Social Innovation in Industry 4.0

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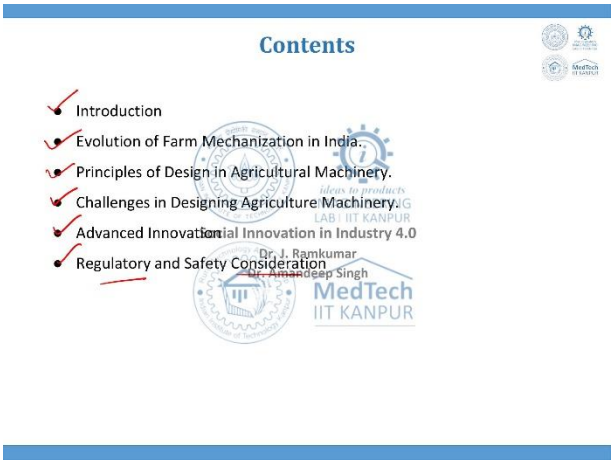
Lecture 37

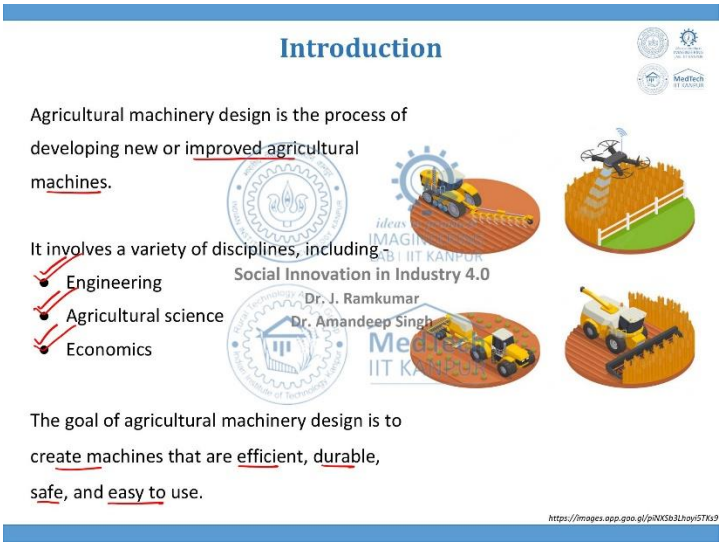
Design and Social Innovation in Agriculture Machinery

Welcome back to the course on Social Innovation in Industry 4.0. I have discussed about Design and Social Innovation in Medical Devices in the last few lectures. I will now talk about Design and Social Innovation in Agriculture Machinery.



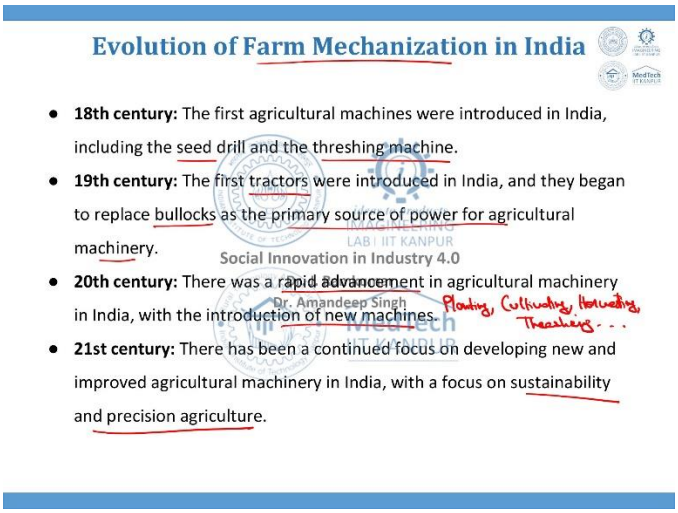
The Contents of the lecture would go in this way. I will just Introduce the Social Innovation part in agriculture machinery. Because we are talking about Design in Agriculture Machinery, the Design in Agriculture Machinery is just not as stringent as what we do in medical devices, but still there are regulatory requirements for that as well. We will try to see them. Evolution of Farm Mechanization in India, Principles of Design in Agriculture Machinery.

Those, you have already studied about design thinking, about the design of medical devices, design in general. But, in agricultural machinery also, we will try to see. Some Challenges are there in Designing, then Advanced Innovation nowadays, that is coming, and Regulatory and Safety Considerations for Agriculture Machinery specific points.



Introduction, agriculture machinery design is a process of developing new or improved agriculture machines. It involves a variety of disciplines including engineering, agriculture sciences and economics. Engineering is because we always have the design of machines here. It is a mechanical design. It could include some software parts nowadays because smart systems are there where we try to monitor the health of the crop as well, health of the farm as well. So, those things are always there. There are certain digital tools also these days which are now being developed by IT engineers, computer engineers. So, engineering becomes a part of it.

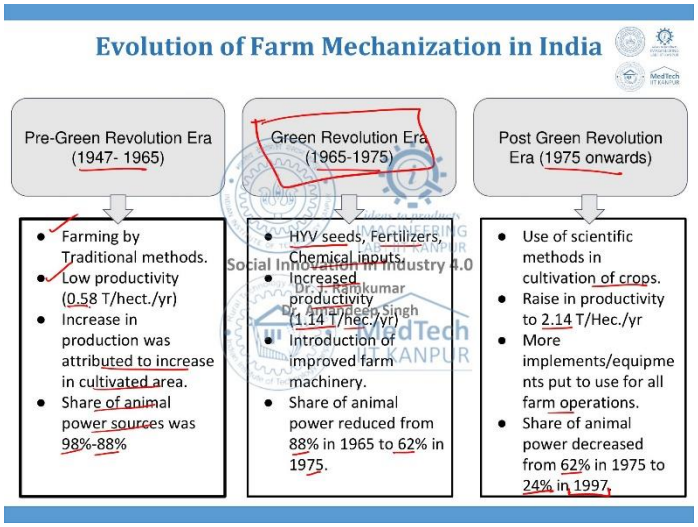
Agriculture science, if I say agriculture science is how to increase the yield, what kind of the depth of the tools that you, suppose, need to sow seeds or need to take the seedlings out or so. So, these agriculture science parts would be covered. Economics part means the business that is being generated from agriculture, the total Agro industry. What is contributing to the overall development of a country? Like, India is one of the agribusiness countries. So, economics people also become part of it. The goal of agriculture machinery design is to create machines that are efficient, durable, safe and easy to use.



If we try to see the evolution of farm mechanisation in India in the 18th century, the first agricultural machines were introduced in India including seed drill and threshing machines. Then, in the 19th century, the tractors came into the picture and they were introduced in India and they began to replace the bullocks, and the primary source of power for agriculture of machinery became the tractors itself.

In the 20th century, there was a rapid advancement because there was an industrial revolution in the 20th century as well. So, in agricultural machinery as well, in India the introduction of new machines came, in which new machines for all the different processes, for planting, for cultivating, for harvesting, and all the similar processes threshing can also be written here, and so on.

In the 21st century, there has been a continued focus on developing new and improved agricultural machinery in India with a focus on sustainability and precision agriculture. This is the major focus nowadays as well.

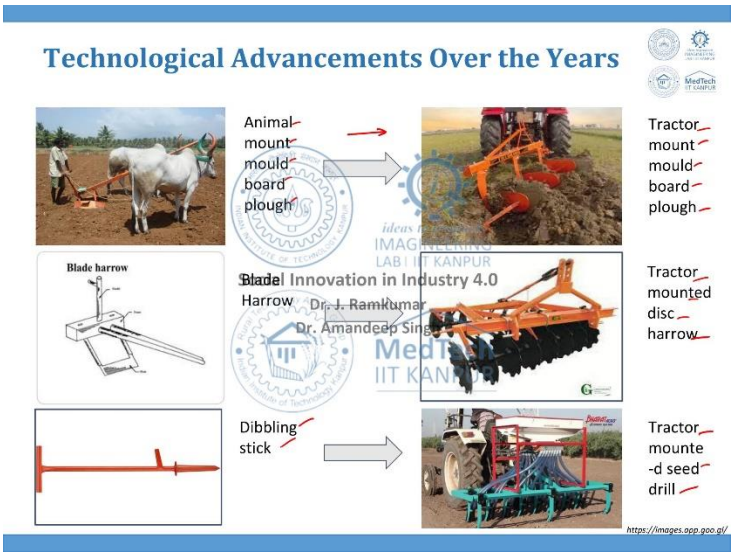


So, let us try to see the revolutions that came through the green revolutions in India. There were three eras 1947 to 65, then 65 to 75 and 75 onwards. This was the post-independence era from 1947 to 65, farming by traditional methods were going on and productivity was very low. That means, it was 0.58 tons per hectare per year. Increase in production was attributed to increase in cultivated area, the share of animal power sources was 98 to 88 percent.

Now in the second revolution era, when the green revolution was there from 1965 to 75 in which India was still a food scarce country, but now India is a food surplus country. We also export a lot of rice, a lot of wheat to neighboring countries or to many other developed countries as well. So, when the green revolution came, HYV seeds, fertilizers, chemical inputs were there, productivity increased from 0.58 to 1.14 tons per hectare per year.

Introduction of improved farm machinery was there, the share of animal power reduced from 88 percent in 1965 to 62 percent in 1975. Then, post green revolution, the use of scientific methods in cultivation came into existence, raise in productivity to 2.14 tons per hectare per year.

More implements or equipment were put into use for all farm operations, the share of animal power decreased from 62 percent to 24 percent in 1997 because here we had tractors, we had combines, we had harvesters, cultivators, those was used to replace the animals and mechanical system was used which were fueled using the petrol or diesel to get the output in a more efficient way.

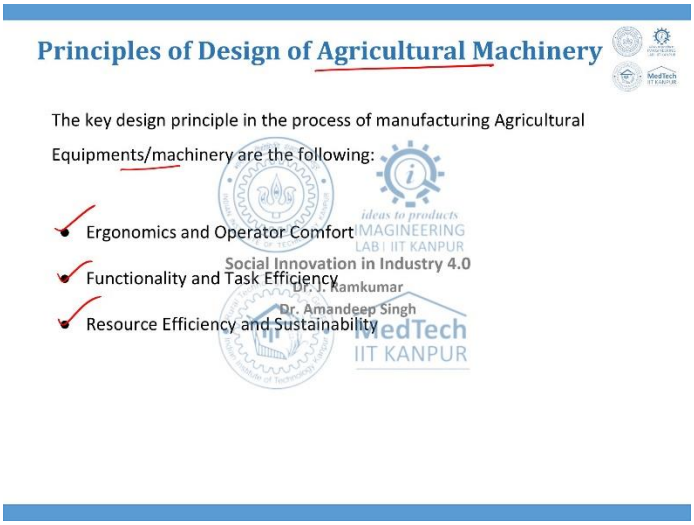


Next is the technological advancement over years, the animal mount moldboard plough. All the things were there in the beginning, which turned to the tractor mount moldboard and plough, and this was mechanization of the system.

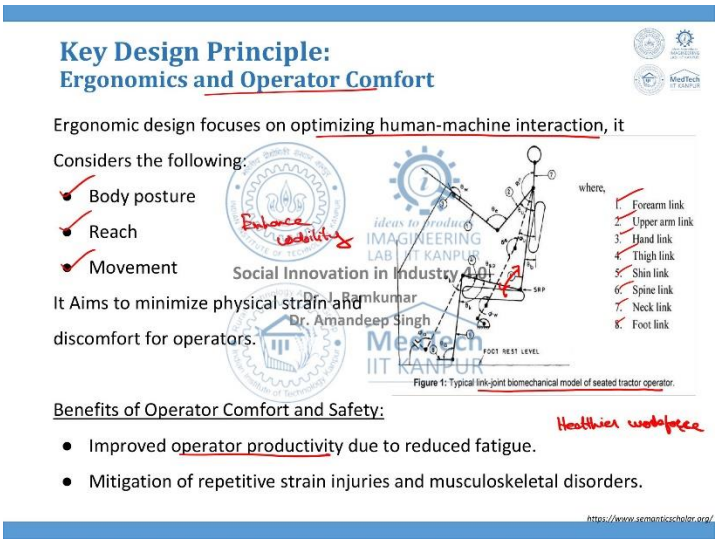
Then, a blade harrow was there which was used for harrowing or preparing the land. So, this turned to the tractor mount risk harrow, there were harrows, there were reapers, there were so many mechanical things now. Dibbling stick which was there that was replaced by tractor mounted seed drill. These were the advancements which came into existence in the initial years only, that is around 1975 or so.

Then, animal drawn planters were there in the beginning, now tractor driven planters then came into existence which replaced the animal drawn planter and these were more efficient, maybe 10 times the number of plants being shown using tractor driven planters now, then it was shown using the animal drawn planter.

Hoes were also replaced by power tillers, then paddy harvesters were also replaced by self probalt combined harvesters. Now, combines were not purchased by all the farmers, but nowadays, for harvesting as well, the farmers give the combined work to the third party. Third party means the people who are owners of the combines or the people who are providing the combined services. They go to different parts of the country to do the harvesting for the people. So, this is a very fast process.



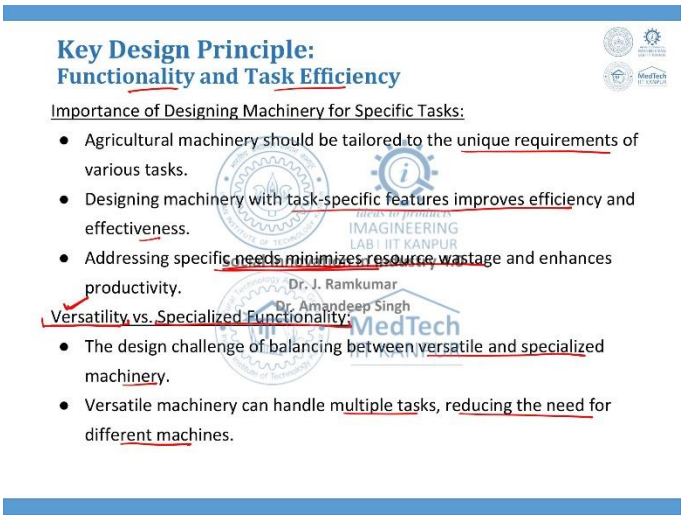
Principles of Design of Agricultural Machinery. The key design principles in the process of manufacturing agriculture equipment or machinery are the following. Number one is ergonomics and operator comfort. Though tractors, combines, tillers, anything that we are using, it should be much more comfortable for the operator to work upon them. Now, functionality and task efficiency, that becomes the basic criteria for any of the products that we try to use. And, resource efficiency and sustainability. Let us try to discuss each of these.



Ergonomics and Operator Comfort. This is a typical link joint biomechanical model of a CT tractor which was designed a few decades back, in which you can say a human forearm link, upper arm link, hand link, thigh link, shin, spine, neck and foot links are there. So, this is how a human would like to sit comfortably with this body posture and there were angles given here, at this angle the human would like to sit.

So, this means the ergonomic design or human-centric design was there already when even the tractor came into existence. The ergonomic design focuses on optimizing human machine interaction. It considers the following body posture, reach, movement. These are all discussed when we try to discuss about the medical devices as well, the overall purpose is to enhance usability. It aims to minimize physical strain and discomfort for operators.

The benefits of operator comfort and safety were improved operator productivity due to reduced fatigue, mitigation of repetitive strain injuries and musculoskeletal disorders and also it created a healthier and motivated workforce.

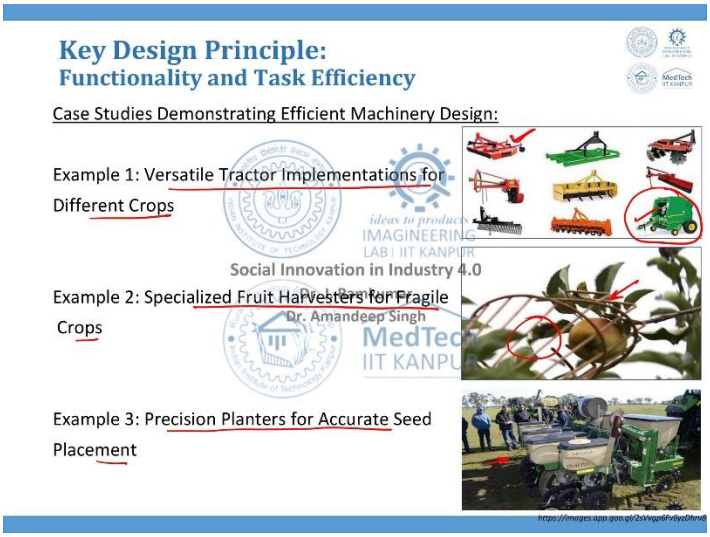


Next comes the second principle, that is Functionality and Task Efficiency. Importance of designing machinery for specific tasks, that is, agriculture machinery should be tailored to the unique requirement of the various tasks. Designing machinery with task-specific features improves efficiency and effectiveness. Addressing specific needs minimizes resource wastage and enhances productivity. Specific needs means I will show you certain examples in this presentation only, we try to develop an Amla grater.

Amla you know, it has a seed in the center and the pulp all around how to grate that so that you get the maximum output and maximum yield of the pulp grated from amla, and to deseed the amla as well is also a challenge. So, specific needs if those are focused or targeted, it leads to minimizing the resource wastage.

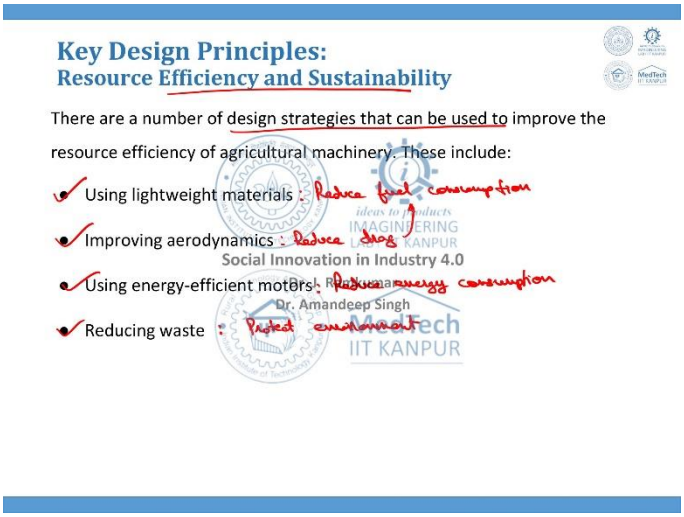
Then, versatility versus specialized functionality. Specialized functionality is only one specific task that could be done that I just mentioned about amla grating machine, or maybe bale grating machine, or maybe period separators. These machines are very specific functionality machines. Versatility machines, a single machine can do multiple things, like a tractor itself is a machine or a vehicle that can have multiple tools fit with it. A ripper, a torque, tiller, that can provide versatile operations.

The design challenge of balancing between versatile and specialized machinery is there. Versatile machinery can handle multiple tasks, reducing the need for different machines. But specialized machinery excels in specific tasks, that is for achieving high precision and efficiency for the particular task that we are trying to focus upon.

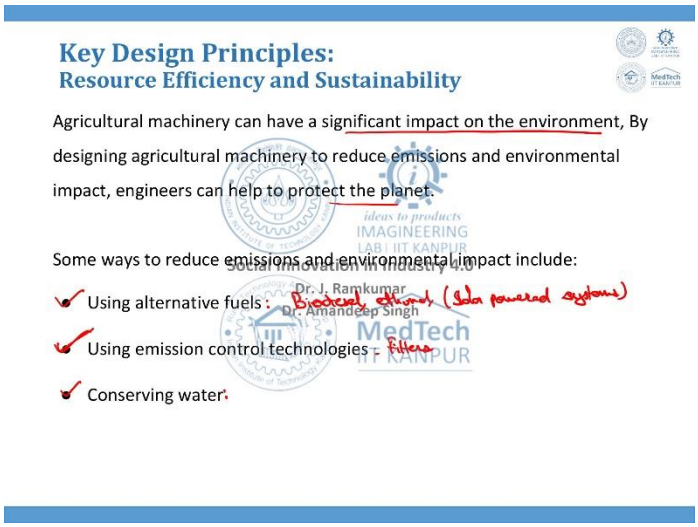


Let us try to see certain examples here. So, example 1 here is versatile tractor implementation for different crops. You can say these are all tractor implements depending upon the kind of the operation we are trying to do in agriculture. This could be attached to a tractor, and we can reap, we can sow, we can till accordingly and we can also do harvesting while adding certain attachments to a tractor.

Example 2 is specialized fruit harvesters for fragile crops. You can see to pluck a fruit from the tree, the specific tool is designed. This tool will pluck it out and it will fall in this basket. These are fruit pluckers which are the specialized fruit harvesters for the specific crops. Then, precision planters for accurate seed placement. So, for accurate seed placement, there are precision planters which are designed. If the land or the farm size is very big, these seed planters can do the work with a very high precision and within a very controlled time limit.



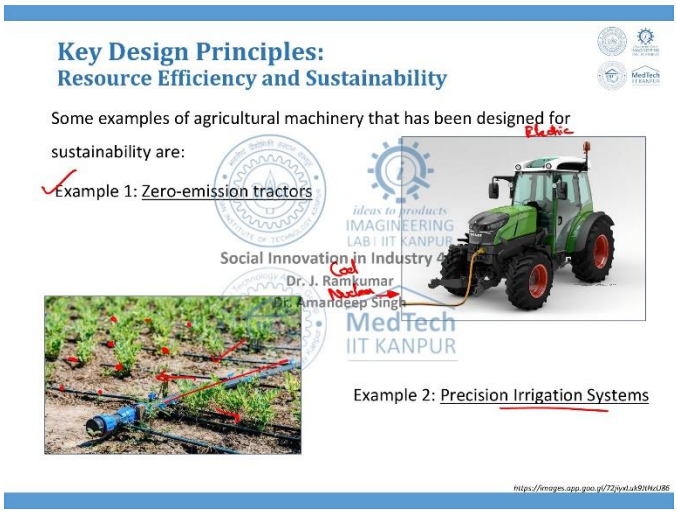
Resource Efficiency and Sustainability is the next principle. Resource efficiency if I may say, that is, there are a number of design strategies that can be used to improve the resource efficiency of agriculture machinery. These include using lightweight materials. When I say lightweight materials, it helps to reduce the fuel consumption. Then, improving aerodynamics, aerodynamics can help to reduce drag. Drag is reduced which in turn also reduces the fuel consumption. Then, using energy-efficient motors. An energy-efficient motors can reduce energy consumption. Then, reducing waste, that means we conserve the resources and protect the environment while reducing waste.



Additionally, agricultural machinery can have a significant impact on the environment. By designing agriculture machinery to reduce emissions and environmental impact engineers can help to protect the planet. Some ways to reduce emissions and environmental impact include using alternative fuels, that means we try to use biodiesel maybe, or maybe ethanol to help reduce emissions, or maybe we can also use solar powered systems. Maybe the tube-well itself that we are using the lights or the internal system of the room where the tube-well is built.

So, that could be powered using the solar energy itself, if you install a solar panel there itself. So, now using emission control technologies is also one of the ways to reduce the environmental impact, that is ex-catalytic converters and diesel particulate filters can help to reduce emissions from agriculture machinery. So, we can add any filters so that emissions are reduced. Then, water conservation.

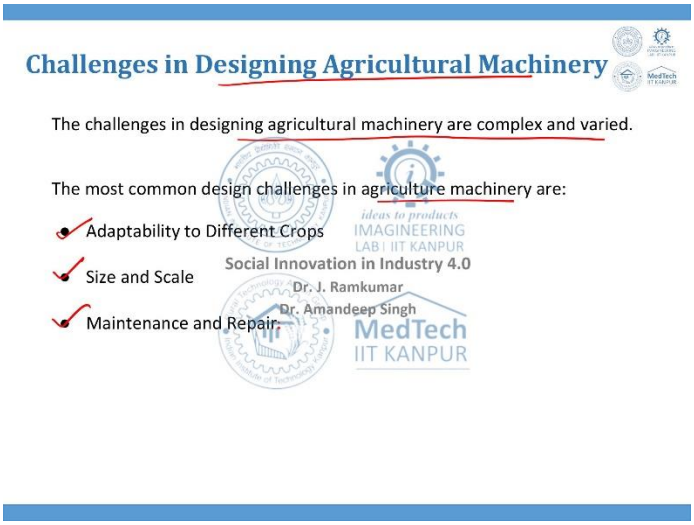
We can protect water resources and reduce the impact of agriculture on the environment. Water consumption, whatever is happening in India, over 80 percent of the water is consumed in agriculture. Domestic consumption is less than 20 percent. So, that means consuming water in agriculture becomes a critical requirement to protect the water cycle and the environment.



Some examples that could be given for the design for sustainability are zero-emission tractors. So, these are the tractors which are electric tractors because no fuel is burnt. So, therefore, there are no emissions, but yes, electric tractors are designed. Electricity is produced, from which source electricity is coming, maybe from coal, that is from thermal power plants, or maybe from nuclear power plants, which are the cleanest source of the energy.

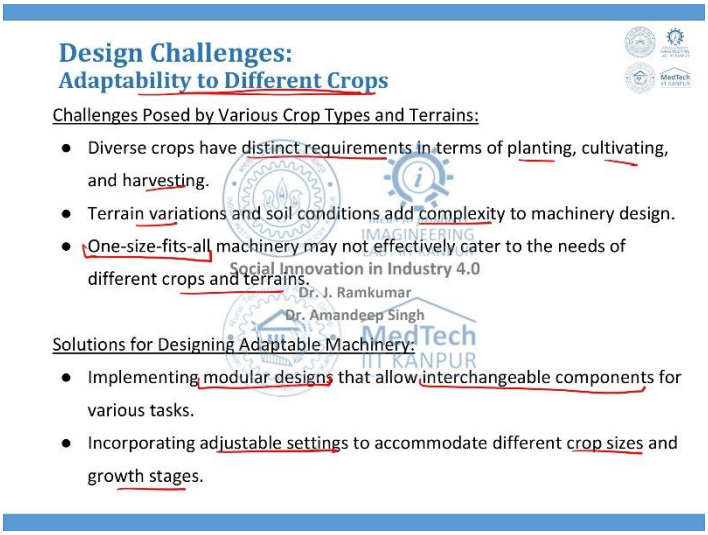
That is a secondary part, from where the electricity is coming, but still the tradeoff could be put in between. But having an electric vehicle, which has zero emissions, is also an innovation. Precision irrigation system means in the place of flood irrigation, when water is completely flooded on the land, we have the drip irrigation system at specific points wherever the water is required. The water is only applied close to the roots or where the seeds are sown.

So, this is a precision irrigation system where a larger pipe is there, and a network of the pipe is there and there might be certain holes here, close to the plants, where the system is dripping the water out.



Challenges in Designing Agriculture Machinery. The challenges in designing agriculture machinery are complex and varied. The most common design challenges in agriculture machinery are adaptability to different crops. Adaptability means where agriculture machinery must be versatile to suit diverse crop requirements. Then, size and scale which means the machinery that we are trying to design should be scalable, for varying sizes, for varying capacity of the working hours.

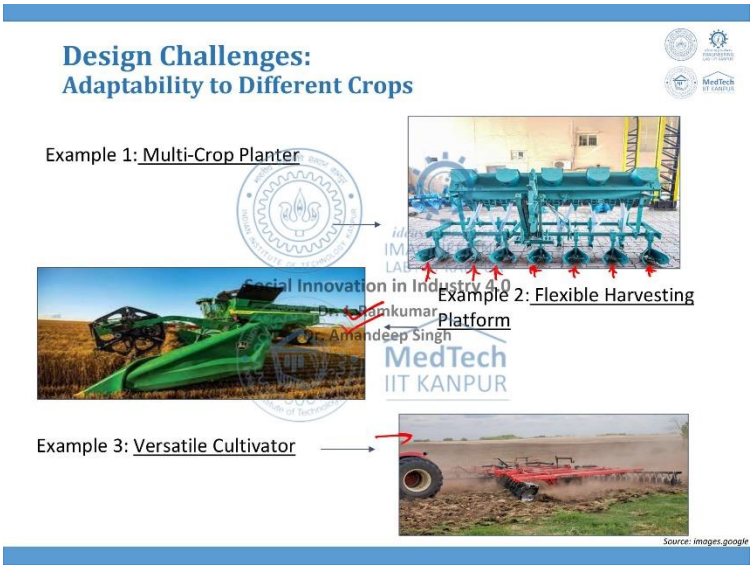
Then, maintenance and repair. The machinery, if we are trying to design a machinery, maybe an electrical vehicle is there where it is to be charged. We need to have a charging station close to the person who is using this tractor. So, maintenance and repair and providing the maintenance and repair services close to the end user and how frequently the maintenance and repair could be done, these all are part of the good design of an agriculture machinery.



First thing is the Adaptability to Different Crops. The challenges posed by various crop types and terrains. Diverse crops have distinct requirements in terms of planting, cultivating, and harvesting.

Terrain variations and soil conditions add complexity to machinery design. Terrain variations and soil conditions are different in different parts of the country or different parts of the world. In the north soil conditions are a little moist and in the south, and in places like Rajasthan or so, the soil conditions would be dry. Terrain variations we are working in the plains, plateau or mountains accordingly the machinery would be designed only.

One-size-fits-all machinery may not effectively cater to the needs of different crops and terrains. Solutions for designing adaptable machinery, that is for different variations, what solutions could be incorporated. Implementing modular designs that allow interchangeable components for various tasks. That incorporates adjustable settings to accommodate different crop sizes and growth stages. So, developing machinery with variable raw spacing and planting depths is also one of the factors that could be a machine adaptable design factor.



Let us try to see some examples. This is a multi crop planter, you can see the raw separation is equivalent here, and a planter equipped with adjustable planting mechanism for different seed sizes could be given here. Then, the second example is a flexible harvesting platform. So, this harvesting platform, that adapts to varying crop heights and conditions, is designed. Then, we have a versatile cultivator, versatile cultivator means this cultivator is versatile in a way with interchangeable tines to suit different soil types. So, this is a versatile cultivator as well.

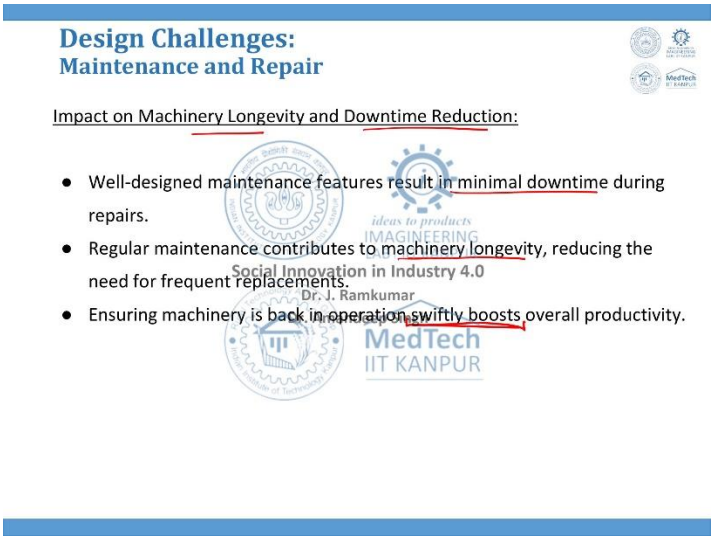
Next comes Size and Scale. Design considerations for different farm sizes. Farms come in varying sizes, from small family owned plots to large commercial operations. Machinery design needs to accommodate the unique requirements of different scales. Ensuring machinery is efficient, cost-effective and suited to the available space. So, design considerations should be for the different farm sizes. Now, challenges of scaling machinery for small and large farms. What are the various challenges here? Number one is scaling down machinery for small farms without compromising functionality.

Then, scaling up machinery for large farms without sacrificing maneuverability and efficiency. So,

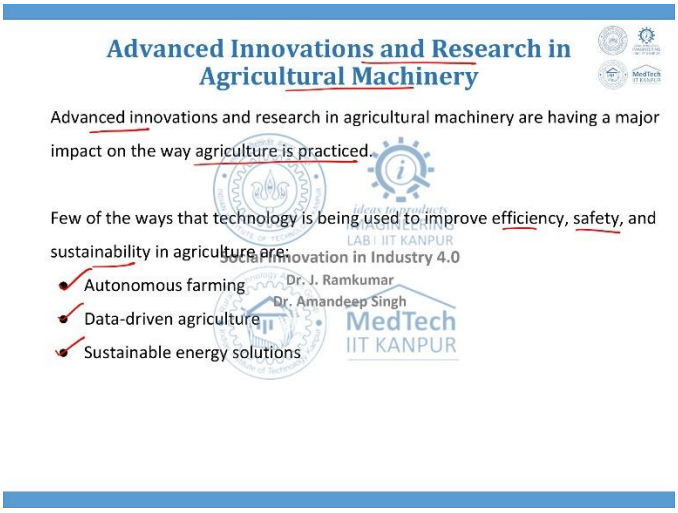
striking the right balance between, I would better put, the right balance between what power, size and, ease of use, now, this become a challenge.

Certain examples that I could quote here are compact tractors for small farms. Though the size is small, the tractors are designed with versatility and agility for smaller operations.

Then, we have modular combined systems for large farms. Modular means the system can have an attachment for the large farms. The size is smaller, but this width is too large here. So, combined systems that can be scaled up based upon the harvesting needs. So, these are the two examples here for the size and scale of modular systems.

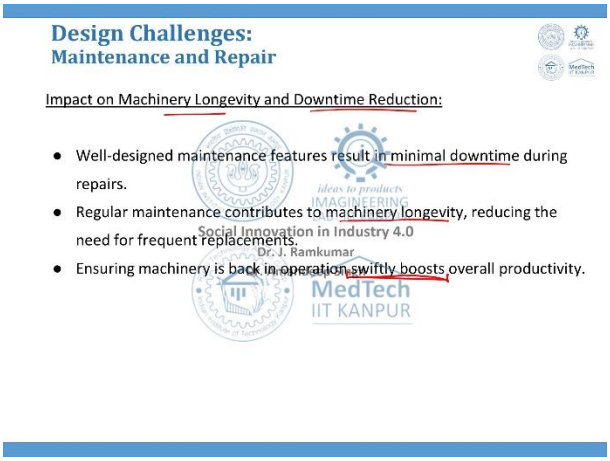


Next comes Maintenance and Repair. Importance of easy maintenance and repair design, ensuring machinery is designed for straight forward maintenance and repair is crucial. Simplifies upkeep tasks and reduces the need for specialized technical knowledge. It promotes timely maintenance, extending machinery longevity and reliability.

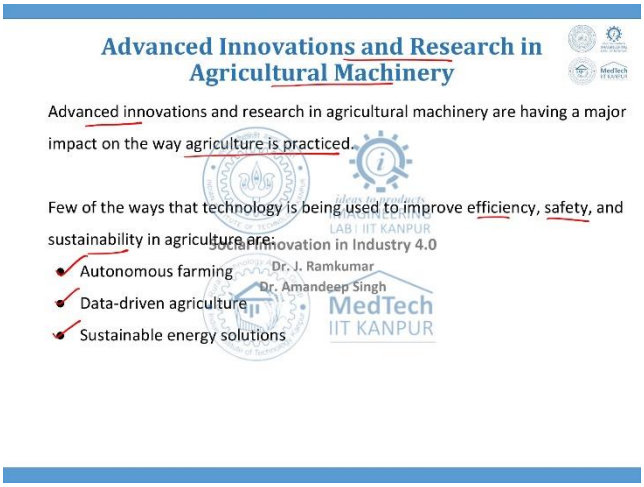


So, certain strategies for user friendly maintenance that could be put here are accessible service points. That means designing machinery with easily reachable components for maintenance.

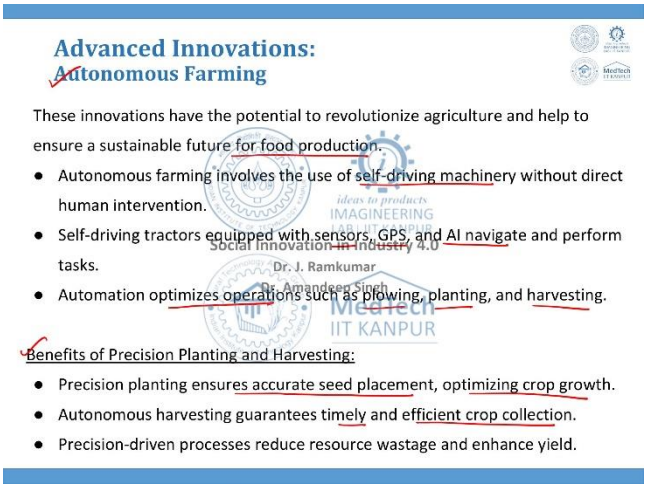
For example, tractors with easily accessible engine compartments and all checkpoints that could be more user friendly than the tractors which are to be only maintained by the professional service people. Then, clear documentation, that is providing comprehensive user manuals and guides for troubleshooting. The example could be the machinery that is accompanied by detailed guides for routine maintenance procedures. Then, comes modular design that is creating machinery with interchangeable parts as I mentioned in the previous slides as well. So, combined with modular headers, that can be swept for different crops is one of the examples.



Impact on machinery longevity and downtime reduction. Well-designed maintenance features result in minimal downtime during repairs, and regular maintenance contributes to machinery longevity, reducing the need for frequent replacements. Ensuring that machinery is back in operation swiftly boosts the overall productivity. Now, advanced innovation and research is there in agricultural machinery. Some of the advanced machines nowadays use artificial intelligence systems. Autonomous systems are there.



Advanced innovations and reach in agriculture machinery are having a major impact on the way agriculture is practiced. Few of the ways that technology is being used to improve efficiency, safety and sustainability in agriculture are number one is autonomous farming, data-driven agriculture and sustainable energy solutions. Let us try to see these innovations one by one.



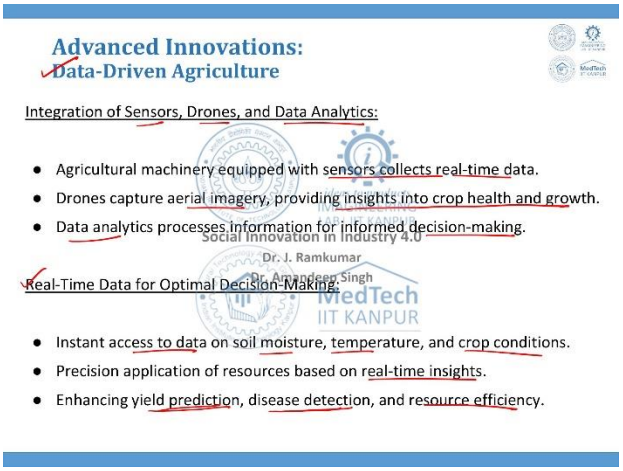
Autonomous Farming, these innovations have the potential to revolutionize agriculture and help to ensure a sustainable future for food production. Autonomous farming involves the use of self-driving machinery without direct human intervention. Self-driving tractors equipped with sensors, GPS systems, AI navigation, and perform the task.

And, automations helps to optimize operations such as flowing, planting, harvesting because the systems are also data-driven, that also we will discuss. The systems are autonomous based upon the data that is provided to them, they do the harvesting at specific areas as well.

Benefits of precision planting and harvesting could be precision planting ensures accurate seed placement optimizing crop growth. Autonomous harvesting guarantees timely and efficient crop collection. Precision-driven processes reduce resource wastage and enhance yield.

A few examples to quote here are autonomous planting and seeding systems. So, this is a system that is an autonomous planting and seeding, in which planting and seeding both the things are happening simultaneously.

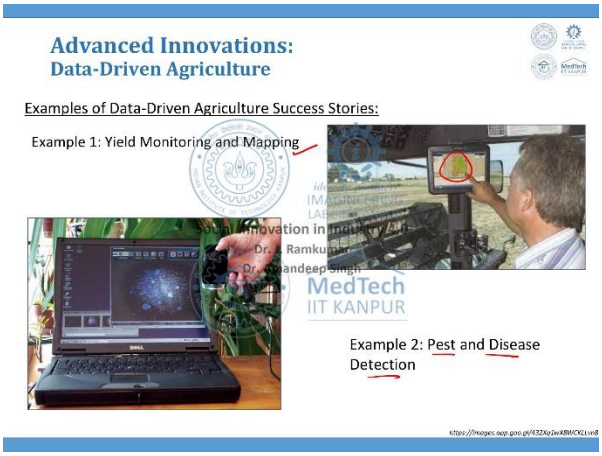
Then, we have a robotic weed control system. The weed control system, which is the autonomous machinery that is targeted to weed management. Wherever the seaweed and the optical systems are there, those are removed by the system.



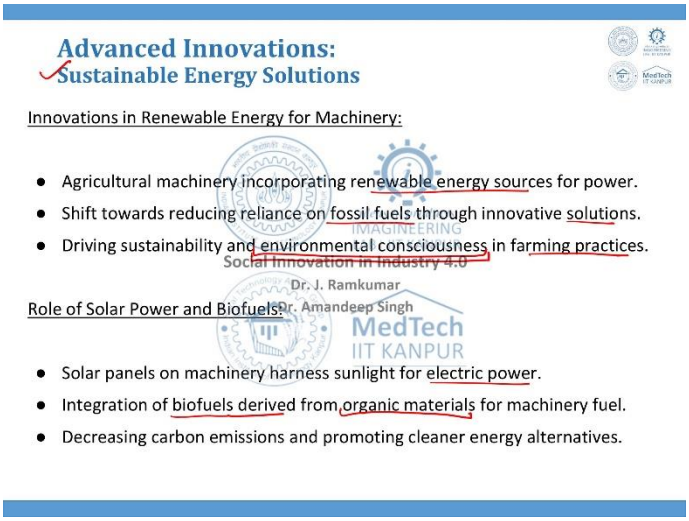
Then, comes Data-Driven Agriculture. Integration of sensors, drones and data analytics has completely revolutionized agriculture systems nowadays. Since the last 5-6 years, you can see drones are able to monitor the system. Drones are also used to provide irrigation, that is the drip irrigation is also happening to drones and the sensors are there to see whether the color of the plant is coming right or not, or the size of the plant is growing right or not. So, all the system that is the data that we are getting from the plants while integrating sensors is helping a lot.

Agriculture machinery equipped with sensors collect real-time data. Drones capture aerial imagery, providing insights into crop health and growth. Data analytics processes information for informed decision-making. Real-time data for optimal decision-making. That is instant access to data when soil moisture, temperature, crop conditions could be there.

Precision application of resources based on real-time insights. Enhancing yield prediction, disease detection and resource efficiency becomes one of the benefits of real-time data processing.

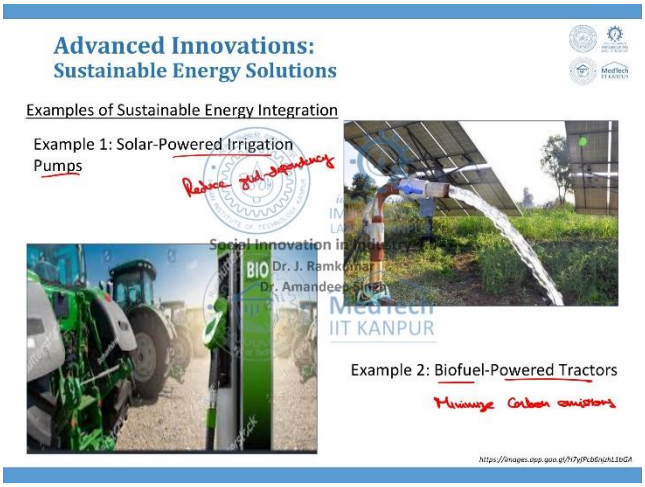


An example here is yield monitoring and mapping. You can see here the machinery that monitors and maps yield variation across the field, how the color of the crop is given, what is the growth and everything that could be managed here. Second example here is pest and disease detection. So, wherever the pests are there or infestations through pests are there, data-driven systems identify early signs of these infestations.



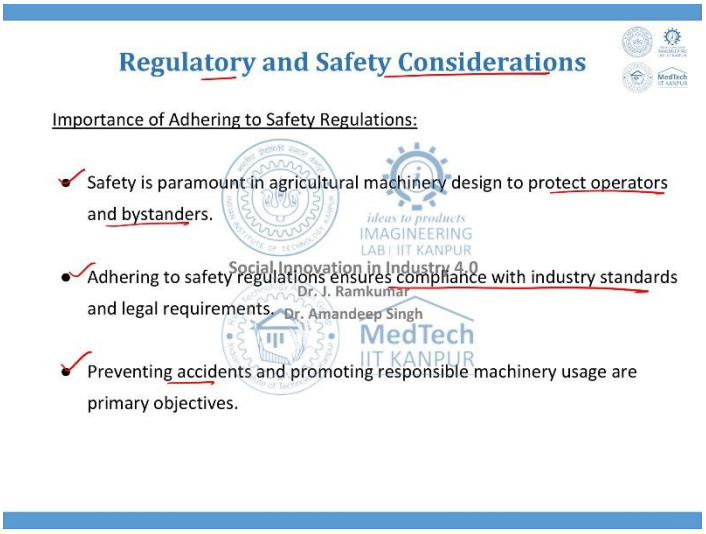
Next comes Sustainable Energy Solutions. Innovations in renewable energy for machinery that is agriculture machinery incorporating renewable energy sources for power. Shift towards reducing reliance on fossil fuels through innovative solutions is there. Driving sustainability and environmental consciousness in farming practices. Environmental consciousness is a very important term here.

Role of solar power and biofuels. Solar panels on machinery harness sunlight for electric power. Integration of biofuels derived from organic materials for machinery fuel. Decreasing carbon emissions and promoting cleaner energy alternatives.



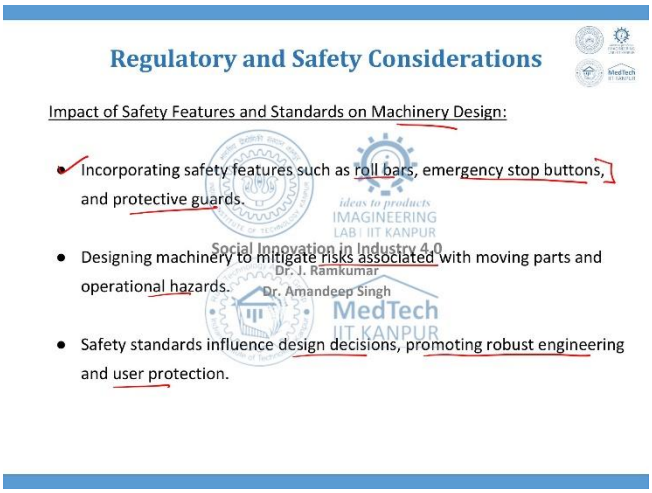
Some of the examples of the sustainable energy solutions here are solar powered irrigation pumps. As I said in the tubal itself the irrigation pumps are powered using solar energy. And, solar energy helps us to provide independence from the grid. So, we reduce grid dependency.

Second example is biofuel powered tractors. The biofuel you can see here, tractors are using biofuel to minimize the carbon emissions. So, we minimize carbon emissions.



Certain regulatory and safety considerations are also there when we are trying to design an agriculture implement. Importance of adhering to safety regulations. Safety is paramount in agriculture machinery design to protect operators and bystanders. Adhering to safety regulations ensures compliance with industry standards and legal requirements.

Preventing accidents and promoting responsible machinery usage are the primary objectives here. Though safety parameters are all discussed majorly in the previous lectures, I will not much try to discuss it with regard to agriculture implements. These are all equivalent to what we discussed in the previous lectures as well.

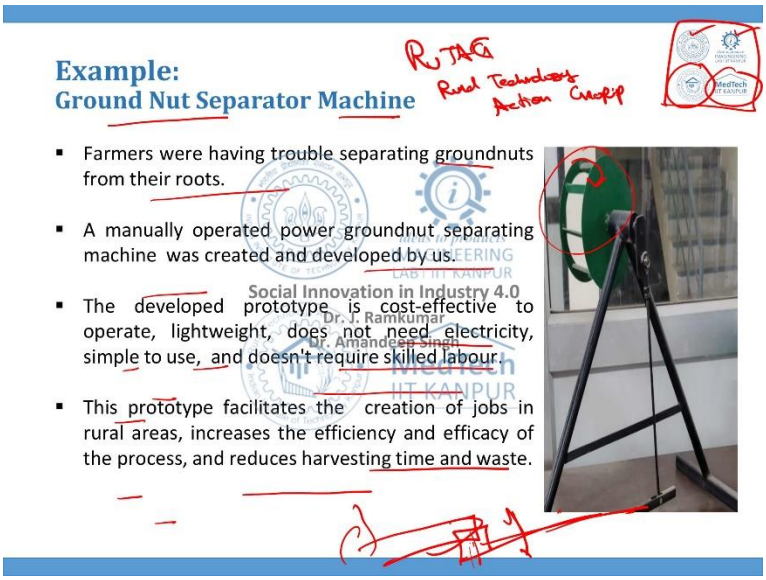


But still the impact of the safety features and standards on machinery design could be put here. That is incorporating safety features such as roll bars, emergency stop buttons and protective guards or so. This could be put on the machinery, so that, for example, if the machine is running at a speed, and we need to immediately stop it, the emergency stop buttons are there.

If suppose, brakes fail or so on. Designing machinery to mitigate risk associated with moving parts and operation hazards. Safety standards influence design decisions promoting robust engineering and user protection.

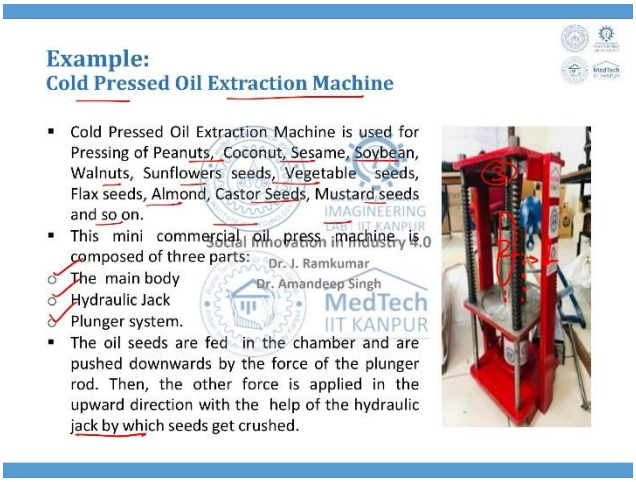
Now, I will show you some of the tools or implements which are developed at IIT Kanpur and which are broadly used in the areas around Uttar Pradesh and within the state of Uttar Pradesh. So, here are the four logos which we have put here, one is IIT Kanpur, another is an imaginary lab, here, professor Ramkumar and I are both associated.

One is RUTAG, which is a Rural Technology Action Group. Fourth logo is MedTech that we already discussed. RUTAG tries to work on developing the technologies for rural people to reduce drudgery. So, these are the few efforts which are made in this direction.

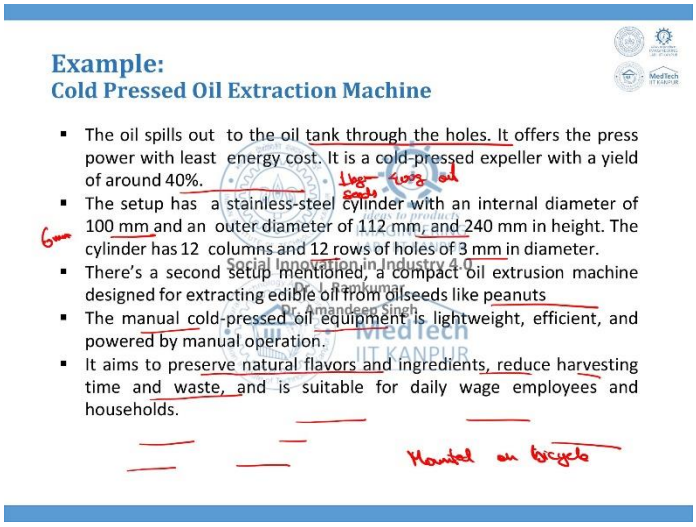


This is a groundnut separator machine. This is operated using just a foot pedal here, this is a foot pedal here. This foot pedal just human foot is put here and while having to and fro motion of the foot, this is rotating. When this is rotating in this direction, the groundnut seeds could be separated when they are put on this. Farmers who were having trouble separating ground nuts from their roots and a manually operated power groundnut separating machine was created and developed by us.

The developed prototype is cost-effective to operate. It is lightweight, does not need electricity, is simple to use, and does not require skilled labor. Maximum of the equipment that RUTAG helps us to develop are passive equipment. Passive equipment means we do not need electricity, we do not use motors, it is only mechanical systems, while reducing the load in the mechanical systems only, the systems are designed. This prototype facilitates the creation of jobs in rural areas, it increases efficiency and efficacy of the process and reduces the harvesting time and waste.



Then comes another system that we have developed which is a cold pressed oil extraction machine. Cold pressed oil extraction machine is used for pressing peanuts, coconut, sesame, soybean, walnuts, sunflower seeds, vegetable seeds, flax seeds, almonds, castor seeds, mustard seeds and so on. This mini commercial oil press machine is composed of three parts, the main body, hydraulic jack and plunger system. The main body is here, this is the hydraulic jack here part number 1, part number 2, I will put it here and the plunger system which is here. The oil seeds are fed in the chamber and pushed downward by the force of the plunger rod, then the other force is applied in the upward direction with the help of hydraulic jack by which seeds get crushed.



The oil spills out to the oil tank through the holes. It offers press power with the least energy cost. It is a cold press expeller with yield of around 40%, that means from 1 kg of the seeds you get 400 grams of oil.

The setup has a stainless steel cylinder with an internal diameter of 100 millimeter, and outer diameter of 112 millimeter, that means the thickness is 6 mm and 240 millimeter in height. The cylinder has 12 columns and 12 rows of holes of 3 mm diameter each. These holes are there on a cylinder here, here the cylinder is there we have holes here, 3 mm dia each, out of which the oil expels out. The holes also serve the purpose to release the trapped air.

During the pressing processes, this also reduces the effort that is required. So, there is a second setup here, that is a compact oil extrusion machine that is designed from extracting edible oil from oil seeds like peanuts. The manual cold pressed oil equipment is lightweight, efficient and powered by manual operation only, it aims to preserve natural flavors and ingredients, reduce harvesting time and waste and is suitable for daily wage employees and households.

So, this is a robust and an ergonomic design which could be also mounted on the bicycle. So, again the pedal energy of the bicycle could be used to operate this oil pressing machine. Bicycle energy means still, we are trying to avoid the electric energy or electric motors or so.

Example:
Amla Deseeder and Grater Machine

- The difficult task in the mechanisation of amla processing and product diversification is to separate the deseeded fruit without breaking the fruit or losing pulp.
- In the processing business, small capacity pricking machines are utilised, although these are less effective, use more power, and are prone to frequent malfunctions. As a result, the processing unit's overall output declines

Example:
Amla Deseeder and Grater Machine

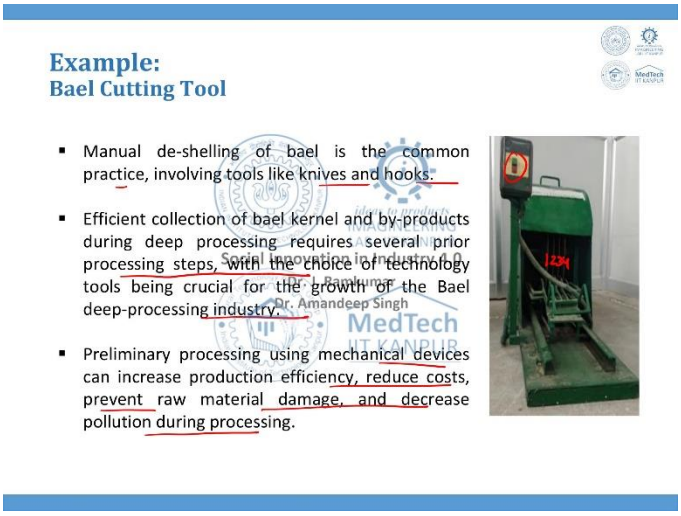
- The main challenge is to separate amla seeds without damaging the fruit or losing pulp during processing.
- An innovative hand-operated amla seed remover was developed to simultaneously deseed and grate amla, reducing processing time and labor fatigue.
- The Amla Deseeder and Grater Machine efficiently handles amla processing, reduces operational costs, and can handle 30-35 kg of amla per hour, minimizing wastage and time.

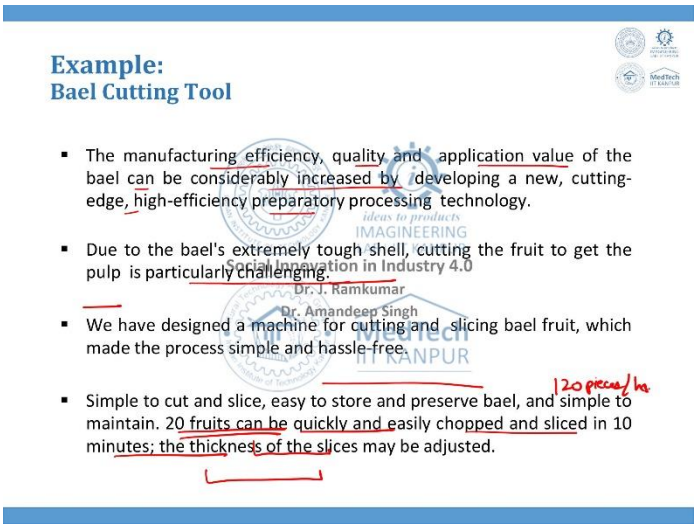
Next is an amla deseeder and greater machine. Amla, as I mentioned before, has a seed at the center and the outer volume is all the pulp.

How do we take the seed out? There is a deseeder and greater machine that is designed here. The difficult task in the mechanization of amla processing and product diversification is to separate the deseeded fruit without breaking the fruit and losing pulp. In the processing business small capacity pricking machines are utilized although these are less effective but they use more power and are prone to frequent malfunctions.

As a result, the processing units overall output declines. How does this amla deseeder and greater machines have a main challenge to separate amla seeds without damaging the fruit or losing pulp during processing? This is an innovative hand-operated amla seed remover and this was developed to simultaneously deseed and grate the amla, reducing the processing time and labor fatigue. The amla deseeder and greater machine efficiently handles amla processing, reduces operational cost and can handle 30 to 35 kg of amla per hour minimizing wastage and time.

So, this became a Social Innovation because these kinds of seeds were not available . All operations which were done manually by the people or the women in rural areas, this is done through this machine which is also a manual operating machine only, but it is reducing the drudgery to a large extent.





Next comes the bale cutting machine. Cutting the bale into slices, the bale is like a ball. When the bale is to be cut in slices, we try to use a saw for that or we try to use the impact energy to cut it, it

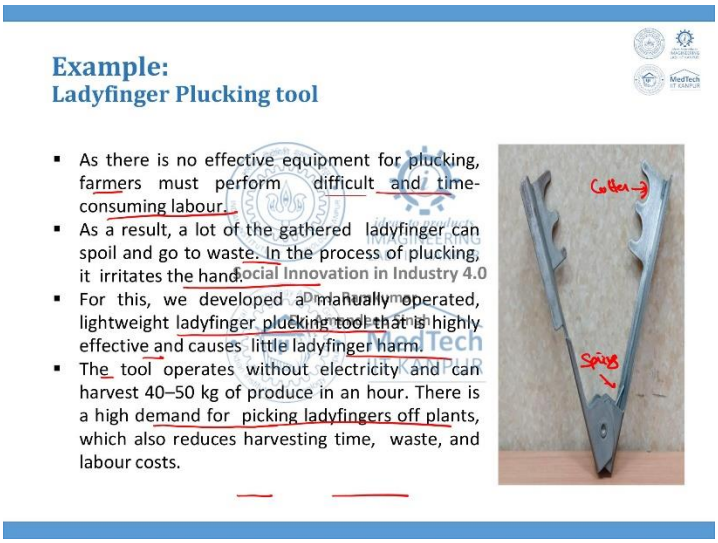
becomes a time consuming process. Now, this is a bale cutting tool which has blades here 1, 2, 3, 4 blades, and bales are passed through them. This is an electrical operated machine where the electric switch is there. So, manual de-shelling of bales is the common practice involving tools like knives and hooks. Efficient collection of bale kernels and byproducts during deep processing requires several prior processing steps. With the choice of technology tools, being crucial for the growth of the bale deep processing industry.

Preliminary processing using mechanical devices can increase production efficiency, reduce cost, prevent raw material damage and decrease pollution during processing. So, this bale cutting tool helps to have manufacturing efficiency, quality and application, value of bale that can be considerably increased.

This new cutting edge high-efficiency preparatory processing technology or tool was developed. Due to bales extremely tough shell, cutting the fruit to get the pulp is particularly challenging. So it is exactly opposite to what Amla was, Amla had a hard core inside and a soft pulp outside. In contrast, bales have a hard cover outside and the pulp is all soft inside. So, here the shell is tough and the pulp is inside.

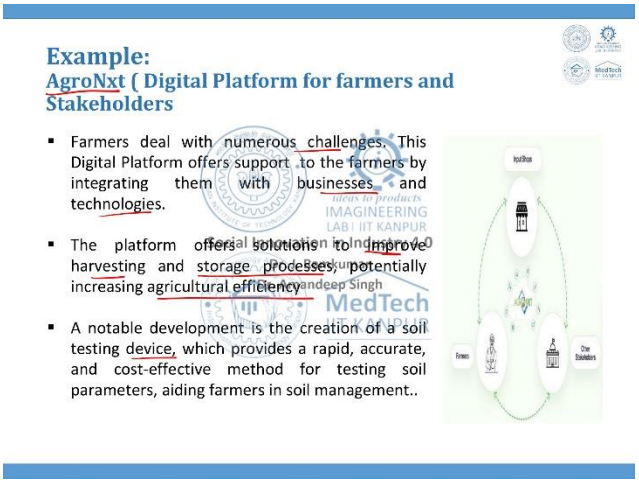
So, there was a challenge to design this machine as well, but it is a simple cutter machine, the cutter which is rotating and the bale is passed through it and we get slices of the bale. We have designed a machine for cutting and slicing bale fruit which made the process simple and hassle-free. Simple to cut and slice, easy to store and preserve bale and simple to maintain. 20 fruits can be quickly and easily chopped and sliced in 10 minutes. That means in an hour 10 into 20, 120 pcs per hour.

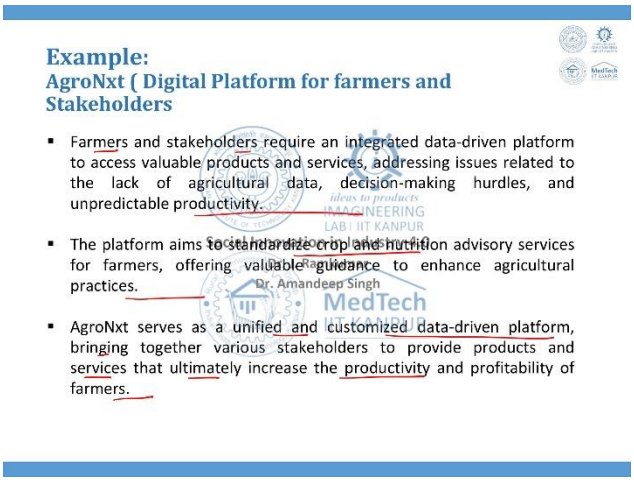
This is the capacity of the machine which is designed. The thickness of the slices may vary and could be adjusted.



Next comes a fruit plucking machine, specifically ladyfinger plucking. So, this is just a kind of a plucker which has a spring here and when we press it, it just cuts using the cutter that is attached to it. It is just this kind of operation, only the plucking and here we have a cutter. As there is no effective equipment for plucking, farmers must perform difficult and time consuming labor.

As a result a lot of gathered ladyfingers can spoil and go to waste. In the process of plucking, it irritates the hand as well, because ladyfinger pulp that is there is also sticky. For this, we developed a manually operated lightweight ladyfinger plucking tool, that is highly effective and causes little lady finger harm. The tool operates without electricity and can harvest 40 to 50 kg of produce in an hour. There is a high demand for picking ladyfingers of plants which also reduces harvesting time and reduces waste and reduces the labor cost as well.

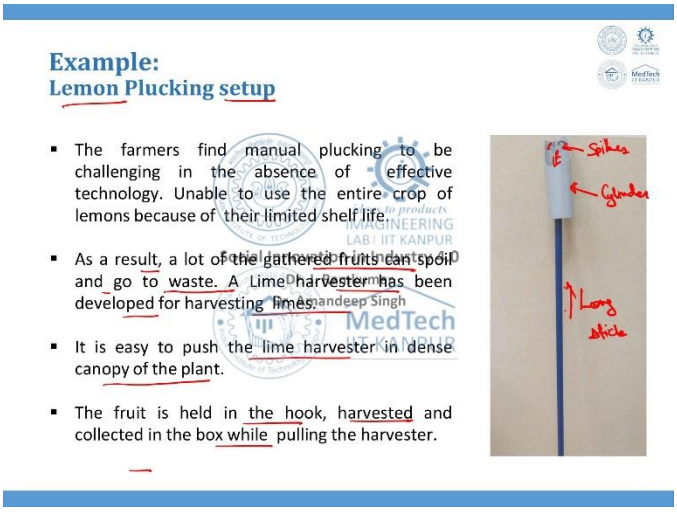


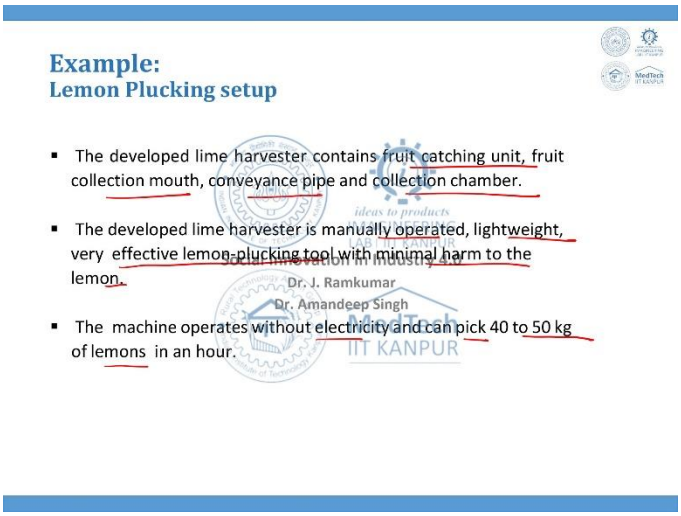


Next comes a digital platform which is developed by a startup known as AgroNxt. Here the platform provides the farmers and stakeholders with a system of connectivity. Farmers deal with numerous

challenges. The digital platform offers support to the farmers by integrating them with businesses and technologies. The platform offers solutions to improve harvesting and storage processes, potentially increasing agricultural efficiency. A notable development is the creation of a soil testing device which provides a rapid, accurate and cost-effective method for testing soil parameters aiding farmers in soil management.

Now, in general farmers and stakeholders require an integrated data-driven platform to access valuable products and services. Addressing issues related to the lack of agricultural data, decision-making hurdles and unpredictable productivity. This platform, AgroNxt, aims to standardize crop and nutrition advisory services for farmers, which offer valuable guidance to enhance agriculture practices. AgroNxt serves as a unified and customized data-driven platform, bringing together various stakeholders to provide products and services. That ultimately increases the productivity and profitability of the farmers.





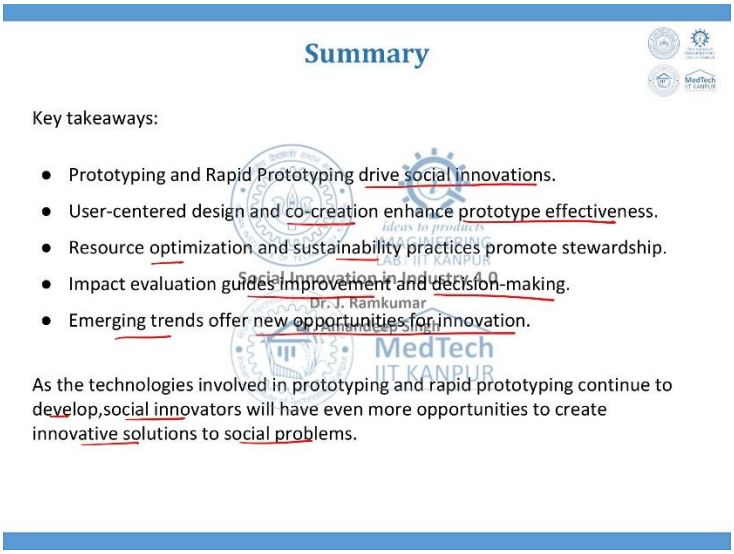
Next comes another fruit plucking machine, that is a lemon plucking setup. So, here we have simple spikes, and this is our cylinder. Lemon is plucked, the stick is long. The lemon is plucked, it falls into the cylinder, lemon falls here. So, farmers find manual plucking to be challenging in the absence of effective technology, unable to use the entire crop of lemons because of their limited shelf life.

The foods which are ripe at height, like mango, lemon or so, to pluck the fruit at height the farmer or the people have to sometimes climb the tree, sometimes there have to be systems or so that they go towards that height. So, this is a tool which has a long stick, using the stick itself it could be plucked and brought down. So, in the absence of this tool because farmers were unable to take lemons out, as a result a lot of gathered fruits can spoil and go to waste.

A lime harvester has been developed for harvesting limes. It is easy to push the lime harvester in the dense canopy of the plant, where even a normal person hand could not have a reach. The fruit is held in the hook harvested and collected in the box while pulling the harvester. The box or the cylinder that I have mentioned here the fruit is collected here.

The lemon plucking setup was so developed that it contains a fruit catching unit, fruit collection mouth, clearance pipe and collection chamber. The developed lime harvester is manually operated, lightweight, very effective lemon plucking tool with minimal harm to the lemon.

The machine operates without electricity and can pick from 40 to 50 kg of lemons in an hour and reach where a normal human hand cannot go. So, intricate places in the canopy within the plant where it could be risky for the human to go or even the height is high. This lemon plucker is very helpful. These were a few examples that we have discussed in IIT Kanpur that we have developed. There are certain examples that I also discussed with the advanced technology using AI, using the data-driven systems or so, that helps us to increase the yield or design the machinery as per the modern requirements.



To summarize this lecture, agricultural machinery design is a dynamic field, continually evolving to meet modern farming needs.

Innovation in design addresses challenges, enhances efficiency and promotes sustainability. Design principles like ergonomics and adaptability are pivotal for effective machinery. Data-driven and autonomous technologies revolutionize precision farming practices. Sustainable energy solutions contribute to eco-friendly and efficient operation.

And, regulatory compliance and safety are fundamental aspects of responsible design. With this, this week is over.

We have discussed about the design and sustainability in the medical devices in agricultural machinery. We will try to understand what is rapid prototyping and rapid manufacturing in the next week. Thank you.