon steeping method reduces water requirement and retting duration by about 50% in comparison with the conventional horizontal steeping of plants.

Raspador Decorticator

For the extraction of sisal and ramie fibre directly from the harvested leaves/canes, the machine 'Raspador Decorticator' was developed, which is powered by 5 hp motor/engine. Sisal leaf or ramie canes are fed in to the machine and manipulated manually to extract fibre. The machine works on the principle of rapid beating and scraping leaves/canes progressively down its length through a rotating drum having beater knives on the periphery. The rotating drum maintains clearance (in which leaves/canes travel) against the base plate for rasping action. It involves two directional feeding actions. A person can extract about 10 kg sisal and 6 kg ramie dry fibre per hour.

CRIJAF Flax Fibre Extractor

Fibre is extracted from flax or linseed plants/stalks after harvesting, deseeding, retting and drying of plants/stalks through mechanical action called scutching. In India flax stalks which contains fibre are remain unutilized after deseeding due to non-availability of suitable machine. The newly developed 'CRIJAF flax fibre extractor' is portable, energy efficient and the scutching efficiency of this machine is more than the manual fibre extraction (1 kg/day). The machine consists three sets of fluted nylon rollers through which straw passes for scutching action. Dry retted flax or linseed stalks are fed manually into the machine and scutchedfibre is collected by the same person. Fibre extraction could be done by man/women in standing or sitting posture. The dimensions of the machine are 840 × 730 × 1120 mm (L ×W ×H) and weighs158 kg.The Capacity of machine is about 5-6 kg dry fibre per hour. It can deal 140 kg of retted and dried straw in a day and can produce 30-35 kg fibre.To extract fibre of a hectare area it needs about 22 working days i.e. 44 man-days for its operation and yields fibre about 643 kg / ha. By use of the machine the labour requirement reducing

from 665 man-days/ha by manual method to 109 man-day/ha.Flax fibre extraction with this machine was found economical and feasible. The cost of machine is Rs. 40900/- (including electric motor).

Ramie and Sisal Fibre Extractor

A portable "ramie and sisal fibre extractor" was designed, developed. The machine is operated by single- phase 3hp electric motor or can be operated by 3.5 hp Diesel engine. The machine needs two workers for its operation; one for material feeding and manipulation into the machine and the other for collection and disposal of machine waste and extracted fibre etc. The throughput capacity and material capacity for ramie fibre extraction is about 300-350 kg plants per hour and 10-12 kg dry fibre for hour, respectively. Similarly, the throughput capacity and material capacity for sisal fibre extraction is about 330-380 kg green leaves per hour and 12-14 kg dry fibre per hour, respectively. The CRIJAF ramie and sisal fibre extractor produces 55-60 % more fibre than existing 'raspador' decorticator with extraction efficiency of more than 90 per cent. The overall dimension of the machine is 1.00 × 1.00 × 1.12 m (L × W × H). The approximate weight of machine with electric motor is about 185 kg. The cost of machine is Rs. 43500/- (including electric motor).

KRISHAK BANDHU

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ଫୁଲବାଣୀ - ୯୪୩୮୭୮୯୭୪
କେନ୍ଦୁଝର - ୯୪୩୭୧୬୭୧୬
ବଲାଙ୍ଗୀର - ୯୪୩୭୦୬୦୪୧୬
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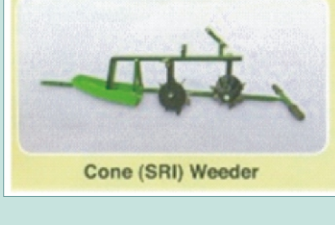
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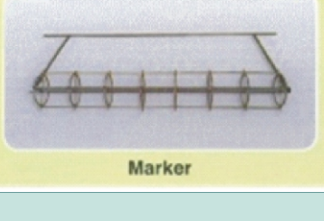
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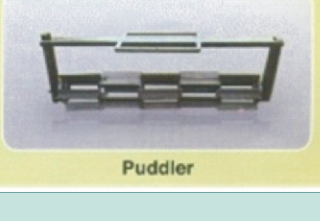
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