

Organic Farming for Sustainable Agricultural Production
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Lecture - 31
Crop Planning and Rotation Design in Organic System (Contd.)

So, I welcome you to lecture 31 the Crop Planning and Rotation Design in a Organic System. This is a continuation of the previous lecture, lecture 30. So, we have discussed in the last lecture the type of crops to be selected when you go for the conversion or the transition from the conventional farming to organic farming.

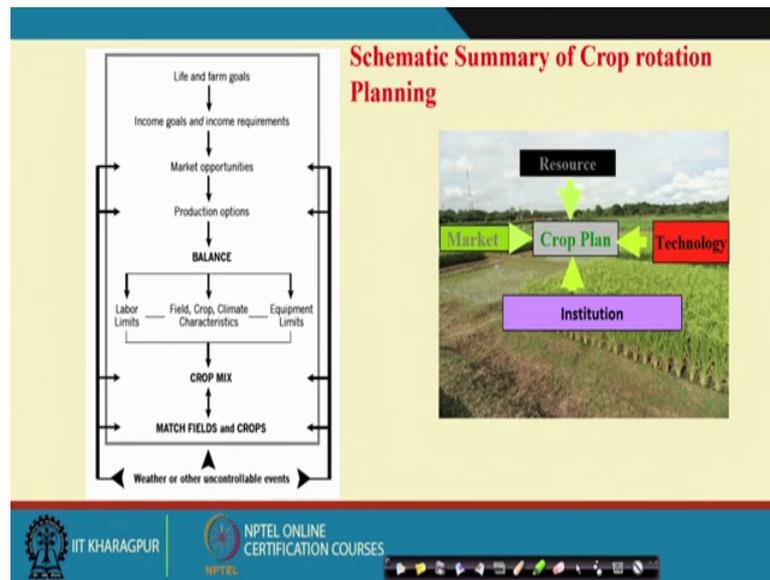
So, what step you should follow and the crop types because that the beginning of the year when are you going for the transition periods the yield may be reduced. So, to compensate the yield loss we should choose the crops that can that require that are that have the demand of the less nutrients and slowly as you go on with the progress of the years transition then and third year you go for the organic labeling of the product.

So, in that year you can grow the crops of the high nutrient demanding by the time probably the soil might have build up with the fertility due to the introducing leguminous crops or the low nutrient requiring crops. So, that the yield loss in the main crop that can be compensated by the way of managing of the soil fertility.

So, here we can discuss what is the planning or the how can plan the crops in a particular area or particular farm, if you are planning to convert your farm to organic from the transition periods and the organic productions.

So, what are the management and specially the crop selections how you can say the crops. So, can you can have a good returns economic returns at the same time you can have a better quality of the products produce in organic farming.

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So, as I discussed in the last class the crop mix or the crop plan or the crop combinations or the rotations so, that depends upon the you know on the four major components as you go for crop planning in the crop rotation plan. The components are one is resource, technology, market and institutions; these are the four major pillar.

When you go for the planning of these the rotation designs or the crop productions because know you need the resource means you are the land, labour, capital, infrastructure these comes under the resource and also of the natural resources that means, the climatic conditions of the locations. So, that indicates what type of crops you are choosing.

So, the resources then technology means the technological knowledge to build knowledge means the organic farming practices, the equipment used for the organic farming starting from your land preparations to the sowing of the seeds, the nutrient organic manure applications, then intercultural operations, weeding operations, spray a plant protection measures and finally, the harvesting and post harvest processing through.

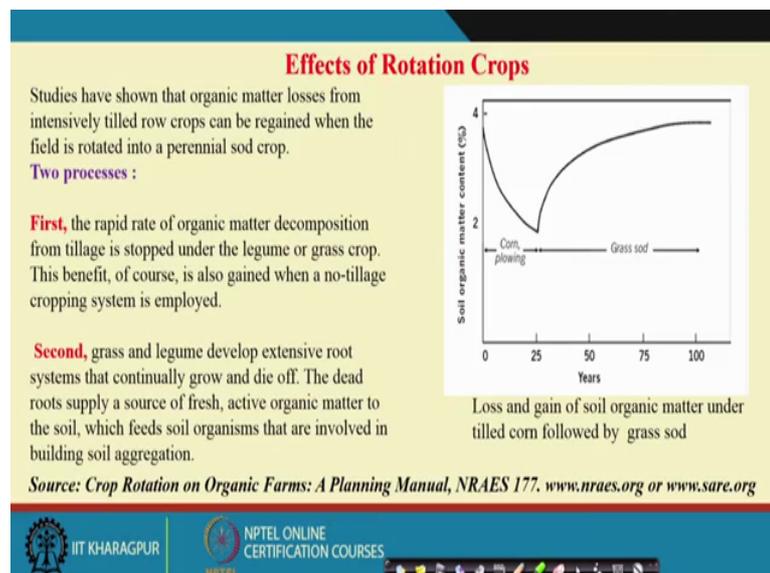
So, the technology that indicates what type of crops you are trying to choose what type of crops you are selecting in the rotation plan then of course, the market. So, as I discussed market is the very important because you are the selection of the crops depends on the market potentials.

If somebody has to go for the productive or the away the benefit economic because we are going for the organic forming of economic output the better returns higher economy in that case you have to see the market where you are going to sell your produce. So, that is as we discussed last class if you do not know where is a market, how to sell your produce better not to plant it.

So, market is very important then institutions that is a linkage where you can have a collaborations, where you can have a as a consultancy feedback advice you can take. So, you have to collaborate institutions, these are the four major pillars of the crop planning. So, that indicates as we discussed this is a then based on this the resource technology, market, and institutions we can have a goal, the objectives, resource goals.

Then based on these market and the production of shunts the plan we can have a crop mix or the crop rotations or the cropping system plan and which can be seen in between based on the weather or the market we can have a alternate plans to meet the demand or the to meet the objectives and also at the same time it should be economically viable, ecologically sustainable and that can give the maximum profit this is how say the crop rotation plan.

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So, we discuss the effect of rotation crops, how they influence the specially the soil fertility as you see as you go for rotations if you see the as we have discussed earlier classes when you go for the rotation design or the selecting crops in the rotations you

should choose such type of such type of crops means there should be defraud crops should follow swallowed crops, cereal crops may be legumes crops because crops of same group should not be grown together.

So, that there should not be any competitions among the crops or the between the crops for the nutrients or water and also there will be less incidence of pest and diseases. For this research report I can see research information's. Studies have shown that organic matter losses from the intensively tilled row crops can be regained when the field is rotated with a perennial leguminous crops. That means, if you are growing the two crops one is the corn crops that require intensive tillage, conventional tillage and if are going for the conventional tillage operations then you can see from this figure.

So, there is a decrease in soil organic matrix are declined in soil organic matter with a continuous cultivation of the corn crops that means, the conventional tillage the with this operation if you go to 0 to around 25 years it is seen. If you continue corn planting with conventional tillage there is a sharp decline in soil organic matter from the beginning to the end of these 25 years. And after that what is said is this first rapid rate of organic matter decomposition from tillage is stopped under legume or grass crop.

If you go for the after that there is a legume grass crops then there is slowly increase in the soil organic matter content of the soils that means, with conventional tillage and growing same type of crops of course, there is a decline in organic matter of the soils. And as you replace the crops with the grass legume crops then there is a increase in organic matter content of soil. So, the organic matter content is against build up that is a accumulated as regained by changing the cropping pattern.

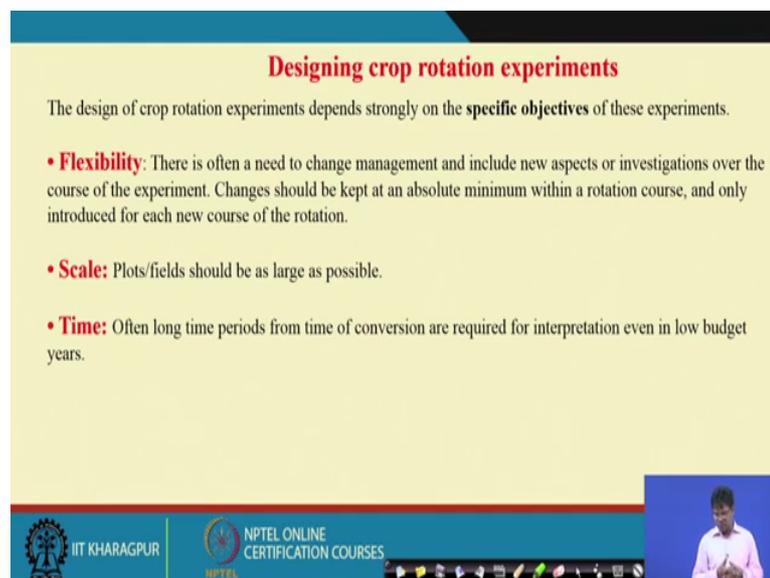
So, that you say by grass or legume developed extensive root systems and that have continually grow and also die off. The dead roots supplies source of fresh and the active organic matter to the soil which feeds the this soil or as a feeds soil organisms and that are involved in building soil aggregation. That means, having the grass crops or the legume crops they leave lot amount of the huge amount of crop residue in the soils.

So, that helps that this active organic matter that acts a food materials for the native soil microbes and they build up their populations by the tab. So, in that way they can build the soil aggregation at the soil organic matter content. This is how the loss and gain of the organic matter with the change of cropping systems as you go on from the corn

planting to legume crops there is a increase in soil organic carbons and more away if you go for the tillage operation also if you follow the minimum tillage or zero tillage, stable mass tillage in that case also so, there the organic matter or the organic carbon content can be regained can be accumulated by continuously following the conjuration tillage as you say or the stable mass tillage, minimum tillage or the zero tillage operations.

So, this research report has been collected from Crop Rotations on Organic Farms: A Planning Manual. There is a natural NRAES, Natural Resource Agricultural and Engineering and Services. For this how the they have the long term experiment where you have the where you have seen that is a the building or the loss in organic matter or the change in organic matter content of soils by change in crops.

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Designing crop rotation experiments

The design of crop rotation experiments depends strongly on the **specific objectives** of these experiments.

- **Flexibility:** There is often a need to change management and include new aspects or investigations over the course of the experiment. Changes should be kept at an absolute minimum within a rotation course, and only introduced for each new course of the rotation.
- **Scale:** Plots/fields should be as large as possible.
- **Time:** Often long time periods from time of conversion are required for interpretation even in low budget years.

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And if you go to designing the crop rotation experiment, when you go for the evaluation of the rotation design you have the two alternate plans of course, based on your the market or the know the resource and technology and the institution linkage we have developed some crop plan also at the same time as we discussed we should have a alternate crop plan in case of weather uncertainty or the market fluctuations to tackle those situations we can have a the second plan on table.

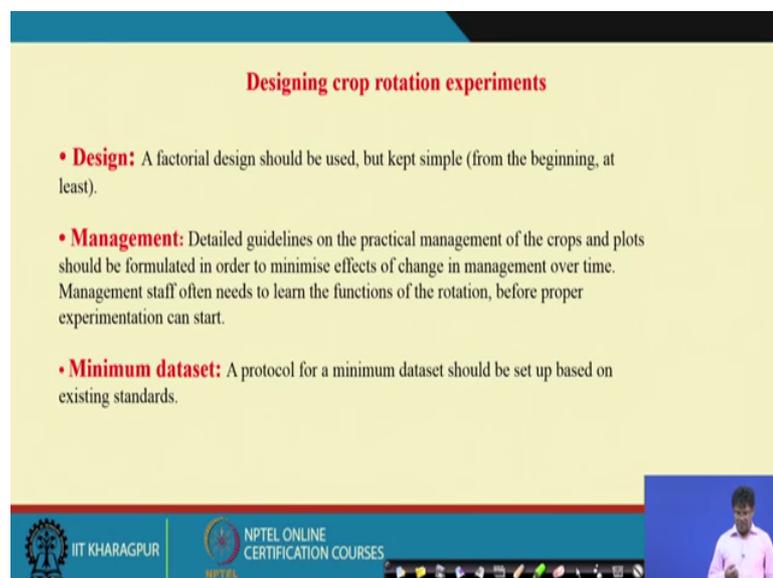
So, when you go for the evaluations of this or the designing of a crop rotation experiment where experiment. So, there should be some of the things we should be considering in mind. Flexibility, so that means so, there is opponent need to change management and

includes that is a new aspects of or investigations over the course of the experiment. So that means, there should have some rooms to make a change and make additions or the deletions of the some of the components as and when needed.

Changes should be kept in an absolute minimum within a rotation force that means a small changes can be accommodated that means, this systems should flexible to accommodate some changes as and when needed during the force of investigations. Then scale also so, better to have the plot and field should have a should be as large as possible because when you are planning go for large scales that means, farmers field not exactly at the small plot in the experiment. So, it should address the large scale that can be scaled up to larger area. And the time often as you go for the organic farming or the rotation designing it is a time taking process.

So, if you continue for the more years then you can have a better interpretation of the results for the evaluation of the cropping system design.

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The slide is titled "Designing crop rotation experiments" in red text. It contains three bullet points:

- **Design:** A factorial design should be used, but kept simple (from the beginning, at least).
- **Management:** Detailed guidelines on the practical management of the crops and plots should be formulated in order to minimise effects of change in management over time. Management staff often needs to learn the functions of the rotation, before proper experimentation can start.
- **Minimum dataset:** A protocol for a minimum dataset should be set up based on existing standards.

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And also when you go for the design, the design you can choose as a factorial design that is a specially for this say there may be two factors or more than two factors of the experiment for the evaluation of this rotation design

And the management detail guidelines on the practical management of the crops and the plots should be formulated in order to minimize the effects of change in management

over time and that means, this should be already the planning that should be made much before the implementation definitely and the management staff often needs to learn the functions of rotations before the proper experiment can start.

And of course, the minimum data sets say protocols when you go for the experimental for the design for the evaluation of the rotation experiment then the protocols of the experiment protocols that should be set and the data minimum data set because without so, that is the effective of a proper evaluations what are the input and data sets that should be documented what are the methodology and what data what are the data should be collected for the crop rotation experiment evaluation.

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ROTATION BALANCE

Annual | Multiyear

Field

Farm

BIOLOGY

BUSINESS

- Crop rotations require multidimensional thinking.
- Rotation management requires understanding both the whole farm and each individual field and balancing field- and farm-scale decisions.
- On successful farms, rotation planning is a rolling, responsive process.
- Expert farmers are continually balancing annual and multiyear (short- and long-term) decisions.
- Business decisions must be optimized for annual returns and cash flow.
- Expert growers indicate that in any given season, market opportunities and logistical needs may override biological concerns
- Experts manage multiple, interacting factors as they implement crop rotations.
- Organic farmers rely on rotations and long-term soil quality to deal with problems and ensure the productivity of fields.

Rotation planning balances the management of field and farm-level decisions on an annual and multi-year basis. Annual farm-level decisions tend to prioritize business concerns. Multi-year decision decisions tend to prioritize and accommodate biological demands

Source: *Crop Rotation on Organic Farms: A Planning Manual*, NRAES 177, visit www.nraes.org or www.sare.org

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So, this is the when you go for the rotation balance is the rotation design experiment, rotation balance. So, what do you mean by the rotation balance means when you go for the designing or the planning a rotation experiment, we plan for the seasonal, annual or the multiyear farm plan and also we plan for the field scale and the farm scale that means, the field to farm.

If you see a particular farm there may be many fields, fields have can have different types all the field may not be same some fields may be up land ecosystem say farm may have the area around 50 hectares or 100 hector farm may be there in that farm. Some field may be up land some field may be lower land some field may be medium land. And also the field there many entity the entities maybe there; some may have the some may

have the crops some may have the livestock some may have the horticultural crops seasonal crops.

So, looking at those aspects those entities or those enterprise when you go for the rotation balance or the rotation design we go for the we look for the annual and also the multiyear rotations. Annual means that means, the if you make for annual plan that gives seasonal returns, every year returns that leads to economic output. So, every year there should be some return. So, that is as a business plan.

So, there should be return of every year and the multi year that is a perennial crop because when you have the crops like perennial crops you have anchored crops as a fruits, fruit crops and you have the other entities like you know you have the livestock or the poultry where your return may not get on the beginning of the years.

So, return you may get after 2 years 3 years depending upon the crop or the depending upon the enterprise. In that case that is a multi years. In for those conditions we look for the mainly that focus on biology that means, when you go for the multiyear crop plans in addition to annuals then multiyear over lapping over the annuals then that indicates in addition to economic returns, it indicates other values like biology means it should give a better output, the production should be high. At the same time you should have environmental sustainable means there should less emission of green house gas at the atmosphere.

So, having the multi year plan, so that means, the enhancing soil fertility, the maintaining soil fertility in a long term basis that is taken into account when you go for the multiyear crop planning that means, it building the soil fertility or as we discussed just before or the increase in the soil carbon content over the years that comes in the multiyear crop rotation or the multiyear plans having different entities that together in the systems.

And also we should see there is a less emission of that means, green house gas at atmosphere. The system should have the less impact or no impact on the environments. So that means, this is a sustainable environments that lay minimizing green house gas emissions at the same time we have the better productions and the better quality good quality because as we are going for the organic concept you are using the organic input management. So, it indicates there should be good quality. The quality of the food is much better, better environment; so, less pollutions of the water and less pollution of the

air. So, better environment and the high productions. So, this looks to the biological value when you go for the multiyear crop plan.

So, as we see the rotation planning balances the management of field and the farm level decision on an annual and the multi year basis. The annual farm level decision lead to prioritize the business concerns and the multiyear decisions tend to prioritize and accommodate the biological demands that as we discussed. So, there should be income journalism you should have the high income, high profit. Profit should be maximized at the same time if you go for the multiyear planning you should see.

So, this sustainable means there is a less effect or zero effect on the environments. And also there is a buildup of a soil carbon, the soil fertility is improved over the years and at the same time the quality you get the better and better quality for the better human health.

So, as you see the rotation balance, so, these are the components as we discussing here. Crop rotation requires multi dimensional thinking. So, when you go for the planning or the design as a field scale or the farm scale integrating the farm scale will integrate the field scale because in farm there may be several fields.

So, you have when you go for the planning of this rotations we have to take account of the field at the same time the farm as a whole and also annual and multiyear; you think the long term planning thinking the and also multi dimension means number of entities, how many entities we can accommodate in the farms.

So, like the crops, livestock or the fishery or the poultry. So, those you need multidimensional thinking can be taken to consider when you go for the crop rotations. And the rotation management requires understanding both the whole farm and each individual field and balancing field and field and the farm scale decisions. So, that means, as you discuss the field may be in the farm all field may not of same fertility or they may not be of same topography some field may be a high land some field may be lowlands.

So, that means, when you go for the rotational design you have to consider you have to have a decision making process you have to understanding about the field where you are operating and the whole farm as a whole to have a proper decision. Then on successful

farms rotation planning is a rolling and the responsive process as you go from rotation. So, you should get response from these rotations and expert farmers are continually balancing annual and multiyear decisions because as a short annual means short term plan and the multi year is long term plan.

So, when you go for the rotation design in a farm we look for the both, we look for the annual and we look for the multi years. So, annual plan means that gives each year return that means, from seasonal crops like your you have the vegetables or may be floriculture or the field crops like a cereals, oil seed, pulses. So, those crops are rotated. So, they give the annual returns or the return every year may be every six months you can get returns and the multiyear planning where you have the perennial crops like the archer crops or you have the different entities like your you have the livestock, poultry, fishery.

So, there you can get the return from return multiyear that is a. So, both the short term and long term is important because annual and the multiyear planning is successful for this rotation design.

So, business decision must be optimized for annual returns and cash flow. Then expert growers indicate that in any given season, market opportunities and logistical needs maybe may override the biological concern. That means the depending upon the market potential, if there is a market for depending upon the crops or the entities.

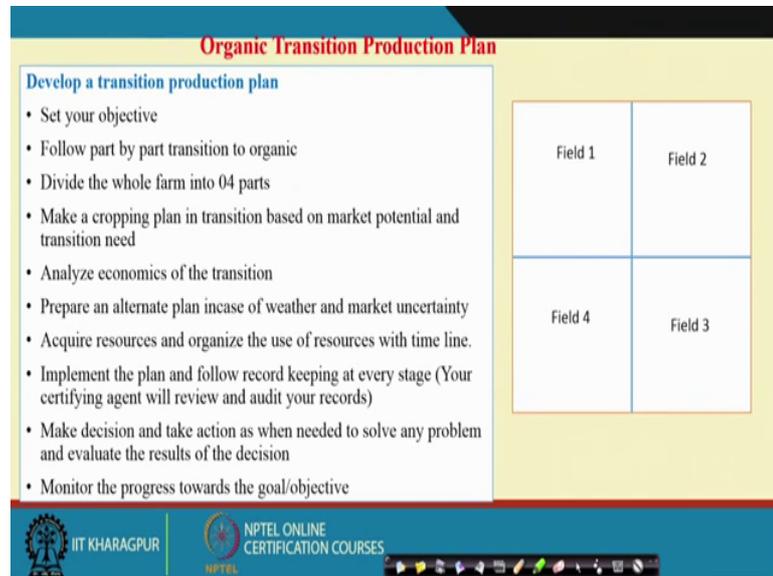
So, as we are planning so, we are looking at the market. So, how what is the demand of market which crop you can grow so, that you can sell it very smoothly very comfortably and you can get a good price.

So, that is taken by account. So, that is a major factor that content that decides the crops to be grown. Then experts manage multiple, interacting factors as they implement crop rotation. So, those things as you go on process of rotation design, so, the either the neutron management, the pest management, the wood management. So, those are taken cares.

Organic farmers relay on rotations and long term soil quality to deal with the problems and ensure the productivity on the fields. So, as we discussed already this one. So, we need the long term soil fertility, soil fertility has to build up, enhanced long term basis in

organic farming. When you go for rotations and there should taken into account how you can build up the soil fertility over the years.

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The slide is titled "Organic Transition Production Plan" in red text at the top. Below the title, there is a section "Develop a transition production plan" with a list of 10 bullet points. To the right of the text is a diagram of a farm divided into four quadrants labeled "Field 1", "Field 2", "Field 3", and "Field 4". The bottom of the slide features logos for IIT KHARAGPUR and NPTEL ONLINE CERTIFICATION COURSES, along with a navigation bar.

Organic Transition Production Plan

Develop a transition production plan

- Set your objective
- Follow part by part transition to organic
- Divide the whole farm into 04 parts
- Make a cropping plan in transition based on market potential and transition need
- Analyze economics of the transition
- Prepare an alternate plan incase of weather and market uncertainty
- Acquire resources and organize the use of resources with time line.
- Implement the plan and follow record keeping at every stage (Your certifying agent will review and audit your records)
- Make decision and take action as when needed to solve any problem and evaluate the results of the decision
- Monitor the progress towards the goal/objective

Field 1	Field 2
Field 4	Field 3

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And then you go for the organic transition or the production plan, how you can go for the organic production. So, these are the some of the steps you need to follow when you go for the organic transitions and this plans has to be take taken care when you are converting your field from conventional forming to organic forming.

The first one,; the set your objectives because you know this is for any business if you go for the any business or farming is a business then you have to set your objective. What is the objective for what you are going to make a organic? So, you are going for the field crops or the vegetables, the agriculture or archer crops or the poultry or the livestock.

So, depending upon these or you have integrations as you say so that means, your objective has to be set, what you are going to do, what production you are what type of production depending upon the then you have to take care of the climate and the resource and the technology and institution based on that you have to set your objectives. What is your objective?

Suppose somebody objective has only to produce the vegetables, the cash crops, vegetable crops kept as vegetables in the field. So, or somebody has the milk production or maybe meat productions or some may have integration of all vegetables, cereals,

gracilar grains, oil seeds and wheat production. Based on the resource technology available institution market you have to set your objectives what type of entities or enterprises and what should be your objective accordingly you can set your objective.

Then follow part by part transition to organic. Once you have set your objectives then go for transitions for a field. Suppose we will give example of a field crops if you are going for growing a field crops then you have to divide the field into four parts. Suppose this is a field where you are going to have the crops maybe vegetable crops or field crops, cereal crops or the oil seed crops, pulses that case you divide the field into four parts; field 1, field 2, field 3 and fold field 4. And also you can at the area that depends upon the type of the topography the soil suppose some field is up land, low land, medium land or the that depending upon the field situation you can have a four almost equal parts or may be some on even that is no problem, but you have to divide the field into four parts.

Then make a cropping plan in transition based on market potential and transition needs. So, if, so, make a cropping in a transition periods. So, from one field you can starts part by part. So, field 4 or you can start the transition and the crop planning depends upon the market or the resource available technology and the institutions. So, that you can have a plan here, implement these on the field 4 then analyze the economics of these transitions.

So, looking at the history or the information's from the base experiments. So, if you go for that transition the plan of the organic production plan for any type any field then what is the returns then can have the economic returns of that plan.

Then prepare an alternate plan in case of weather and market uncertainty. So, looking at the as you see market uncertainty or there may be weather fluctuation sometimes it may be drier sometime they very wet here or the flood or the drought looking at the extreme conditions we can have a the second alternate plan must be ready because whether you cannot prediction you cannot do for a long term basis.

So, when you go for the seasonal plan, so, based on the future weather of two months or three months weather the forecasting weather the rainfall or the monsoon should be normal or there is some variation or the dry conditions. So, depending upon that the crop can be say changed actual decision. Suppose you are planning for a rice crop in case of the up land eco system or the low land ecosystem, up land ecosystem based on the normal rainfall if there is monsoon is normal.

In case there is a fluctuation monsoon or the prediction there will be dry years there will be variability in monsoon then you may switch over from rice to some other crops like corn crops can be taken instead of rice crop because corn crops require less water that can survive in even if the less rainfall areas.

So, accordingly, so, you can have a alternate plan or in case have they very flood years you are planning a flood years that maybe flood condition in that case you have (Refer Time: 23:24) some other crops you can shift to rice crops which can sustain on the flood conditions. So, likewise prepare alternate plan and in case of the weather or the market uncertainty same for the market uncertainty.

Once you have the plan ready then acquire resources and organize the use of resources within timeline. So, once you have made the plans for the transition or the organic productions then accordingly the resource should be you know the source obtain the resource the resource should be gathered the acquired resources and organized the use of resources with timeline. Then it times will active times should be prepare at what time what type activities should be performed to attain or to reach the goal.

Then implement the plan and follow record keeping at every stage. So, that is very important as we discussed also earlier class. Whatever you do in a organic farming record keeping is very important starting from the land preparation or you have planning, there is a planning. From planning it is then land acquire of resources from where you are getting resources. Suppose seeds fertilizer the manures or seed start from where are you getting those should be documented proper records should be there and up to the harvest and post harvest whatever the operations you are performing each operations should be documented because those documents you are because you will be requiring when your certifying agent will review one audit records that is required documentation is highly essential as record keeping is very important when you go for the applying for certification process.

Then make decisions and take action; this is very important as and when needed to solve any problem and evaluate the resource of the result of the decision. That means, what you say? Suppose that is anything unwanted things may happen because you unexpected things may happens during the course of the experiment because planning because

suppose you have the plan there is a immediate or the sudden outbreak or the any decease or the pest.

So, that we are not usually prepared to tackle. In that case, so, you have to take a quick decisions and also implement the actions as quick as possible of your decisions and at the same time you have to evaluate this say the results or the decisions whether this decision was proper or wrong decision. It may be wrong decisions sometime not necessary that always your decision may be right, sometimes it may be wrong decision, but you can get a learning, even the wrong decisions you can take learning you can have a learning of this your the decisions.

Then you have to analyze the results of the decisions. Then monitor the progress towards the goal objective, so, regular monitoring. So, in between, so, there is a regular assessment. So, whether we are meeting when you are attending as per the goals.

So, these are the steps that should be followed when you go for the organic transitions or the conventional field to organic fields, that means, you have the field, you divide the field four parts and go on the transition have a plan transition plan and go for the implementation of the plans from the year the transition year.

So, as you see example you can give example for transitions.

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Field Plan: Organic Rice-Chickpea system

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Field 1	Conv: Rice-chickpea	Conv: Rice-chickpea	Conv: Rice-chickpea	Trans: Soybean-Radish	Trans: Soybean-Carrot	Organic: Rice-chickpea
Field 2	Conv: Rice-chickpea	Conv: Rice-chickpea	Trans: Soybean-Radish	Trans: Soybean-Carrot	Organic: Rice-chickpea	
Field 3	Conv: Rice-chickpea	Trans: Soybean-Radish	Trans: Soybean-Carrot	Organic: Rice-chickpea	Organic: Rice-chickpea	
Field 4	Trans: Soybean-Radish	Trans: Soybean-Carrot	Organic: Rice-chickpea	Organic: Rice-chickpea	Organic: Rice-chickpea	

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So, this is a field plan of organic rice chickpea system. So, this is a whole field. So, this divided into four parts; field 1, field 2, field 3 and field 4. In case of field 4, so, when you go for the transition, so, leave field 1, field 2, field 3, start your transition from field 4. From field 4, you have the crop transition plan.

So, here we have taken the beginning of the transition. You have the system of rice chickpea. You want to have the rice and rice chickpea, your main crop for the systems. In this case transition years we are introducing soybean in the Kharif season followed by radish in the on dry season they are winter seasons. So, the purpose of having soybean and radish I discussed these are the crops which require less nutrient, less demand of nitrogen.

So, having soybean or the radish at the beginning at the transition that can so, that we can get the same yield, yield level can be maintained.

So, the yield loss can be compensated having the soybean or radish because they have the less demand of nutrients. So, through organic farming we can attend the yield as of chemical farming for those type of crops soybean or radish. So, and the second year we are going to send soybean crops and the carrot, soybean is a leguminous crops.

So, in the way it can fix atmospheric nitrogen and you can build up the soil fertility and the inertia of changing the carrots also a low nutrient demanding crops and once you have done the two years then you go for the third year the yours the main crop as you are the system rice chickpea system and this is the third year the product can be labeled as a organic product and from the third year you can it because you already have followed transitions for the last two years and you can apply transit with the certificate in the third years and third year will be a review process there will be proper revision and the verification of the system of the production systems then you can apply for certification you can get the certification organic, you can sell your (Refer Time: 28:17) organic from the third years.

Now, similarly from the field 3, so, you can go for all the fields are conventional and the field 3 is second year you can start for the transition and accordingly you can get organic in the fourth year and same process for a field 2, you can go for transition from the third year and you can get the organic the produce in the fifth year and the finally, the field 1

you can start the transition fourth years and you can get organic in the sixth year that means, after fifth year from sixth there onwards the whole farm is converted to organic.

So, by step by step as you go for this one the organic you can get the whole farm organic from the sixth year. We have one economic analysis of this system.

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Economic analysis of Organic Rice-Chickpea (residual) system

Nutrients	Yield, kg/ha		Cost of production, Rs/ha		Gross return, Rs/ha		Net return, Rs/ha
	Rice	Chickpea	Rice	Chickpea	Rice	Chickpea	
No fertilizer	1050	100	24000	14000	13650	3500	-20850
Chemical Fertilizer	6150	105	32000	14000	79950	3675	37625
Organic fertilizer	5000	650	40000	14000	78000	27300	51300



If you see after third year, we did analyze what is the economic returns of the organic rice chickpea system. So, we compare three fertilizers; one is from this our experiment where one plot we applied no fertilizer is this is grow on as a native site as a control one and the other plot we have plot only chemical fertilizers and the other the third plot organic fertilizers. That means no chemicals.

So, in this if you see the yield of rice and chickpea, so, in case of no fertilizer control yield is a very low and the chickpea is was grown on an residual fertility of rice no fertilizer applied to the chickpea crop, only fertilizer was applied to rice crop and chickpea was grown after harvest of rice in the same soil without adding any fertilizers even if a chemical fertilizer organic fertilizer.

So, that is why if you see the residual effect of no fertilizer is nothing. So, the chickpea is very low and same for the chemical fertilizer there is a very because as we discussed earlier also is a very sort acting and also the very fast release and it has very low or no residual as good as a no application of fertilizer because yield remains same chickpea

whether you go for no fertilizer or the chemical fertilizer they have no residual, but if you see of organic fertilizers, it has a high residual effect and the yield we are getting from the residual of organic is 6150 kg per hector. Whereas, in case of chemical fertilizer is 105 kg per hector of chickpea field that mean it indicates that that organic fertilizer has a high residual activity, it can because the residual activity organic fertilizer that can meets some of the nutrient demand of chickpea crops at it can give some of the returns which is based significantly higher than that of chemical fertilizer.

And with this if you see the this is a cost of production of both rice and chickpea and this is a gross return of rice and chickpea and it is net return in case of no fertilizer there is a loss around 20850 rupees per hector because so, as because you are spending everything, land preparation, seeds, labour everything; irrigation you are putting everything on no fertilizers. So, there is a negative return. The loss one if you are going chemical fertilizer the return is around 37625 rupees per hectare whereas, you are going for organic fertilizer the return is around 51300 rupees per hectare and if see because there.

So, there is a increasing return, we have put in organic fertilizer organic the organic farming as compared to chemical farming. The price selling price of the produce we have kept 23 percent higher in organic forming as compared to chemical farming and also there is a production cost is higher in organic farming because you are using the vermicompost that is a high dose as compared to the chemical fertilizer.

So, because of that the production cost is higher in case of the organic farming though there is a high production cost and because high residual effect and it compensate the nutrient requirement of the structuring crops. So, you are able to get the higher return in case of the organic farming as compared to chemical farming.

So, the point is that here when you go for the rotation designer, your crop planning and rotation design you should keep in mind that the type of crops you are choosing in the beginning at the transition periods when you are targeting a main crops, transition periods take the crops which requires a low nutrients and less maintenance and that can suppress their weight growth in that way we can build the soil fertility for your main crops and also different type of crops combinations should be chosen and you go for the economic analysis you can see that the organic farming that give that if you do properly

proper management, scientific management organic farming definitely will give the better return as compared to the chemical farming. With this I conclude this lecture.

Thank you very much.