Enhancing Agricultural Productivity and Rural Livelihoods through Scaling-up of Science-led Development in Odisha: Bhoochetana

Manual on the Training Workshop for Master Trainers of the Department of Agriculture, Government of Odisha

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IDC ICRISAT DEVELOPMENT CENTER
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INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

Contents

Introduction

This Manual is being developed to train the DOA staff who are one of the key stakeholders of the Odisha Bhoochetna Project. Collaborative organizations such as Department of Agriculture, State Agricultural Universities (SAUs), Krishi Vigyan Kendras (KVKs), Civil Society organizations will be the other stakeholders in the area of Capacity Building which is an integral component of the Odisha project. The manual is in a modular form so that any tailor-made program can be organized depending on the need of stakeholders. The contents have been developed by ICRISAT scientists who has also developed tools for presentations for a program. It has a section on "Adult Learning Principles" (Andragogy) for equipping trainers for an appropriate training methodology- often ignored or little understood. Following are the major themes of the proposed program.

- Climate and weather, climate change impacts, adaptation and mitigation strategies
- Soil sampling, soil fertility and soil health , Integrated nutrient management
- Fertilizer calculation, fertilizer application, fertigation
- Methodologies of training, participatory training, developing training tools, protocols for conducting and designing training programs- group exercise, case studies, Andragogy

Sessions

Session 1: Climate of Odisha, Climate smart agriculture

At the end of this session you will be able to:

- Define Weather and climate
- Study climate change and variability of weather parameters
- Learn water balance and Length of Growing period
- Characterize different types of droughts
- Apply climate change adaptation and mitigation

Global Warming

Greenhouse gases trap heat in the atmosphere and without the greenhouse gases, earth surface temperatures would have been much lower than what we observe now. Carbon dioxide, Methane and Nitrous Oxide are the major greenhouse gases. Growing concentration of greenhouse gases in the atmosphere is raising our temperatures around the world, which is known as "Global Warming". Carbon dioxide enters the atmosphere mostly through burning fossil fuels. Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills. Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste. Global atmospheric concentration of CO_2 has increased from preindustrial level of 280 parts per million (ppm) to 408 ppm in Feb 2018. Global projections indicate higher temperature of 1.5 to 4.5°C by the year 2050, as a result of enhanced greenhouse gases. Significant increasing trends in mean maximum temperature over many states in India were reported.

Weather and climate

Weather, the day-to-day state of the atmosphere, consists of short-term variation of energy and mass exchanges within the atmosphere and between the earth and the atmosphere. It results from processes that attempt to equalize differences in the distribution of net radiant energy from the sun. Acting over an extended period of time, these exchange processes accumulate to become *Climate*. To define in simple terms, *climate* is the synthesis of weather at a given location over a period of about 30 years. *Climate*, therefore, refers to the characteristic condition of the atmosphere deduced from repeated observations over a long period. More than a statistical average, climate is an aggregate of environmental conditions involving heat, moisture and motion. Any study of climate must consider extremes in addition to means, trends, fluctuation, probabilities and their variations in time and space.

Climate change and variability

Evidences over the past few decades show that significant changes in climate are taking place all over the world as a result of enhanced human activities through deforestation, emission of various greenhouse gases and indiscriminate use of fossil fuels. Climate change has aroused serious consciousness because it can result in severe impacts on most vulnerable sections of society, sectors and regions. Changes in climatic parameters affect agriculture and water

demand of an area. Changed rainfall patterns lead to frequent extreme conditions like floods, droughts and cyclones. Changes in temperatures impact crop yields, enhance crop water requirements and change the length of the growing period; all these necessitates changes in crops, varieties and management practices at specific regions for sustainable agricultural production.

Various studies show that climate change in India is real and it is one of the major challenges faced by Indian Agriculture. India Meteorological Department (IMD, 2017) reported that the annual mean temperature for the country in the year 2016 was +0.87 °C above the 1971-2000 average, thus making the year 2016 as the warmest year on record since 1901. At the country scale, no long-term trend in the onset date of southwest monsoon over Kerala and total monsoon rainfall over whole country was observed.

A study carried out by ICRISAT under the National Initiative on Climate Resilient Agriculture (NICRA) project based on the gridded rainfall and temperature data of India Meteorological Department quantified the changes in areas under different climates in India. The study indicated a net reduction in the dry sub-humid area (10.7 m ha) in the country, of which about 5.1 Million ha (47%) shifted towards the drier side and about 5.6 Million ha (53%) became wetter, comparing the periods 1971-1990 and 1991-2004 (Kesava Rao et al., 2013). Results for Madhya Pradesh have shown the largest increase in semi-arid area (about 3.82 Million ha) followed by Bihar (2.66 Million ha) and Uttar Pradesh (1.57 Million ha). Relatively little changes occurred in AP; semi-arid areas decreased by 0.24 Million ha, which were shifted to both towards drier side (0.13 Million ha under arid type) and wetter side (0.11 Million ha under dry sub-humid type). Results indicated that dryness and wetness are increasing in different parts of the country in the place of moderate climates existing earlier in these regions.

Based on data for sixty years (1951-2010), Rathore *et. al*. (2013) reported significant increasing trends in mean maximum temperature over all states in India except those in the Indo-Gangetic plains wherein spatially coherent decreasing trends were observed in the annual mean maximum temperature with significant decrease over Haryana (-0.02 °C/year) and Punjab (-0.01 °C/year). Maximum increase in annual mean maximum temperature was observed in Himachal Pradesh with a rate of change of about +0.06 °C/year. Rate of increase in annual mean minimum temperature was highest in Sikkim (0.07 °C/year) while the rate of decrease was highest in Uttara hand (-0.03 °C/year).

Agroclimatic Zones of Odisha

Odisha State has to broad regions; the plateau region and the coastal region. Based on rainfall, soil and crops, there are ten agroclimatic zones in Odisha (Table 1.1).

Table1.1. Agroclimatic zones of Odisha.

Sl. No.	Agroclimatic Zone	Agricultural Districts	Climate	Normal			Broad Soil groups
				Mean annual rainfall (mm)	Mean maximum summer temp (°C)	Mean minimum winter temp (°C)	
1	North Western Plateau	Sundargarh, parts of Debagarh, Sambalpur &Jharsuguda	Hot & moist sub-humid	1600	38.0	15.0	Red, Brown forest, Red & Yellow, Mixed Red & Black
2	North Central Plateau	Mayurbhanj, major parts of Kendujhar, (except Anandapur&Ghasipura block)	Hot & moist sub-humid	1534	36.6	11.1	Lateritic, Red & Yellow, Mixed Red & Black
3	North Eastern Coastal Plain	Baleswar, Bhadrak, parts of Jajpur&hatdihi block of Kendujhar	Moist sub-humid	1568	36.0	14.8	Red, Lateritic, Deltaic alluvial, Coastal alluvial & Saline
4	East & South Eastern Coastal Plain	Kendrapara, Khordha, Jagatsinghpur, part of Cuttack , Puri, Nayagarh& part of Ganjam	Hot & Humid	1577	39.0	11.5	Saline, Lateritic, Alluvial, Red & Mixed red & Black
5	North Eastern Ghat	Kandhamal, Rayagada, Gajapati, part of Ganjam& small patches of Koraput	Hot & moist, sub-humid	1597	37.0	10.4	Brown forest, Lateritic Alluvial, Red, Mixed Red & Black
Sl. No.	Agroclimatic Zone	Agricultural Districts	Climate	Normal			Broad Soil groups
				Mean annual rainfall (mm)	Mean maximum summer temp (°C)	Mean minimum winter temp (°C)	
6	Eastern Ghat High Land	Major parts of Koraput, Nabarangpur	Warm & humid	1522	34.1	7.5	Red, Mixed Red & Black, Mixed Red & Yellow
7	South Eastern Ghat	Malkangiri& part of Kendujhar	Warm & humid	1710	34.1	13.2	Red, Lateritic, Black
8	Western Undulating Zone	Kalahandi &Nuapada	Hot & moist sub-humid	1352	37.8	11.9	Red, Mixed Red & Black and Black
9	Western Central Table Land	Bargarh, Balangir, Boudh, Subarnapur, parts of Sambalpur &Jharsuguda	Hot & moist sub-humid	1614	40.0	12.4	Red & Yellow, Red & Black, Black, Brown forest, Lateritic
10	Mid Central Table Land	Angul, Dhenkanal, parts of Cuttack &Jajpur	Hot & moist sub-humid	1421	38.7	14.0	Alluvial, Red, Lateritic, Mixed Red & Black

Long-term rainfall trend in Odisha

Long term (1871-2016) rainfall data (source: IITM, Pune) of Odisha subdivision was analyzed for the southwest monsoon season (Jun-Sep) for identifying long term trends and short term variability in the time series. It is seen that there is large year-to-year variability in the monsoon rainfall (Figure 1.1). Analysis shows cyclic pattern with short period increasing and decreasing trends and there appears a slightly increasing trend after 1990 onwards.

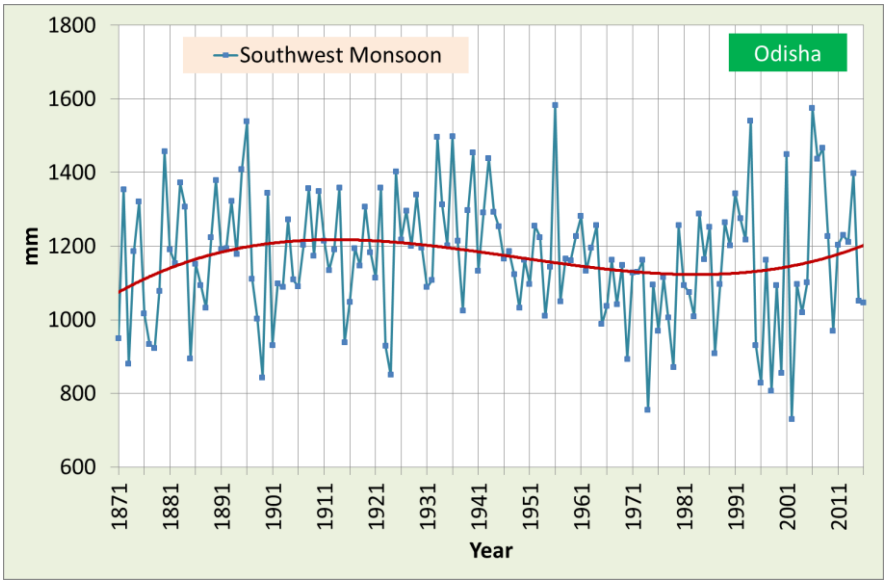

Figure1.1: Monsoon rainfall variability in Odisha.

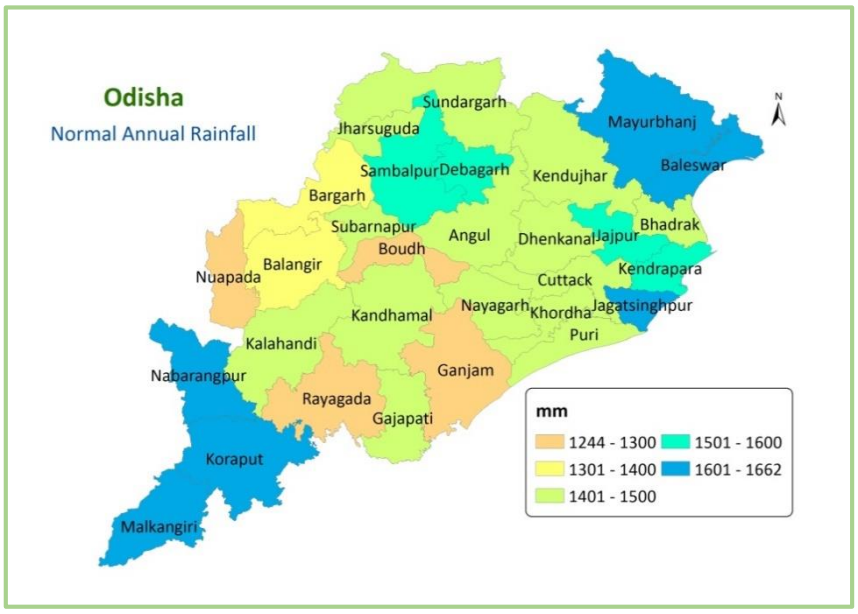

Figure 1.2: Annual rainfall in districts of Odisha.

Though Odisha receives good rainfall, there is great spatial variation in annual rainfall (Figure 2.2). Districts like Baudh, Ganjam, Nuapada and Rayagada receive rainfall between 1200-1300 mm, while Koraput, Malkangiri, Nabarangapur, Jagatsinghapur, Baleshwar and Mayurbhanj

districts receive above 1600 mm of annual rainfall. Across the various districts, about 80 to 90 per cent of the annual rainfall is received in the Kharif (Jun-Oct) season.

Rainfall probability

Rainfall characterization of watersheds helps in understanding the sowing period characters and to identify the optimum sowing windows. Selection of crops and cultivars is thus influenced by beginning of sowing rains as well as rainfall distribution in the season.

Characterization of a watershed based on average rainfall can yield good results, provided the rainfall distribution is normal. However, weekly rainfall totals include a number of zeros. Hence several researchers suggested "fitting of incomplete gamma distribution" to this kind of skewed data. Weekly rainfall that can be expected at different probability levels based on incomplete gamma distribution model can be computed using suitable software. As an example weekly rainfall expected at different probability levels were computed for Nuapada and Cuttack districts (Figure 2.3) based on long-period rainfall data (1987-2016).

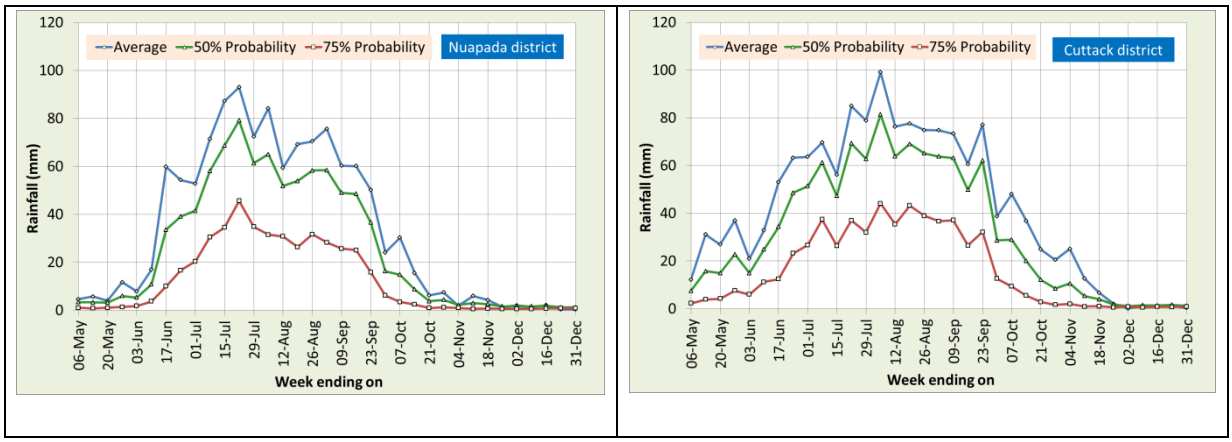

Figure 1.3: Probability rainfall distribution in Nuapada and Cuttack districts.

In Nuapada district, peak rainfall occurs in the middle of July while it occurs in the first week of August in Cuttack. In three out of four years (75 per cent probability), above 20 mm rainfall is received during July to middle of September in Nuapada. In Cuttack district, above 20 mm rainfall is received from last week of June to third week of September, indicating comparatively better moisture regime at Cuttack compared to Nuapada.

Dry and wet spells

Agricultural operations are determined by the receipt of certain amount of rainfall at each stage. Specific amounts of rainfall are required for activities like land preparation, sowing, transplanting, fertilizer application etc. Thus, estimation of probabilities with respect to a given amount of rainfall is useful for rainfed agricultural planning. *Initial Probability* is the probability of receiving a certain amount of rainfall in a given week and is denoted by P(W). The interesting point to be noted is that the probability of getting a next week as a wet week, given the

condition that the current week is a wet week – can be estimated. These are called Conditional Probabilities and denoted by P(W/W).

Length of growing period

Length of the rainfed crop-growing period (LGP) is defined as the length of the rainy season, plus the period for which the soil moisture storage at the end of rainy season and the post-rainy season and winter rainfall can meet the crop water need. Because the amount and distribution of rainfall varies considerably from year to year so does the rainfed crop-growing period. Growing period length also depends on the type of soil under a given quantity of rainfall. In areas receiving rainfall for two months, the growing season may be 80 days in a coarse textured soils or 100 days in soils of clayey or clay texture. Similarly in areas with five rainy months, the LGP ranges from 180 to 210 days depending upon soil texture and moisture holding capacity. Therefore, LGP depends on the rainfall distribution, soil depth, water holding capacity and moisture release characteristics of the soil. This assumes great importance from a watershed perspective where soil depth changes with slope and alters the LGP across the watershed, being highest in the low-lying areas and lowest in the upper reaches of the watershed. The National Bureau of Soil Survey and Land Use Planning (NBSS & LUP) estimated LGP using the FAO method, where the growing period starts when P > 0.5 PET and ends with utilization of an assumed quantum of stored soil moisture (100 mm) after P falls below PET. The study indicated that LGP vary from 90 days in NW India to 300 days in NE region. In semi-arid region, LGP varies between 120-150 days, in dry sub-humid climates it varies from 150-180 days.

Table 1.2. Variability in rainfed crop-growing period in selected districts of Odisha.

District	Rainfed crop-growing period		
	Beginning	Ending	Duration (days)
Malkangiri	10 Jun	25 Nov	160-170
Mayurbhanj	10 Jun	15 Nov	150-160
Nuapada	20 Jun	31 Oct	130-140
Puri	15 Jun	28 Nov	160-170

Based on long period (1987-2016) gridded rainfall data (India Meteorological Department) of representative pixels of the four districts, beginning and end of the rainfed crop-growing season / periods were delineated and the LGP was estimated (Table 1.2).

Results indicate that there is variability in the beginning, ending and thus the length of the rainfed crop-growing period across the selected districts in Odisha. Short period of about 130 to 140 days is seen in Nuapada while in Malkangiri and Puri districts, the rainfed crop-growing period could be 160 to 170 days.

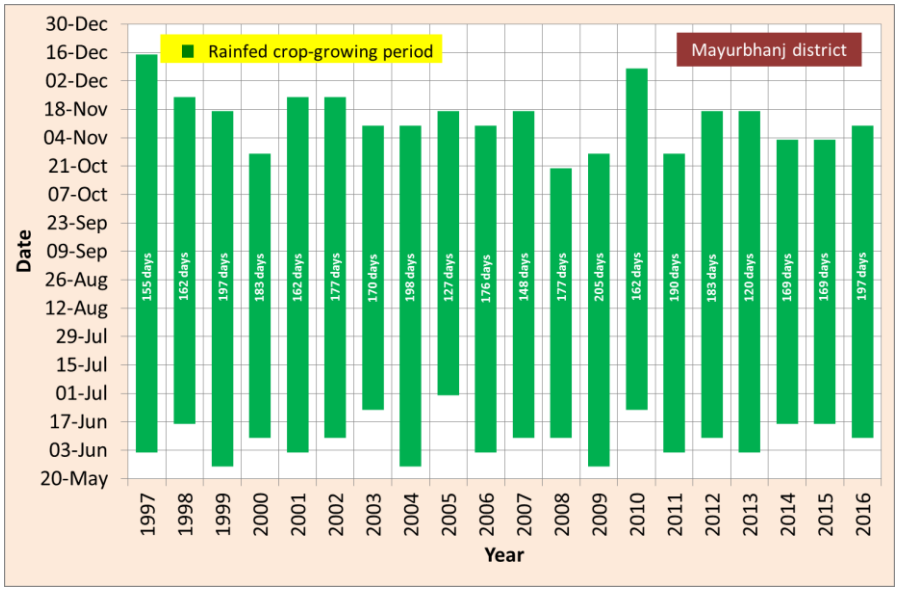

Figure 1.4: Variability in the rainfed crop-growing period in Mayurbhanj district

Due to changes in the onset of southwest monsoon rains and rainfall distribution, growing period characters change across years at a location. Considering rainfall data of 20 years (1997-2016), beginning and ending of crop-growing period was estimated for Mayurbhanj district (Figure 1.4).

Results show that though the normal beginning of the season is 10 June and ends by about 15 November. Variability in both beginning and ending is seen. Rainfed crop-growing period began as early as last week of May in the year 2004 while it was delayed up to the first of July in the year 2005. In the year 2008, the growing period ended as early as 20 October while in the years 1997, the growing period was extended up to middle of December. Shortest period of about 135 days was observed in the year 2008, while the year 1997 witnessed the longest rainfed crop-growing period of about 200 days. There is more variability in the ending of the season compared to the beginning of the period.

Crop-growing period of a watershed can also be estimated based on the rainfall, PET data and Available Water holding Capacity (AWC) of the soil. In Odisha, at present, rainfall data is available at block level (total 314 blocks) and weather parameters required for estimating PET are available at district level. Data on AWC is available for only dominant soil types occurring in the State. Using the above data on Available Water holding Capacity (AWC) of soils, weekly rainfall and potential evapotranspiration, soil water balance indices and length of rainfed crop-growing period can be estimated.

At the farm / watershed level, there will not be much change in the PET and rainfall amount. But the available water holding capacity of soils occurring in a watershed will vary significantly from soil to soil. Since the soils occurring in a watershed vary in depth, texture, coarse fragments and type of clay, organic matter content etc., the WHC of the soils also varies accordingly, which may range from very low to very high in one watershed area itself. This affects the crop growth significantly, particularly during the grain formation and later maturity stages, and hence at the watershed level, the LGP is decided significantly by the AWC of the

soils occurring in a watershed area. This variation in LGP due to the difference in the AWC of the soils occurring in a watershed area is very important for crop planning at watershed level.

Soil moisture availability period determines effective cropping season. In very dry areas, effective cropping season is normally 11 - 17 weeks, which restricts the choice of crops and limits the farmer to a single crop in the rainy season. In semi-arid and sub-humid regions, the effective cropping season is comparatively longer (22 - 32 weeks). Rainfall pattern and soil depth together determines the choice of crops and cropping systems. On shallow to medium Alfisols and related soils, only single season cropping, mostly during the rainy season is possible. Amount of pre-monsoon rains received in May determines whether or not double cropping is possible on Alfisols.

Drought characterization

Drought is a climatic anomaly, characterized by deficient supply of moisture resulting either from sub-normal rainfall, erratic rainfall distribution, higher water need or a combination of all the three factors. More than 60 definitions have been reported on the assessment of drought. National Commission on Agriculture in 1976 has categorized drought into three types, viz., meteorological drought, hydrological drought and agricultural drought based on the concept of its utilization which re defined as below:

Meteorological drought: It is a situation when there is significant (> 25%) reduction in rainfall compared to normal over an area.

Hydrological drought: Meteorological drought, if prolonged, results in hydrological drought with marked depletion of surface water and consequent drying up of reservoirs, lakes, streams and rivers.

Agricultural drought: It occurs when soil moisture and rainfall are inadequate to support a healthy crop growth during growing season; cause extreme crop stress and crops may wilt permanently.

For agricultural planning purposes, knowledge on agricultural droughts is of paramount importance. Crop production under rainfed conditions is influenced by various intensities of drought experienced at different crop growth stages; therefore, knowledge on the frequency of agricultural droughts of varying intensities is essential for developing suitable technologies for increased and sustainable production. Impact of drought depends on the phenological stage of crop as the water requirements of a crop vary with phenological phases. Droughts have a multiplier effect on crop production during the subsequent years also due to:

- Non-availability of quality seeds for sowing of crops
- Inadequate draught power for carrying out agricultural operations as a result of either distress sale of cattle or loss of life
- Reduced use of precious inputs like fertilizers as the investment capacity of the farmers' decline
- Non-availability of raw material in agro-based industries, and

- Deforestation to meet the energy needs in domestic sector as agricultural wastes may not be available in required quantity

Drought is a creeping phenomenon and its effect can be felt after it has happened. Earlier approach for drought management was to wait until an event occurs and try to mitigate its consequences by whatever means available. Water needs in agricultural sector are going to be very high, as several thousand tons of water is required to produce each metric ton of food grains. Therefore, long-term strategies for mitigation of droughts have to be based upon conservation, development and management of water resources. In this context, the farmer-participatory consortium model for integrated watershed management developed by ICRISAT was very successful and is being scaled-up in many states in India and more countries in Southeast Asia and Sub Saharan Africa.

Climate variability and change impacts on agriculture

The rate of increase of atmospheric carbon dioxide (CO_2) over the past 70 years is nearly 100 times larger than that at the end of the last ice age. As far as direct and proxy observations can tell, such abrupt changes in the atmospheric levels of CO_2 have never before been seen. Carbon dioxide remains in the atmosphere for centuries and in the ocean, where it acidifies the water, for even longer. In July 2017 the CO_2 content has gone up to 407.25 ppm. Atmospheric CO_2 growth rate has increased from about 0.73 ppm per year to 2.11 ppm per year from 1959 to 2014. Under the threat of increased greenhouse gases and resultant higher temperatures and uncertainty in rainfall regimes, there is a critical need to understand the climate variability and assess climate change and its impacts on crops for developing and communicating suitable adaptation and mitigation strategies to all stakeholders particularly farmers and agricultural extension personnel and planners to enhance resilience and also to reduce greenhouse gas emissions.

Table 1.3. Rainfall changes in selected districts of Odisha.

District	Change in Rainfall (mm) Between (1991-2017) and (1961-1990)			
	Summer	Kharif	Rabi	Annual
Cuttack	34	179	-15	198
Kandhamal	25	159	-17	165
Angul	2	138	-15	125
Sundargarh	0	80	-6	74
Ganjam	25	52	-29	48
Khurda	13	41	-14	40
Koraput	-25	53	-10	18
Bhadrak	5	16	-29	-8
Kendujhar	6	-6	-10	-10
Sambalpur	-11	-12	2	-21
Balangir	-11	-4	-14	-29
Nuapada	-27	1	-20	-46

To understand the rainfall variability, fifty seven years' (1961-2017) monthly rainfall data of twelve districts were collected and seasonal totals computed for all the years. The thirty-year

period from 1961 to 1990 was considered as normal and seasonal rainfall for this normal period was compared with the average rainfall of 27-years (1991-2017) for the selected districts (Table 1.3). It is seen that Cuttack district witnessed greatest increase of 198 mm in annual rainfall; while Nuapada district experienced a decreased rainfall of about 46 mm. Results indicate that rainfall in increasing in certain districts and is decreasing in some other districts. These trends indicate the need for assessing the crops and cropping patterns with reference to changing moisture regimes.

Studies indicate that in the past fifty years, temperatures are continuously increasing in several parts of India, particularly in Rabi season. Analysis of temperature data for 66 years (1951-2016) for Odisha indicated (Figure 1.5) that the Rabi maximum temperature increased by about 1.2 °C from 28.8 to 29.6 °C. Increase in Rabi temperature affects the productivity of crops like wheat, chickpea and mustard.

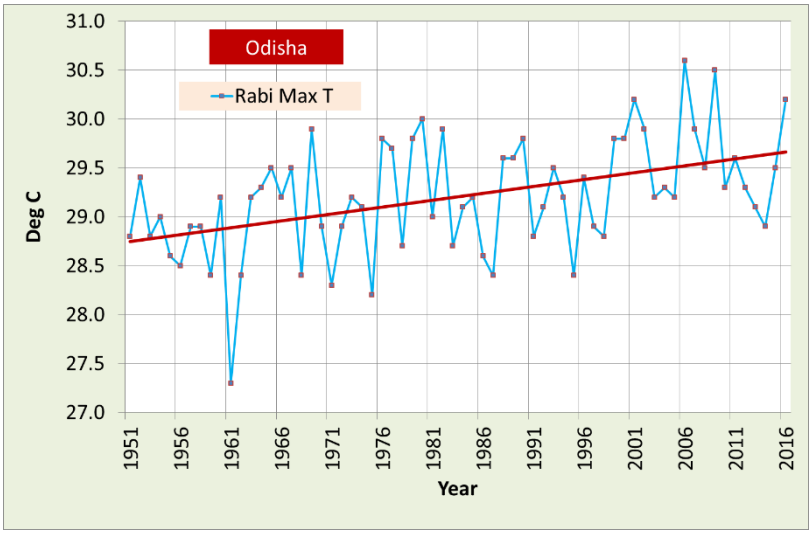

Figure 1.5: Rabi maximum temperature change in Odisha.

Climate projections

Projections of future climate are based on the output of atmosphere / ocean general circulation models and are used to simulate conditions in the future based on projected levels of greenhouse gases. There are several models available with different spatial resolutions. Majority of projections of future climate come from Global Circulation Models, which vary in the way they model the climate system, and so produce different projections about what will occur in the future. Representative Concentration Pathways (RCPs) are the four greenhouse gas concentration trajectories adopted by the IPCC which are used for climate modeling and research.

Projections based on CESM!_CAM5 climate model under RCP 8.5 for 2030s for Odisha indicate that both maximum and minimum temperature are projected to increase by 0.9 to 3.0 °C compared to the present conditions (Table 1.4). Though the projected annual rainfall is positive (85 mm), June and July together are projected to receive lower rainfall of about 39 mm compared to the present conditions.

Table 1.4. Temperature and rainfall projections for Odisha.													
Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Max T °C	0.9	1.0	1.2	1.2	0.9	1.6	1.4	1.3	0.9	1.2	1.4	1.0	0.9
Min T °C	2.3	2.3	2.1	2.1	1.4	1.6	1.5	1.3	1.3	2.2	2.9	3.0	2.3
Rainfall	6	5	1	6	18	-34	-5	3	50	15	17	3	6

In general, minimum temperature is projected to increase more compared to maximum temperature. Changes in temperatures impacts crop yields, enhance crop water requirements and change the length of the growing period; all these necessitates changes in crops, varieties and management practices at specific regions for sustainable agricultural production. Studies indicate that though the rainfall increases, the number of rainy days are likely to decrease, causing flooding a more frequent event during the sensitive crop-growing period. Duration between two rain events in the crop-growing period is likely to be longer. These lead to a peculiar situation of extreme events like droughts and floods occurring one after another in the crop-growing period. Identifying and developing crop cultivars with enhanced water use efficiency, tolerance to both drought and floods is the need.

Climate Smart Agriculture

Climate-smart agriculture (CSA) is a way to achieve short-and-long-term agricultural development priorities in the face of climate change and serves as a bridge to other development priorities. The three conditions viz., food security, adaptation and mitigation are referred to as the “triple win” of climate-smart agriculture. Climate-smart agriculture includes practices and technologies that sustainably increase productivity, support farmers’ adaptation to climate change, and reduce levels of greenhouse gases.

Climate change adaptation

Climate change adaptation refers to the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damage, to take advantage of opportunities, or to cope with the consequences. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.

Adaptation strategies need to be identified properly for increasing resilience of agricultural production to climate change. Several improved agricultural practices are evolved over time in various regions of the country. Management practices that are being followed under conditions of weather aberrations could also become potential adaptation strategies for climate change.

Resilience to climate change requires identifying climate smart crops and management practices and degree of awareness of community. Intercropping with grain legumes is one of the key strategies to improve productivity and sustainability of rainfed agriculture. Productive intercropping options identified to intensify and diversify rainfed cropping systems are

- Groundnut with maize
- Pigeonpea with maize
- Pigeonpea with soybean

Some of the other initiatives are ridge planting systems; seed treatment; Integrated Pest Management (IPM); adoption of improved crop varieties and production technologies; promoting community-based seed production groups and market linkages. Farmers need to be encouraged to practice seed treatment with *Trichoderma* sp and fungicides for managing seedling diseases and IPM options for controlling pod borer in chickpea and pigeonpea. Improved water use efficiency through IWM is the key in rainfed agriculture. Alternative sources of irrigation water are the carefully planned reuse of municipal wastewater and drainage water.

Climate change mitigation

Strategies for mitigating methane emission from rice cultivation could be alteration in water management, particularly promoting mid-season aeration by short-term drainage; improving organic matter management by promoting aerobic degradation through composting or incorporating it into soil during off-season drained period; use of rice cultivars with few unproductive tillers, high root oxidative activity and high harvest index; and application of fermented manures like biogas slurry in place of unfermented farmyard manure.

Methane emission from ruminants can be reduced by altering the feed composition, either to reduce the percentage which is converted into methane or to improve the milk and meat yield. The most efficient management practice to reduce nitrous oxide emission is site-specific, efficient nutrient management. The emission could also be reduced by nitrification inhibitors such as nitrapyrin and dicyandiamide (DCD).

Direct Seeded Rice (DSR) is an alternative method that can reduce the labour and irrigation water requirements. In the face of increasing population and growing demand for food, the upgrading of rainfed areas through DSR can help in soil and water conservation and deal with risks arising from climate change. Conservation agriculture technology helps to cope up with climate change impacts.

Legume-based systems are more sustainable than cereal only systems on *Vertisols.* Several soil and crop management practices affect carbon (C) sequestration in the soil. Among them, conservation tillage, regular application of organic matter at high rates, integrated nutrient management, restoration of eroded soils, and soil and water conservation practices have a relatively high potential for sequestering C and enhancing and restoring soil fertility in the longer-term.

Leaf Color Chart (LCC) is an easy-to-use and inexpensive tool for determining nitrogen status in plants. Use of the LCC promotes timely and needed application of N fertilizer in rice and wheat to save costly fertilizer and minimize the fertilizer related pollution of surface water and groundwater. It is a promising eco-friendly and inexpensive tool in the hands of farmers.

Renewable energy and farming are a winning combination. Wind, solar, and biomass energy can be harvested forever. Among various renewable sources of energy, biomass, which is produced right in the villages, offers ample scope for its efficient use to carry out domestic, production agriculture, livestock rising and agro-processing activities through thermal and bio-

conversion routes. Usage of solar energy is slowly increasing in rural India for solar cookers for cooking, solar drier for drying agriculture produce, solar water heaters and solar photovoltaic systems for pumping devices which are used for irrigation and drinking water. Farmers can lease land to wind developers, use the wind to generate power for their farms, or become wind power producers themselves.

Implementing Integrated Watershed Management Programme in a holistic way can mitigate the adverse effects of climate variability and change, and enhance the capacity of small-farm holders to manage extremes of drought and floods in a sustainable way. Agroclimatic analysis at watershed level coupled with crop-simulation models, and better seasonal and medium duration weather forecasts, help build resilience to climate variability / change.Farmers having access to climate and weather information are more likely to take better crop management actions. Scaling-up of issue of weather-based agroadvisories for better crop management using new ICT tools to reach the farming community will enhance resilience to climate variability and change.

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Session 2: All about soil

At the end of this session you will be able to:

- Define correct Soil Sampling procedure as a first step towards INM
- Practice various sampling methods, tools to be used
- Recall how to understand a Soil Card for efficient nutrient management

Soil Sampling

Soil testing is an essential component of soil resource management. Each sample collected must be a true representative of the area being sampled. Utility of the results obtained from the laboratory analysis depends on the sampling precision. Hence, collection of large number of samples is advisable so that sample of desired size can be obtained by sub-sampling. In general, sampling is done at the rate of one sample for every two hectare area. However, at-least one sample should be collected for a maximum area of ten hectares. For soil survey work, samples are collected from a soil profile representative to the soil of the surrounding area.

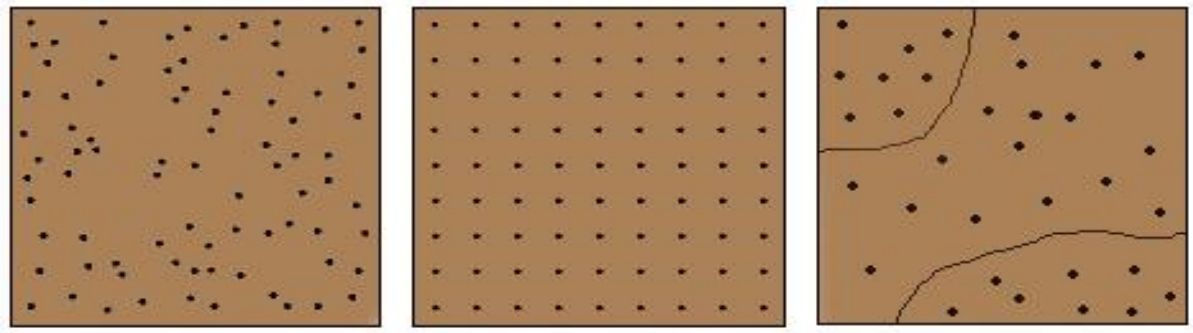


Figure 2.1: Types of Soil sampling.

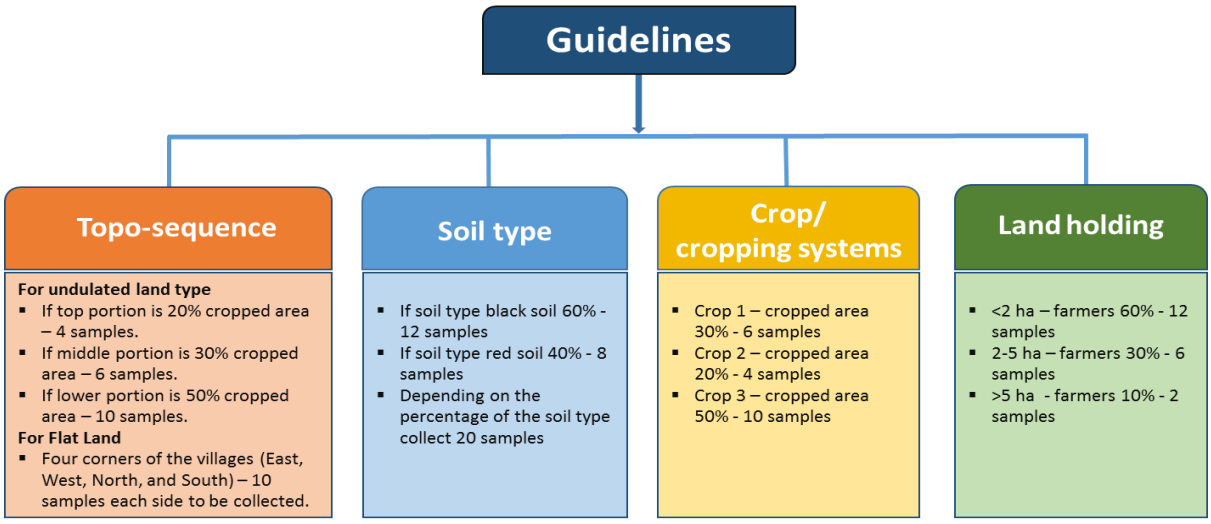


Figure 2.2: **Guidelines for stratified random sampling**

Figure 2.3: Equipment for soil sampling- Screw augur, Plastic tray, Polythene bag, label and marker

Soil sampling in annual agricultural crops

- Follow stratified soil sampling method to ensure collection of a representative sample
- Divide target village into three topo-sequences.
- At each topo-sequence location, take samples proportionately from different farm-holding sizes.
- Within farm size class in a topo-sequence, take samples representing soil colour, texture, cropping system and agronomic management
- Remove the surface litter at the sampling spot.

- Drive the auger to a plough depth of 15 cm and draw the soil sample.
- Collect at least 10 to 15 samples from each sampling unit and mix together to make a composite sample and place in a bucket or tray.
- If auger is not available, make a 'V' shaped cut to a depth of 15 cm in the sampling spot using spade.
- Remove thick slices of soil from top to bottom of exposed face of the 'V' shaped cut and place in a clean container.
- Mix the samples thoroughly and remove foreign materials like roots, stones, pebbles and gravels.
- Reduce the bulk to about half to one kilogram by quartering or compartmentalization.
- Quartering is done by dividing the thoroughly mixed sample into four equal parts. The two opposite quarters are discarded and the remaining two quarters are remixed and the process repeated until the desired sample size is obtained.
- Compartmentalization is done by uniformly spreading the soil over a clean hard surface and dividing into smaller compartments by drawing lines along and across the length and breadth. From each compartment a pinch of soil is collected. This process is repeated till the desired quantity of sample is obtained.
- In Grid sampling system, follow above stratification principles – only one sample per 10 ha.
- Follow precautions not to collect samples from recently fertilized plots, bunds, channels, marshy spots, near trees, cow dung heap or other non-representative areas.

Materials required

1. Spade or auger (screw or tube or post hole type)
2. Khurpi
3. Core sampler
4. Sampling bags
5. Plastic tray or bucket

Soil sampling in horticultural plantations

- For soil sampling in horticultural plantations, follow following protocols;
- Divide the orchard into blocks of trees of the same species, age and other characteristics like topography, soil color, soil texture and management practices.
- Within a block, select representative 5 trees.
- From each indicator tree in a block, pull 3 to 4 cores.
- Mix the resulting 15-20 cores in the block and take ~1 kg (following partitioning method) composite sample.
- Sampling depth varies from crop to crop as in Table 2.1.

Table 2.1. Recommended soil sampling depth and distance from tree trunk.			
Sl	Crop	Recommended sampling depth (cm)	Recommended distance from tree trunk for sampling (cm)
1	Mango	0-40	75-100
2	Citrus	0-25	100-125
3	Gauva	0-30	75-100
4	Ziziphus	0-40	75-100
5	Papaya	0-45	75-100
6	Banana	0-25	0-25
7	Pomegranate	0-45	25-50
8	Cashew	0-30	
9	Coconut	0-30	
10	Cocoa	0-30	
11	Chillies	0-15	

Note: In general, the sampling spot is the center point between trunk and spread of canopy.

Horticultural Plantations - Leaf Sampling

With tree crops it is important to use plant analysis to check nutrient mobilization related deficiencies due to reasons like extensive root systems and nutrient storage by woody plants and slow internal nutrient transport. There has to be a specific plant part at a specific stage of the growth because the concentration of different nutrients varies significantly over the life cycle of a plant. Generally, the recently matured fully expanded leaf just before the onset of the reproductive stage is collected. The proper plant tissue to be sampled is indicated in Table 2.2.

Table 2.2 Plant tissue sampling guidelines for horticultural crops.			
Sl	Crop	Tissue	Growth stage
1	Mango	Leaves + Petiole	4-7 month old leaves
2	Citrus	3-5 month old leaves from new flush. 1st leaf of the shoot	June
3	Guava	3rd pair of recently mature leaves	August/December (Bloom stage)
4	*Ziziphus*/Ber	6th leaf from apex from secondary shoot	2 months after pruning
5	Papaya	6th petiole from apex	6 month after planting
6	Banana	Petiole of 3rd open leaf from apex	4 month after planting
7	Pomegranate	8th leaf from apex	April/August months
8	Cashew	4th leaf from tip of matured branches	At beginning of flowering
9	Coconut	Pinnal leaf from each side of 4th leaf	
10	Cocoa	3rd or 4th leaf from apex of shoot	
11	Chillies	Most recent fully developed leaves	

Precautions in soil sampling and transportation

- Do not take sample by the side of the road or places where manure heaps are stacked
- Do not put samples in empty fertilizer/chemical bags
- Take separate samples for problematic areas
- Dry the sample collected from the field in shade by spreading on a clean sheet of paper after breaking the large lumps, if present.
- Spread the soil on a paper or polythene sheet on a hard surface and powder the sample by breaking the clods to its ultimate soil particle using a wooden mallet.
- Sieve the soil material through 2 mm sieve.
- Repeat powdering and sieving until only materials of >2 mm (no soil or clod) are left on the sieve.
- Collect the material passing through the sieve and store in a clean glass or plastic container or polythene bag with proper labeling for laboratory analysis.
- For the determination of organic matter it is desirable to grind a representative sub sample and sieve it through 0.2 mm sieve.
- Air-drying of soils must be avoided if the samples are to be analyzed for NO_3-N and NH_4-N as well as for bacterial count.
- Field moisture content must be estimated in un-dried sample or to be preserved in a sealed polythene bag immediately after collection.
- Record all information for the sample and ensure that number on sampling bag and in data sheet are same.
- Put a tag (with bag number written using lead pencil) inside the sample bag for additional security.
- Tightly put a rubber around the top of bag to avoid loss of sample during transportation.
- Pack samples very carefully.
- Arrange to transport collected samples on a fortnightly basis

Points to be considered

- Collect the soil sample during fallow period.
- In the standing crop, collect samples between rows.
- Sampling at several locations in a zig-zag pattern ensures homogeneity.
- Fields, which are similar in appearance, production and past-management practices, can be grouped into a single sampling unit.
- Collect separate samples from fields that differ in colour, slope, drainage, past management practices like liming, gypsum application, fertilization, cropping system etc.
- Avoid sampling in dead furrows, wet spots, areas near main bund, trees, manure heaps and irrigation channels.
- For shallow rooted crops, collect samples up to 15 cm depth. For deep rooted crops, collect samples up to 30 cm depth. For tree crops, collect profile samples.
- Always collect the soil sample in presence of the farm owner who knows the farm better

Figure 2.4 (a) Locating GPS coordinates

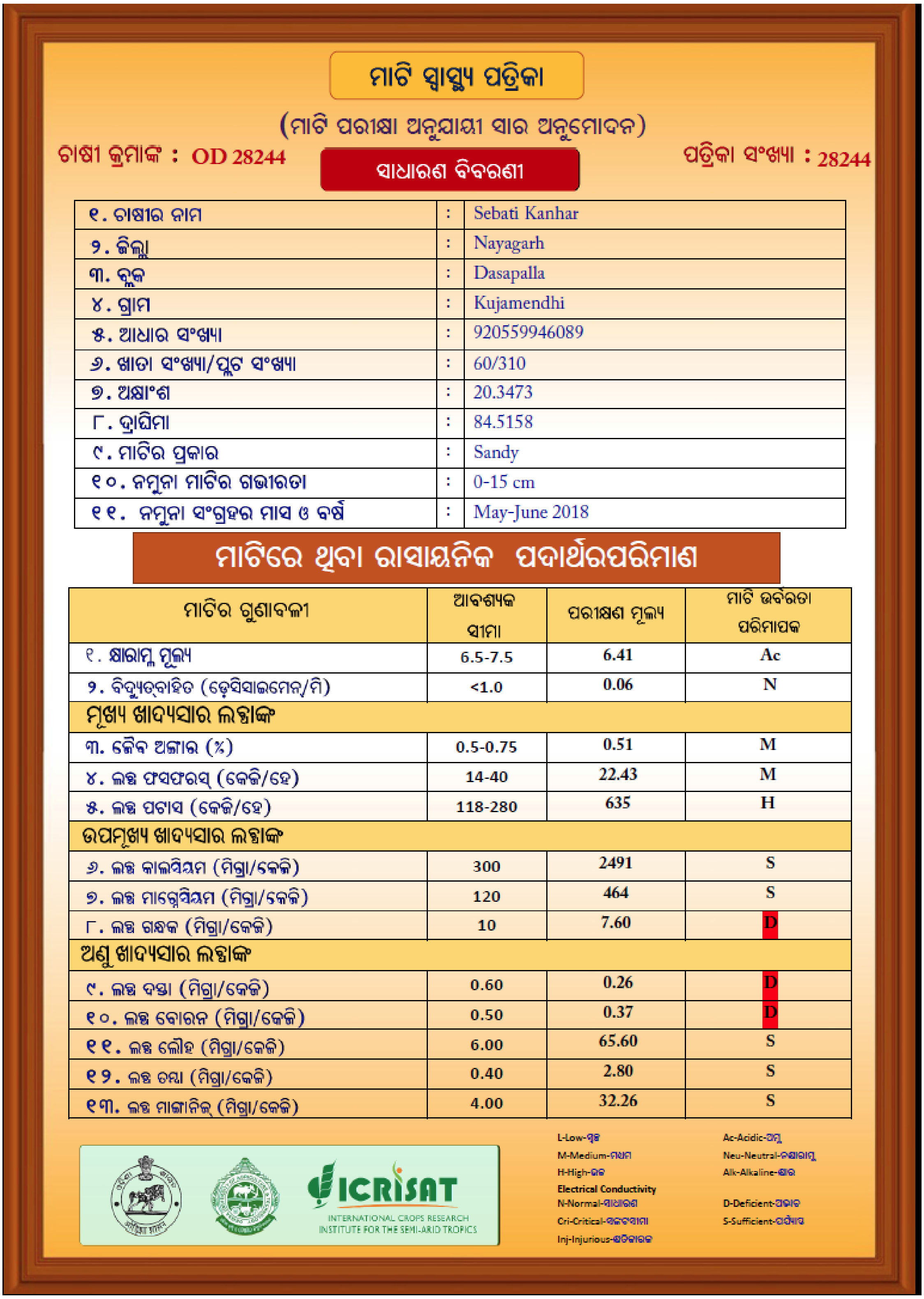
Figure 2.4 (b) Collecting the soil sample at 0-15 cm depth

Figure 2.5 (c) Mixing of soil samples collected from different spots

Figure 2.6 (d) Packing of collected soil samples.

Soil health cards

Soil health cards prepared from soils collected from Odisha will be GPS based soils collected information. It will include farmer details including survey number, district, mandal, village, mobile number, soil type, soil depth and month and year of sampling. It will have the initial soil test values for 12 parameters, based on which farmer based nutrient recommendations will be given for 20 crops. General fertilizer based recommendations will be drawn up for Odisha soils as per the OUAT guidelines.



ମାଟି ସ୍ୱାସ୍ଥ୍ୟ ପତ୍ରିକା

(ମାଟି ପରୀକ୍ଷା ଅନୁଯାୟୀ ସାର ଅନୁମୋଦନ)

ଚାଷୀ କ୍ରମାଙ୍କ : OD 28244

ପତ୍ରିକା ସଂଖ୍ୟା : 28244

ସାଧାରଣ ବିବରଣୀ

୧. ଚାଷୀର ନାମ	:	Sebati Kanhar
୨. ଜିଲ୍ଲା	:	Nayagarh
୩. ବ୍ଲକ	:	Dasapalla
୪. ଗ୍ରାମ	:	Kujamendhi
୫. ଆଧାର ସଂଖ୍ୟା	:	920559946089
୬. ଖାତା ସଂଖ୍ୟା/ପ୍ଲଟ ସଂଖ୍ୟା	:	60/310
୭. ଅକ୍ଷାଂଶ	:	20.3473
୮. ଦ୍ରାଘିମା	:	84.5158
୯. ମାଟିର ପ୍ରକାର	:	Sandy
୧୦. ନମୁନା ମାଟିର ଗଭୀରତା	:	0-15 cm
୧୧. ନମୁନା ସଂଗ୍ରହର ମାସ ଓ ବର୍ଷ	:	May-June 2018

ମାଟିରେ ଥିବା ରାସାୟନିକ ପଦାର୍ଥରପରିମାଣ

ମାଟିର ଗୁଣାବଳୀ	ଆବଶ୍ୟକ ସୀମା	ପରୀକ୍ଷଣ ମୂଲ୍ୟ	ମାଟି ଉର୍ବରତା ପରିମାପକ
୧. କ୍ଷାରାମ୍ଳ ମୂଲ୍ୟ	6.5-7.5	6.41	Ac
୨. ବିଦ୍ୟୁତ୍‌ବାହିତ (ଡ଼େସିସାଇମେନ୍/ମି)	<1.0	0.06	N
ମୂଖ୍ୟ ଖାଦ୍ୟସାର ଲବ୍ଧାଙ୍କ			
୩. ଜୈବ ଅଙ୍ଗାର (%)	0.5-0.75	0.51	M
୪. ଲବ୍ଧ ଫସଫରସ୍ (କେଜି/ହେ)	14-40	22.43	M
୫. ଲବ୍ଧ ପଟାସ (କେଜି/ହେ)	118-280	635	H
ଉପମୂଖ୍ୟ ଖାଦ୍ୟସାର ଲବ୍ଧାଙ୍କ			
୬. ଲବ୍ଧ କାଲସିୟମ (ମିଗ୍ରା/କେଜି)	300	2491	S
୭. ଲବ୍ଧ ମାଗ୍ନେସିୟମ (ମିଗ୍ରା/କେଜି)	120	464	S
୮. ଲବ୍ଧ ଗନ୍ଧକ (ମିଗ୍ରା/କେଜି)	10	7.60	D
ଅଣୁ ଖାଦ୍ୟସାର ଲବ୍ଧାଙ୍କ			
୯. ଲବ୍ଧ ଦସ୍ତା (ମିଗ୍ରା/କେଜି)	0.60	0.26	D
୧୦. ଲବ୍ଧ ବୋରନ (ମିଗ୍ରା/କେଜି)	0.50	0.37	D
୧୧. ଲବ୍ଧ ଲୌହ (ମିଗ୍ରା/କେଜି)	6.00	65.60	S
୧୨. ଲବ୍ଧ ତମ୍ବା (ମିଗ୍ରା/କେଜି)	0.40	2.80	S
୧୩. ଲବ୍ଧ ମାଙ୍ଗାନିଜ୍ (ମିଗ୍ରା/କେଜି)	4.00	32.26	S

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L-Low-ସ୍ୱଳ୍ପ
M-Medium-ମଧ୍ୟମ
H-High-ଉଚ୍ଚ
Electrical Conductivity
N-Normal-ସାଧାରଣ
Cri-Critical-ସଙ୍କଟସୀମା
Inj-Injurious-କ୍ଷତିକାରକ
Ac-Acidic-ଅମ୍ଳ
Neu-Neutral-ନକ୍ଷାରାମ୍ଳ
Alk-Alkaline-କ୍ଷାର
D-Deficient-ଅଭାବ
S-Sufficient-ପର୍ଯ୍ୟାପ୍ତ

Figure 2.7: sample soil health card

Session 3: Soil fertility status and soil test based balanced nutrient management

At the end of this session you will be able to:

- Define soil fertility status of plot
- Underline soil analysis and nutrient status of Odisha soils
- Schedule soil test based balance nutrient management
- Apply foliar application of fertilizers
- Demonstrate Aerobic composting for OM
- Practice Fertilizers and fertilizer application

Background

Odisha Bhoochetana project aims at improving and sustaining crop productivity and rural livelihoods through science based natural resource management (soil management in particular) in the state of Odisha. This will provide a sound base for precise fertilizer management not only for NPK but also deficient secondary and micro nutrients. Declining soil health is often cited as one of the reasons for stagnating or declining yields. The limiting nutrients do not allow the full expression of other nutrients, lower the fertilizer response and crop productivity. The constraints of emerging S, Zn, Mn and B deficiencies in specific cropping systems/ regions also need to be alleviated to enhance soil-crop productivity.

Preliminary soil analysis results for pilot sites have shown multi-nutrient deficiencies of secondary and micro nutrients like sulphur (S), boron (B) and zinc (Zn) along with nitrogen (N), phosphorus (P) and potassium (K). The imbalanced and sole use of high analysis NPK fertilizers coupled with declining use of organic manures in the past decades have resulted in soil fertility degradation through developing negative balances of secondary and micronutrients and low carbon (C) levels. The deficiencies will further aggravate when we attempt increasing the crop productivity without resorting to proper soil fertility management practices.

Table 3.1. Odisha Bhoochetana project, District and Block wise Initial soils nutrient % deficient data												
District	OC	Av P	Av K	Av Ca	Av Mg	Av S	Av Zn	Av B	Av Fe	Av Cu	Av Mn	No of samples
Angul	32.98	30.87	6.73	46.83	2.79	35.48	60.29	78.37	0.77	1.35	2.69	1040
Deogarh	28.46	47.95	11.28	58.72	1.54	42.31	54.62	75.64	1.03	0.26	0.26	390
Kendrapara	26.92	25.30	10.77	32.65	0.00	35.81	18.80	35.21	0.00	0.00	0.00	1170
Jagatsinghpur	44.23	16.06	18.65	49.62	0.00	57.79	55.29	63.17	0.10	0.00	0.77	1040
Khurda	61.69	40.08	30.46	72.85	4.46	64.85	25.46	82.69	0.00	0.23	0.15	1300
Nayagarh	54.13	18.56	15.77	39.13	1.35	47.69	42.02	80.87	0.10	0.00	0.29	1040
Kandhamal	41.59	40.37	6.58	78.70	0.81	71.10	40.64	86.91	0.75	2.04	0.14	1474
Kalahandi	50.35	53.42	7.11	36.40	0.09	52.81	61.93	85.26	0.44	0.00	0.53	1140
Nabrangpur	38.29	45.19	12.33	70.91	2.38	70.17	59.24	94.74	0.08	0.08	1.15	1217
Rayagada	52.77	17.52	1.98	62.28	1.19	44.26	27.62	79.50	1.19	0.40	0.10	1010
Cuttack	36.98	22.42	25.71	49.40	0.38	41.04	17.91	82.69	0.33	0.05	0.22	1820
Dhenkanal	31.92	40.48	12.88	48.85	0.77	41.35	18.65	73.65	0.29	0.00	0.77	1040
Puri	43.52	14.65	27.61	51.62	3.17	49.72	29.65	63.24	0.07	1.13	1.90	1420
Bhadrak	40.44	20.33	15.60	21.10	0.66	48.90	38.24	57.36	1.76	1.32	1.32	910
Jajpur	49.31	23.69	29.38	54.54	2.46	46.85	25.23	77.00	0.69	0.00	0.62	1300
Sambalpur	39.49	35.04	12.39	69.06	4.53	44.44	40.68	92.39	0.94	0.09	0.43	1170
Boudh	48.21	28.21	20.77	41.54	1.79	49.23	62.82	88.97	2.56	0.00	0.00	390
Sonepur	35.64	40.13	14.62	51.54	1.54	24.62	63.97	90.13	0.26	0.13	0.51	780
Bargarh	35.76	23.03	18.75	56.81	2.56	28.60	52.85	89.38	0.45	0.19	0.32	1563
Balangir	46.12	50.85	10.23	37.55	0.88	43.87	75.92	92.30	1.70	0.77	0.88	1819
Nuapada	22.37	49.01	0.15	16.29	0.00	26.94	72.15	80.06	0.30	0.00	0.76	657
Ganjam	44.30	38.11	9.72	39.27	2.10	39.20	31.50	62.90	0.35	0.03	0.28	2860
Gajapti	60.54	28.57	3.75	81.79	8.39	79.11	40.71	89.29	1.43	0.00	0.18	560
Keonjhar	45.92	54.97	27.87	67.57	6.51	69.29	53.79	86.98	0.06	0.24	0.18	1690
Sundergargh	47.33	59.10	10.41	73.98	1.81	45.25	39.41	94.62	0.14	2.53	0.05	2210
Jharsuguda	45.67	39.33	21.00	77.67	3.00	50.67	32.67	93.67	0.00	0.33	0.00	300
Balasore	52.00	33.42	41.68	64.45	5.16	37.35	41.48	68.06	1.10	0.26	1.29	1550
Mayurbhanj	44.98	63.16	36.27	76.68	8.41	66.26	39.12	91.35	0.27	0.00	0.30	3328
Koraput	24.51	23.80	9.46	85.82	3.94	87.08	49.01	82.90	0.00	0.08	0.00	1269
Malkangiri	41.43	51.06	26.59	65.90	4.43	57.80	50.87	90.37	0.00	0.96	0.39	519

Outcomes of Odisha Bhoochetana soil analysis:

- Organic carbon is deficient (43%) in most of the analyzed soil samples
- Exchangeable bases followed the deficiency order: Ca > K > Mg
- Sulphur deficiency 50%) was also prominent in analyzed soils
- Boron (80%) was the most limiting amongst all micro-nutrient followed by zinc (43%)
- Micronutrient deficiency followed the order: Zn > Fe >Mn> Cu

Soil test based balanced nutrient management

Soil testing is essential and is the first step in obtaining high yields and maximum returns from the money invested in fertilizers. Soil testing as a tool for judicious fertilizer use is a well-recognized practice all over the world which takes care of too little, too much or disproportionate applications of nutrients. The soil testing and fertility management programmes have been given adequate importance for sustaining crop production and balanced fertilization in Indian agriculture. Fertilizer has been and will continue to be the key input for achieving the estimated food grain production goals of the country. But, the escalating cost coupled with increasing demand for chemical fertilizers and depleting soil health necessitates the safe and efficient method of nutrient application. The soil test based fertilizer recommendation is therefore the actual connecting link between research and its practical application to the farmers' fields. A farmer who follows only the soil test based fertilizer recommendations is assured of a good crop. A fertilizers recommendation from a soil testing laboratory is based on carefully conducted soil analyses and the results of research on the crop, and it therefore is more scientific information available for fertilizing that crop in the field. Nutrient management play a major role in increasing the crop yield. Plant nutrition along with other management practices viz. improved cultivar, pest and disease management, soil and moisture conservation, water management, weed control, interculture, cropping systems also has decisive effect on crop yields. Despite concerted efforts by the state the requisite knowledge on improved package of practices among the farmers is lagging. Several efforts are undertaken by the government agencies, NGOs and researchers to spread the importance of soil testing and balanced soil test based fertilizers application which ultimately has implication on crop yield.

Soil test-based basal application of micro/secondary nutrient fertilizers

- Addition of recommended deficient secondary and micro nutrients like S, B and Zn as basal application within 30 days of sowing.
  To add yearly doses of recommended S, B and Zn. Yearly full doses per ha are 15 kg S, 0.25 kg B and 5 kg Zn.

Foliar application of fertilizers

If basal applications of S, B and Zn are missed within 30 days, the alternate option could be to resort to foliar application of nutrients to cover-up losses in yields and incomes. Plants can absorb nutrients from dilute solutions applied on to the leaves; and so Zn, B and S deficiencies can be readily corrected through foliar application as described below:

- foliar application of *Agribor* (0.1%) + Zinc sulphate(0.5%) + Unslaked lime (0.25%), 2-3 times at 7-10 days interval between 30–60 days after sowing/transplanting. For making above fertilizer solution, dissolve 100 g *Agribor* + 500 g zinc sulphate + 250 g lime in 100 l of water (For ½ acre).
- Urea meant for top dressing may further be split and applied along with micronutrient sprays, @ 1-2% (i.e. 1-2 kg urea/100 l of solution) for getting higher efficiency.
- Addition of unslaked lime is needed to neutralize acidity caused by zinc sulphate ionization. The solution required for one ha is 500 l.
- Optimum time of day for foliar application is early morning (7 to 10 am), because of less evaporation and longer period absorption of nutrients through opened stomata. Major drawbacks in foliar application are that it needs more labor and plants lose critical period of 1 month or more without proper nutrition which adversely affects crop growth. Moreover, it has little or no effect in improving soil fertility. However, it is an efficient corrective measure for any deficiency in the standing crop and has the following advantages:
- Smaller quantities of the nutrients are required than when applying to the soil.
- The danger of fixation and/or leaching is reduced.
- Nutrients applied to the foliage are absorbed more rapidly than when applied to the soil.
- It provides a convenient method of application for fertilizers required in small amounts.

Fertigation

- Identify area with drip systems in agricultural and horticultural crops
- Promote crop-specific fertigation schedules for regulated supply of micronutrients.
- Emphasize to promote regular fertilizers like N, K, Zn, B in fertigation
- Filter the regular fertilizer nutrient-solution before putting in the system

Aerobic composting

- Aerobic composting refers to the process of composting using decomposing microbial culture and ensuring enhanced aeration.
- Aerobic composting can effectively be practiced on ground surface; however, for effective handling, cemented platform (2 m wide and 3 m or as required long) may be constructed.

Composting materials –

Organic waste=100 kg

Dung = 20 kg

Rock phosphate = 4 kg

Urea = 0.5 kg (priming of raw biomass @ 0.5% should be done before one week to lower C:N ratio)

Microbial culture = 1.0-2.0 kg ton^{-1}

Procedure

- Spread raw biomass on cemented platform.
- Sprinkle rock phosphate @ 4 kg per 100 kg straw biomass on the waste material and then sprinkle cow dung slurry. Fill in layers Fill the heap up to 0.75 m height.
- Do turnings of biomass (upside down and vice-versa) at 10 days' interval up to 50 days.

Precautions

- Take care to maintain proper moisture content by watering at alternate days.
- Instead of sole use of huge amounts of fertilizer nutrients, the integration of cost effective biofertilizers can contribute in enhancing the use efficiency of fertilizer management to bring in better economics or benefit/cost ratio. Biological fertilizers include mainly – vesicular arbuscular mycorrhizae (VAM), phosphate solubilizing micro-organisms (PSM) and nitrogen fixing bacteria.

Aerobic composting and Different factors affecting composting process

Aerobic composting is a decomposition process carried out by microorganisms in presence of oxygen whereas anaerobic composting is carried out by anaerobic microorganisms and vermi composting is carried out by Earthworms. Aerobic composting is called as hot process and anaerobic, vermi composting are cool processes. In the first couple of days of aerobic composting, the temperature of the heap raise to 65^{o}C – 70^{o}C which is called as thermophilic phase. The decomposition starts with mesophilic phase (25^{o}C - 45^{o}C for 2 to 5 days) and then proceeds to thermophilic phase (>45^{o}C for 10-15 days) followed by drop down of temperature to mesophilic conditions which prevails till the end of the process.

- The microbial action in the first mesophilic phase raises the temperature of the heap by their metabolic activity, and then the thermophilic bacteria breakdown polymeric substances. Finally further breakdown and maturation of compost happen in the second mesophilic phase.

$$\text{Organic matter} + O_2 = \text{Compost} + CO_2 + H_2O + NO_3^- + SO_4^{2-} + \text{Heat}$$

Different factors affecting aerobic composting

Particle size

The size reduction of biomass increases the exposed surface area for microbial action. The ideal particle size for aerobic composting is 5 cm. The size reduction can be achieved either by tractor mounted shredding machine or electric shredding machine. Tractor mounted shredding machine has the advantage of mobility of machine to the biomass location otherwise have to transport the biomass to the electric shredding machine.

***Figure 3.1: Tractor run shredding* machine**

Shredder machines

Table 3.2. Different models of tractor mounted shredder machines.			
Model	Power (HP)	Machine (RPM)	Approx. output capacity (Kg/Hr)
CS33	5 to 10	2800	500
CS50	10 to 15	1600	1000
CS80	30 to 40	1100	3000
C80	25 to 30	1100	2000 – 3000
CS80 heavy duty	50	1100	3000

Table 3.3. Trouble shooting different problems in shredding.		
Problem	Possible cause	Remedy
Rotor stalls or stops	Obstructed discharge	Use branch or similar object to clear discharge
	Plugged rotor	Clear rotor, feed material more evenly
	Feed material that id too large	Reduce size of material
Chipper does not chip	Dull chipper blades	Rotate or sharpen blades
	Drive belts loose or worn	Inspect drive belts, adjust or replace if needed
	Attempting to feed branches that are too large	Limit branch size
	Broken or missing chipper blades	Replace blades
Hard to feed chipper, requires excessive power to chip	Dull chipper blades	Reverse or sharpen blades
	Obstructed discharge	Use branch or similar object to clear discharge
	Improper blasé clearance	Adjust clearance between chipper anvil and chipper blades
Shredder requires excessive power or stalls	Obstructed discharge	Use branch or similar object to clear discharge
	Plugged rotor	Clear rotor, feed material into shredder more evenly
	Wet or green material will not discharge	Alternatively feed dry material or install large discharge screen
Belt squeals when engaging clutch	Engaging clutch too fast	Engage clutch more slowly
	Plugged rotor	Clear rotor, feed material more evenly
	Belt tension too loose	Replace belt
Material around chipper wraps around too fast	Stringy, green material bypasses chipper blades	Rotate branch or material when feeding to cut completely
	Dull chipper blades	Sharpen blades
	Improper blade clearance	Adjust clearance between anvil and chipper blades

Nutrients

The microorganisms require Carbon (C), Nitrogen (N), Phosphorus (P), and Potassium (K) as primary nutrients for their metabolic activities and growth. The ideal C:N ratio of biomass material for composting is 30:1 and the range between 25 to 40 is satisfactory. The wide ranges of C:N ratio lead to longer composting time and less C:N ratio leads to loss of excess nitrogen into atmosphere by denitrification (Denitrifying bacteria). The C:N ratio can be maintained by blending the green and brown biomass or by adding nitrogen source like Urea or DAP to the biomass that is deprived of nitrogen. The C:N ratios of different agricultural waste are listed in the below table (table no 3.4). The C:P ratio of the biomass should be between 75:1 and 150:1 (Misra *et al.,* 2003).The biomass with high lignin content takes longer time for decomposition. High content of the lignin leads to slow decomposition due to the recalcitrant nature of lignin. Lignin also reduces the bioavailability of other cell wall constituents. Addition of lignin decomposing fungi may increase the rate of decomposition.

Table 3.4: List of C:N ratios of different biomass.

Material	N%	C:N
Wheat straw	0.3 – 0.5	80-130
Rice straw	0.3 – 0.5	80-130
Cotton stalks	0.6	70
Maize stalks and leaves	0.8	50-60
Sugar cane trash	0.3 – 0.4	110-120
Green weeds	2.45	13
Fallen leaves	0.5 - 10	40 - 80
Grass clippings	2.15	20
Cow dung	2.0	19
Biogas slurry	2.0	20.4

Aeration (Turning over)

Aeration of the heaps is very important as the composting process is led by aerobic microorganisms. Frequent turnover of the heaps i.e., for every 7 to 10 days supplies enough aeration required by the microorganism. Turning over can be done either manually or by compost heap aerator machine (windrow turnover machine). The machine turnover achieves aeration, proper heap shape and supplies moisture also by the water tank attached to the machine.

Figure 3.2: Compost heap turning over machine

Moisture

The ideal moisture content of 50% should be maintained for better and fast decomposition. Irrigation of heaps on every alternative day is required to maintain the moisture content. Over irrigation of heaps leads to development of anaerobic condition and slow down the process. To monitor the moisture content take a hand full of composting biomass and squeeze it. No water should drip out, but still the biomass should be wet. If water drips out of the squeezed biomass it indicates excess moisture content and one should stop irrigating heaps until moisture content becomes normal.

Figure 3.3: Irrigation of aerobic composting heaps.

Temperature

Aerobic composting has mesophilic (25^{o}C to 45^{o}C) and thermophilic phases of temperature (45^{o}C to 70^{o}C). Although the composting process starts with mesophilic phase with in few days it enters the thermophilic phase as the temperature raise due to the microbial activity in mesophilic phase. The increased temperature of the windrows (heaps) indicates the robust microbial degradation of the polymers like starch, cellulose, hemicellulose etc. present in the biomass. The change in temperature of the heap is an indicator for the progression of composting process and one can monitor the process using thermometer. The temperature of the heaps can be regulated by aeration and turnings.

Table 35. Ideal characteristics of good material for quality compost.

Sl	Characteristic	Range
1	C/N ratio	<20
2	pH	6.5 – 7.5
3	Color	Dark brown to black
4	Odor	No foul odor
5	Total organic carbon % by weight	12
6	Total Nitrogen (as N) % by weight	8
7	Total Phosphate (as P_2O_5) % by weight	0.4
8	Total Potash (as K_2O) % by weight	0.4
9	Particle size	Minimum 90% of the material should pass through 4.0 mm sieve

Vesicular Arbuscular Mycorrhizae (VAM)

- VAM infects roots, increases effective root surface and soil volume explored for nutrient uptake through extensive mycelia along with solubilizing effect by chemicals released.
- VAM culture may be applied either as mixed with organic composts and spread at sowing/transplanting; coated onto the seed; seedlings dipped into the VAM spore solution; or sprayed onto soil around the plant and watered into the root zone.
- Depending upon the number of spores in VAM culture, the quantity of the culture should be adjusted in a way to apply 10 to 20 spores per individual germinating plant.

Vermicomposting

Vermicomposting is a simple process of composting with the help of earthworms to produce a better enriched end product. In vermicomposting process, earthworms consume biomass and break it into small pieces which expose raw waste biomass to intensive microbial decomposition. Moreover, after passing through the earthworm gut, resulting earthworm castings (worm manure) are also rich in microbial activity to hasten the composting process.

Basic Requirements

- **Earthworms:** *Eiseniafetida* and *Eudriluseugenae* species of earthworms are consistently used in vermicomposting for their high multiplication rate and efficacy to convert organic matter into vermicompost.
- **Organic Raw Biomass:** Various sources of wastes like crop residue, cattle waste, dairy sludge, brewery yeast, vine fruit industry sludge, textile mill sludge, sugarcane industry wastes like press mud, bagasse and trash, kitchen and agro wastes, paper waste and sludge are converted into valuable organic manures using earthworms. In general cow dung is the most preferred food for earthworms and so it is best to mix it with other raw biomass.
- **Environmental & Other**: Earthworms dislike sunlight; therefore cool and shade is the first and foremost requirement for vermicomposting. It have a moist environment for earthworms to live. The ideal moisture-content range for materials in conventional composting systems is 45-60%. Worms are oxygen breathers and cannot survive anaerobic conditions.

Composting material

- Various ingredients required and ideal ratios in general are as under,
    - Dry organic wastes (DOW) 100 kg
    - Dung slurry (DS) 30 kg
    - Rock phosphate (RP) 4 kg
    - Earthworms (EW) 1000–1500
    - Water (W) 10 L every three days

Procedure

- Fill the biomass in layers of 15-30 cm at weekly interval. In case of crop residues being the dominant biomass, sprinkle dung slurry after crop residue layer.
- Release about 1-2 kg earthworms after filling 1st biomass layer.

- Rock phosphate can be added in between the layers to increase P content of the compost.
- The height of the heap must to taken to max 0.7-0.8 m.
- Once vermicompost is mature, stop watering a week before harvesting.
- Harvest entire heap except bottom 15-30 cm biomass and keep the harvest near the heap.
- Immediately start filling the harvested heap.
- After 15-20 days, the harvested vermicompost can be taken for field application.

Precautions

- Different feeds can contain a wide variety of potentially toxic components. Prominent among them are de-worming medicine in manures, particularly horse manure.
- Some naturally occurring tannin in trees like as cedar and fir can harm worms and even drive them from the beds.
- Materials of animal origin such as eggshells, meat, bone, chicken droppings, etc are not preferred for preparing Vermicompost.
- The material should be free from plastics and glass pieces as they damage the worms' gut.
- After completion of the process, the Vermicompost should be removed from the bed at regular intervals and replaced by fresh waste materials, because earthworm casts are toxic to their population.
- The earthworms should be protected against birds, termites, ants and rats.

Phosphate solubilizing micro-organisms (PSM)

- PSMs can solubilize the complex insoluble form of phosphorus into simple soluble forms that can be taken up by plants.
- For PSM application, mix the culture uniformly with the seeds by using minimum amount of water, dry the inoculated seeds under shade and sow immediately.
- If the seed is to be treated with pesticides; first follow the pesticide treatments and finally treat seeds with PSM.
- For transplanted crops, mix the inoculants with desired stickers in bucket of water, stir the mixture vigorously and then dip the roots of seedlings in this mixture before transplanting.
- Use 5 to 10 g culture (~10^9 spores/cells per g) per kg of seed, 1 to 2 kg for soil application per acre of land, 1 kg for root application (root dipping) of one acre of crop.

Nitrogen fixing Bacteria

- *Azotobacter*/*Azospirillum*group of bacteria in association with non-leguminous while *Rhizobium* in leguminous crops fixes the atmospheric nitrogen and makes it available to plants.
- For inoculating N-fixing bacteria, mix the culture uniformly with the seeds by using minimum amount of water, dry the inoculated seeds under shade and sow immediately.
- For transplanted crops, mix the inoculants in bucket of water, stir the mixture vigorously and then dip the roots of seedlings in this mixture before transplanting.

- Use 15 to 20 g culture (~10^9 spores per g) per kg of seed, 1 to 2 kg for soil application per acre of land, 1 kg for root application (root dipping) of one acre of crop.

Fertilizers and Fertilizer Application

Types of Fertilizers and Manures

Among the plant nutrients required in large amounts for successful crop production are nitrogen (N), phosphorus (P), and potassium (K). These elements may need to be supplied regularly to maintain high crop productivity. Commercially available fertilizers are divided into single element fertilizers (urea or potassium chloride) and complex fertilizers with two or more nutrients (mono-ammonium phosphate or di-ammonium phosphate).

Analysis or Grade of Fertilizers

The amount of a nutrient element in a fertilizer is expressed as a percentage. Ammonium sulphate usually has 20% N. This means that every 100 kg of ammonium sulphate contains 20 kg of nitrogen. The three major nutrients are thus expressed as a percentage of each element in the order N–P–K. A complex fertilizer labeled 14–14–14 contains 14% N, 14% P and 14% K. The remaining 58% is carrier materials that usually have no effect on crop production.

Storing Fertilizers

Since the quality of fertilizer is affected by the way it is stored, care must be taken to select a storage area that is dry and well ventilated. Place wooden pallets on the floor and stack fertilizer bags on them. Do not place more than eight bags in a stack, otherwise the pressure on the bag at the bottom will lead to the fertilizer caking. Stack only unbroken bags and arrange the stacks closely to minimize air space between them.

Precautions

- Do not store fertilizer with insecticides or herbicides
- Do not store with fuels, oil, flammable liquids, acids, sulphur, or explosives
- Do not smoke in the storage area
- Store the fertilizer in moisture-proof containers or bags.

Fertilizer Calibration

Calculate the rate of nutrients to be applied per unit area. Identify the fertilizers that will supply the nutrients, either singly or in combinations. Then calculate the amount of fertilizer that will supply the required amount of nutrients ha^{-1}, m^{-2}, $plot^{-1}$, or for a row. Application rates for major nutrients are reported as kg ha^{-1}.

Procedure for Calculation

Calculate the quantity of a straight fertilizer to supply 120 kg of N ha^{-1} for a plot with 10 rows. Each row is 10 m-long and 0.5 m-wide. Therefore, the total area is 50 ^{m2}. The fertilizer to be used is ammonium sulphate.

Ammonium sulphate contains 20% N or 20 kg N in each 100 kg.

Therefore, 120 kg N will be available from:

$$\frac{\text{100 kg ammonium sulphate X 120 kg N}}{\text{20 kg N}} = \text{600 kg of ammonium sulphate.}$$

To supply 120 kg N ha^{-1} requires 600 kg of ammonium sulphate.

The required ammonium sulphate for each m^2 to provide 120 kg N ha^{-1} will be:

$$\frac{\text{600 kg ha}^{-1}\ \text{ammonium sulphate X 1000 g kg}^{-1}}{\text{10,000 m}^2\ \text{ha}^{-1}} = 60\ \text{g m}^{-2}\ \text{of}\ (NH_4)_2SO_4$$

The plot area in this example is 10 m X 5 m or 50 m^2.

The amount of ammonium sulphate for a plot of 50 m^2 will be:

$$60\ \text{g m}^{-2}\ \text{X}\ 50\ \text{m}^2 = 3000\ \text{g or}\ 3\ \text{kg plot}^{-1}.$$

Similarly, the other two plant nutrients can be obtained by using straight fertilizers such as single superphosphate (7% P) or triple superphosphate (20% P), and muriate of potash (50% K).

Calculation for Using Double Carriers

When two nutrients are to be applied simultaneously, we can use double carriers. For instance, if N and P are to be applied, we can use diammonium phosphate (DAP), that contains 18 kg N and 20 kg P per 100 kg and urea that contains 46% N.

In a plot the area is 50 m^2. The desired application is 100-17-0 ha^{-1} by using DAP and urea.

1.First, calculate the quantity of DAP to provide 17 kg of P. DAP contains 20% P and 18% N. Therefore, 17 kg P would be supplied in:

$$\frac{\text{17 kg P in 100 kg DAP}}{\text{20 kg P}} = \text{85 kg DAP}$$

2.Now, find the N available in 85 kg of DAP if 100 kg of DAP has 18% N

$$\frac{\text{18 kg N X 85 kg DAP}}{\text{100 kg DAP}} = \text{15.3 kg of N}$$

Urea contains 46% N. Therefore, 84.7 kg N will be available from

100 kg urea X 84.76 kg N or 184 kg of urea to supply 46 kg N

Therefore, 85 kg of DAP and 184 kg of urea will be required to provide 100 -17- 0.

The required DAP is 8.5 g m^{-2} and required urea is 18.4 g m^{-2}.

Fertilizer Application - Manual

Figure 3.4: Fertilizer application-basal dose.

Hand Application

Most soils will need some fertilizers applied for good crop establishment, good vegetative growth, and increased grain production. The elements that are frequently needed for good crop growth are nitrogen and phosphorus. The fertilizers supplying these nutrients may be applied as a basal application before or at sowing. Sometimes, a portion of the required amount is applied as a top dressing. Fertilizer needs to be applied carefully so that the material does not damage germinating seeds. At the same time, the required amount of various nutrients must be available near the seedlings for them to produce the desired yield.

Application at Sowing

- Open the furrows with tractor-mounted or hand-drawn furrow openers a little deeper than the sowing depth. Fertilizers should be placed slightly below the seeds and to the side to avoid fertilizer burn from direct contact with the emerging primary root.
- Distribute the calculated amount of fertilizer uniformly in a band, one replication at a time.
- Cover the fertilizer lightly with soil to prevent direct contact with the seed.
- Complete each fertilizer application, replication by replication. Do not hand apply fertilizer across replications.
- Sow the seed, close the furrows, and immediately compact the soil around the seed.
- Animal-drawn fertilizer drills or tractor-drawn applicators could be used for placing fertilizers before sowing.

Top Dressing

Most crops need a top dressing of fertilizer, especially nitrogenous fertilizer, to meet the demand of the crop at the critical stages of plant growth. Top dressing is usually done for sorghum and millet just prior to the boot stage.

Figure 3.5: Application of top dressing by tractor.

Procedure

- Open a furrow about 5–6 cm deep and about 5–6 cm away from the crop row, one replication at a time, with a sickle, hoe or tine. Do not damage the roots while doing so. Hand applications can be done by making holes beside and between the plants to reduce root damage. Drill 5-6 cm holes uniformly 5–6 cm away from each plant or in clusters of two to three plants. Care should be taken to distribute the fertilizer uniformly among the holes.
- Distribute the fertilizer uniformly to all the plants.
- Cover the fertilizer immediately after application.

In intercropping trials where more than two rows of crops have been sown closely, fertilizer may be top dressed by opening furrows near the cereal row in a cereal/legume combination. Fertilizer may be side dressed to the cereal crop in the same way as for a sole crop.

General Recommendations:

- Biomass generation from soil fertility point of view, and short duration pulse promotion in summer/*rabi* fallows – greengram, blackgram, horsegram.
- The quantities should be based on crop and soil test results as recommended by the respective SAU or NARS institute
- The sources of nutrients be in compliance with soil, crop, variety and availability in the local market
- The sources should be environmental friendly and culturally compatible
- Apply 25 per cent higher N, P and K over and above RDF if the nutrient status is low and 25 percent lesser if soil status is high
- Boron should be applied to soil @ 1kg per ha every year
- Sulphur should be applied to soil @ 30 kg per ha (200 kg gypsum) for cereals and 45 kg per ha for oilseeds in deficient soils
- Zinc should be applied to soils @ 5 kg Zn/ha/year (25 kg $ZnSO_4$) in case of paddy, 2.50 kg /ha/year for pulses and other cereals and 2 kg Zn/ha/year for oilseeds in deficient soils

- Preference should be given to use biofertilizers like Azospirillum, Azatobacter, PSB, Rhizobium
- Promoting the seed priming with 1 % zinc sulphateheptahydrate and 1 % KH_2PO_4 in acidic soils
- Promoting application of well decomposed poultry manure @ 2.5 t/ha in furrows as a substitute of lime in management of acid soil

Session 4: Principles and Methods of Training

At the end of this session participants will be able to:

- Define the importance of communication
- List the participants acquisition of knowledge
- Employ the factor of motivation
- Recognize the System approach to training
- List the areas of training
- The trainers roles and responsibilities

Introduction

A measure of the success of training is the relationship that develops between trainer and trainees. In a sound, productive training situation there is mutual respect and trust between them, with the trainer taking care to ensure that even the weakest trainee performs to the highest possible level, and the trainees feeling a desire within themselves to achieve. In this situation the trainer is the motivator and the trainees are the motivated.

It is intended that the modules that follow will be of assistance to those wishing to train and those already training.

The objective is to address the basic elements necessary for the effective preparation, implementation and evaluation of training, with the aim of that training being "to get the message across".

To achieve that objective, the modules that follow are intended to provide guidance to trainers in the skills of conveying their message successfully and transferring related information.
Training is essentially the instructing of others in information new to them and its application. It may, and often does, involve the teaching of new skills, methods and procedures.

Very few people are born trainers, and most of those who wish to be trainers require training. Even those few who are born trainers benefit from training, and their effectiveness is enhanced as a result.

The most important element in a training situation is the trainer. The trainer who is enthusiastic, energetic and genuinely interested in both the subject and getting his or her message across will evoke the greatest response from the trainees. The trainer who lacks interest in training, who has little or no enthusiasm for the subject of the training and who merely goes through the motions of training is a failure. Such a trainer wastes not only his or her own time but also that of the trainees. The inept trainer is quickly identified by the trainees, who react with inattention, lassitude, undisciplined behaviour and absence from training sessions.

Successful training - that which produces the desired result - lies almost entirely in the hands of the trainer. In the trainer's hands lies the heavy responsibility for ensuring that the trainees achieve the maximum possible from the training.

Why training is important?

Being educated and skilled is a privilege in our country as many do not get the chance. Utilizing the knowledge and skill optimally to achieve professional assignments efficiently is the main reason we need training. Sometimes, updating our skill and knowledge with latest developments in the field of expertise is required to harness their potential. Regular training has no substitute to acquire new skill sets and to gain expertise in them. For example, driving a car, swimming or yoga sessions are examples of skill-training whereas on farm or in-industry apprenticeships are skill and knowledge training. The three basic importance of training are:

- Knowledge transfer
- Skill development
- Capacity building

Principles of effective communication - "Getting the message across"

Objective

To familiarize the participants with the elementary principles of successful oral communication of information and to heighten awareness of the factors that interfere with communication and reduce its effectiveness

Suggested method of instruction:

- Lecture/discussion with maximum trainee participation through questioning and relating of personal experience

Aids

- Handouts
- Power point presentations
- Videos using projectors, peico projectors, using tablets in rural areas

Time frame

- One hour lecture/discussion

Content

- Effective communication
- Interference
- Ways of avoiding interference

Presentation suggestions

The foregoing module is easily adapted to discussion. The trainer should attempt to elicit from the trainees their experiences with transmission, interference and ways of avoiding interference, which are well within the purview of trainee experience.

Trainees should be asked to tell the course participants about good communicators and poor communicators they have known, describing why they are memorable. The reasons they give should be related to the types of interference and ways in which interference was or could have been avoided.

Such a discussion invariably brings out other indirectly related aspects of spoken communication which provide points of reference when subjects in later modules are being dealt with.

Learning outcome

Participants should be aware of effective communication principles.

Effective communication

Communication specialists compare the way people communicate to the way a radio transmission takes place. That is to say:

Transmitter (Speaker/writer) >> Message >>> Receiver (Listener/reader)

Three types of transmission are identified:

- Spoken
- Written
- Gesture/sometimes referred to as "body language"

Transmission is in code:

- Spoken language
- Written language
- Gestures

In spoken language the unit of code is the word, heavily supported by gestures. Some communication specialists believe that at least 40 % of the full meaning of messages transmitted by speech is conveyed by body language (gestures). In written language the units of code are words and symbols (e.g. figures, punctuation). In the remainder of this module and the modules that follow reference to communication is to spoken communication only and assumes the transmitter can be seen by the receiver.

Successful communication depends on the message being received by the receiver intact and interpreted by the receiver to have the same meaning as when transmitted

Interference

Frequently the message suffers from interference. That is, something interferes with the message between its transmission and reception and distorts it. The following are some types of interference.

Weak transmission

- Speaking too softly
- Speaking in a flat voice (monotone) without inflection
- Not speaking in a direct line with the receiver
- Insufficient volume of transmission to prevail over competing transmissions and
- localized noise (static)

Garbled transmission

The transmitter (speaker) often scrambles the contents of the message so that the facts it contains are not in logical order and often appear unrelated.

Wrong language

The transmitter may use words, terms and expressions unknown to the receiver.

Pitching message at the wrong level

The speaker may transmit information in a context beyond the experience of the receiver (this may involve the use of wrong language). This is sometimes called "transmitting or talking over the receiver's head". Examples are teaching watershed management or IWMP to people who have no experience in watershed management principles thereby transmitting detailed and profound scientific messages to a receiver without a scientific background.

Receiver not receiving

- Receiver turned off (gone to sleep!)
- Tuned into another transmitter
- Transmission too weak
- Strength of receiver diminished (lack of interest - boredom)
- Receiver distracted by a competing focus of interest (an attractive person walks by)
- Receiver fatigued

Competing transmissions

The receiver may be unable to select between transmissions (too many people talking at once).

Overloading the message

The receiver does not possess the capacity to retain all of the information contained in the message. This frequently leads to receiver confusion/fatigue and anxiety.

Ways of avoiding interference

- Speak up and out
- Speak slowly and deliberately
- Use language that the receiver understands
- Do not talk over the receiver's head
- Ensure you have the attention of the receiver
- Only transmit your message in suitable surroundings where there is no, or little, competition
- Make the message succinct (as few words as possible) and transmit it in the simplest terms
- Plan the message in logical order

As a trainer it is essential that you get your message across-otherwise your effort to train will be wasted

Summary

To be a successful communicator

- Use your voice effectively
- Know your subject
- Know what you want to say
- Prepare your message carefully
- Arrange your points logically
- Display interest and enthusiasm
- Sound convincing and sincere

Effective oral communication

Objective

To assist the trainee-trainers to identify and become acquainted with the essential elements of getting the message across and becoming an effective oral communicator

Content

- The importance of being an effective oral communicator
- Essential elements in transmitting a message
- Communication hazards

Exercise

Each trainee is required to give a three- to four-minute impromptu talk. The following are examples of possible subjects:

- My reasons for attending the course
- The aspect of my work I enjoy the most
- Why I think Watershed technology is important

In giving this talk the trainee will be expected to take into account the essential elements in transmitting a message.

A handout sheet may be helpful to assist the trainees with their short presentations. The following is an example:

- Describe your work.
- Why is it important to you?
- Which aspect of your work do you enjoy the most?
- Which aspect do you dislike the most?
- What do you think you are best at?
- What aspect of your work would you like to know more about?
- If you had a choice, which aspect of "Quality control" would you like to specialize in and why?

Learning objectives:

- Improved and updated know-how
- Methods of knowledge dissemination to various stake holders
- Updating of knowledge and skill sets
- Recognition from the department
- Improved communication skills

Learning outcomes:

- Knowing the Odisha Bhoochetana project objectives, strategy and activities better
- Enhancing productivity and input use efficiency among the local farming communities
- Improved staff competence for the department

The importance of being an oral communicator

As a trainer much of your effectiveness is measured by your ability to speak with clarity and conviction in getting your messages across.

Men and women in training positions are expected to be highly competent at presenting ideas, giving directions and explaining procedures. In fact, this quality of being an effective communicator is generally considered to be an essential element of the effective trainer's skills.

The information you communicate as a trainer is often critical to the people you train and to the workings of the organization as a whole. The way you explain procedures or give directions can make the difference between an employee being productive or frustrated. Sometimes clear information from you can make the difference between people doing a job safely or unsafely, working efficiently or inefficiently or doing things correctly or incorrectly.

How you present even an obviously brilliant idea can make the difference between whether or not anyone listens to you. The way in which you interpret and transmit information about agency policies, goals, values and procedures has significant influence on the way your staff or subordinates develop their perceptions and their commitments to the organization.

Communicating clearly - "getting your message across" - is not an inherited ability; people are not born with it. It is a learned skill developed through planning and practice.

Essential elements in transmitting a message

Strengthen your main point with supporting points

Your explanations, instructions or ideas are more compelling when supported by clear facts and observations. Your objective is to gain respect and belief from your listeners and for them to gain insight into the details of the message you are communicating. The following guidelines will make the transmission of your message effective.

- Use simple language. Avoid technical jargon unless you are sure that everyone understands it.
- Keep your explanation short so you do not risk boring people. Do not swamp them with unnecessary detail (which is called "overloading").
- Choose reasoning that is natural and familiar to your listeners and your topic.
- Make your explanations as colorful as possible, using examples to illustrate your point.
- List all your supporting points first; then return to each point and fill in the details.
- Use visual aids, where possible, to illustrate your points.

www.youtube.com/watch?v=4EiM_-oSWzI-

Why train? The trainer's role and responsibility

Objective

To introduce the participants to the basic principles of training in the simplest possible way and to establish fully the responsibility of the trainer

Content

- The process of learning
- Factors that hinder learning
- Obtaining and holding the learners' attention
- Facilitating understanding
- Steps in skill training

Approach

Discussion should play a major part in the presentation. Because of their life-experiences the trainees will be familiar with learning, even though they may never have analyzed the process.

Therefore the major task of the trainer is to plan a sequence of questions that will lead the trainees to an identification of the elements and steps in the learning process and the factors that hamper learning. Trainees should be encouraged to recall the good trainers and teachers they have known and to identify the skills that made their training and teaching memorable.

The material in the lecture and power point presentation is in point form and requires explanation by the trainer.

Learning outcome

The participants should be aware of and understand the trainer's role and responsibilities.

Why train?
To improve the trainee's knowledge and skill

What is the responsibility of the trainer?
To get the message across - that is, to ensure that the trainees have received and understood the message

Training is not easy
Training is hard work
Some trainers merely go through the motions of training
Some trainers are unsuccessful

The process of learning

The successful trainer possesses insight into the process of learning. The learning process conforms to the following pattern: external sensations stimulate the sense organs - ears, eyes, body (touch), nose and tongue - and the nervous system conveys impressions to the relevant sections of the brain. The brain then transmits impulses to the muscles and organs of movement and speech, and the end result is a reaction.

Observing the learners

The only way the trainer can know if people have learned the material is by observing their behavior:

- Their actions
- Their written impressions
- Their speech

Factors that hinder learning

- The learning plateau: at intervals the rate of learning flattens out as the brain rests
- Saturation: if the message is overloaded the receiver rejects the excess and learning stops
- Fatigue: a tired receiver is not as receptive as an alert one

- Inability to concentrate: the longer the message, the more concentration decreases from beginning to end

Obtaining and holding the learners attention

Before people can learn any material they must focus their voluntary attention on it. The desire to learn comes from within; it is spontaneous.

The good trainer tries to gain and maintain voluntary attention in every session he or she presents.

- Relate what you aim to teach to those subjects in which you know the trainees are interested.
- Introduce the session in such a way that the trainees will not only see and become interested in this relationship, but will want to learn more about it.
- Begin with a good story to which the trainees can relate. An effective trainer makes it his or her business to know the background of the trainees.
- Having done these things, maintain the trainees' attention by doing all that is possible to facilitate their understanding and absorption of the material.
- Ensure that the trainee's learning is an active process in which the trainer and trainees are equal partners in terms of participation.

Facilitating understanding

To facilitate understanding, the trainer proceeds from:

- Known to unknown
- Simple to complex
- Whole to part and back to whole
- Concrete to abstract
- Particular to general
- Observations to reasoning
- Point to point in logical order

To facilitate absorption, remember that trainees learn only by impressions received through their senses.

Steps in skill training

Having learned a skill, trainees must reinforce its acquisition by using it. Learning by doing is the basic principle underlying the acquisition of any skill.

- When teaching skills, the trainer most often achieves the best results by keeping the talk short and by working through a set sequence of discrete steps, as follows:
- Show the trainees the actual skill they are to acquire.
- Demonstrate and explain, step by step, the operations involved (this requires an analysis of the total procedure by the trainer).

- Have trainees imitate the necessary actions.
- Have trainees practice performing the operations.
- Devote at least 50 % of the session to trainee practice time.

Summary

The first rules of training are:

- Make the best use of the most effective channels to the brain - the senses: sight, hearing, touch, taste and smell.
- Use a combination of the senses. For knowledge, use the trainees' eyes and ears. For manual skills, use the trainees' hands, eyes and ears.
- Make presentations as vivid as possible.

These are the basic principles of instruction - the means by which the instructor reaches and makes an impression on the brains of the trainees.

Learning Systems and Methods of Training

Introduction:

Learning systems and methods of training are important factors in designing a training program

At the end of this session participants will be able to:

- Distinguish between Pedagogy and Andragogy
- Appraise the principles of Adult learning
- Design a program using Andragogy followed by a group exercise

Principles

Adults must want to learn .They learn effectively only when they are free to direct their own learning and have a strong inner motivation to develop a new skill or acquire a particular type of knowledge.

Adults will learn only what they feel they need to learn. Adults are practical in their approach to learning; they want to know, “How is this going to help me right now? - Is it relevant (Content, Connection and Application).”

Adults learn by doing. Children also learn by doing, but active participation is more important among adults.

Adult learning focuses on problems and the problems must be realistic. Children learn skills sequentially. Adults start with a problem and then work to find a solution.

Experience affects adult learning .Adults have more experience than children. This can be an asset and a liability.

Adults learn best in an informal situation .Children have to follow a curriculum. Often, adults learn by taking responsibility by the value and need of content they require to understand and the particular goals it will achieve, being in an inviting environment and having roles as an active participant in the learning process makes it efficient.

Adults want guidance .Adults want information that will help them improve their situation or that of their children. They do not want to be told what to do. They want to choose options based on their individual needs.

Adult learning styles

A learning style refers to how a person learns, categorizes, and processes new content. Each person may have multiple preferred learning styles. The three primary learning styles are: visual, auditory, and kinesthetic.

Visual learners tend to learn by looking, seeing, viewing, and watching. Visual learners need to see an instructor's facial expressions and body language to fully understand the content of a lesson. They tend to sit at the front of the classroom to avoid visual distractions. They tend to think in pictures and learn best from visual displays. During a lecture or discussion, they tend to take detailed notes to absorb information.

Auditory learners tend to learn by listening, hearing, and speaking. Auditory learners learn best through lectures, discussions, and brainstorming. They interpret the underlying meaning of speech by listening to voice tone, pitch, and speed and other speech nuances. Written information has little meaning to them until they hear it. They benefit best by reading text out loud and using a tape recorder.

Kinesthetic learners tend to learn by experiencing, moving, and doing. Kinesthetic learners learn best through hands – on approach and actively exploring the physical world around them. They have difficulty sitting still for long periods of time, and easily become distracted by their need for activity and exploration.

History of Andragogy

Originally the term Andragogy was used by Alexander Kapp (a German educator) in 1833, Andragogy was developed into a theory of adult education by Eugen Rosenstock-Huessy and was popularized in the US by American educator Malcolm Knowles. Knowles asserted that Andragogy (Greek: "man-leading") should be distinguished from the more commonly used *P*edagogy Greek: "child-leading".

In 1967, Knowles made use of the term "androgogy" to explain his theory of adult education. Then, after consulting Merriam-Webster, he corrected the spelling of the term to "andragogy" and continued to make use of the term to explain his collection of ideas about adult learning. Knowles' theory can be stated with six assumptions related to motivation of adult learning:

Need to know:

1. Adults need to know the reason for learning something.

2. Foundation: Experience (including error) provides the basis for learning activities.

3. Self-concept: Adults need to be responsible for their decisions on education; involvement in the planning and evaluation of their instruction.

4. Readiness: Adults are most interested in learning subjects having immediate relevance to their work and/or personal lives.

5. Orientation: Adult learning is problem-centered rather than content-oriented.

6. Motivation: Adults respond better to internal versus external motivators.

On this formal level 'above practice' and specific approaches, the term andragogy could be used relating to all types of theories, for **reflection, analysis, training**, in person-oriented programs as well as human resource development.

Recent research has expanded andragogy into the online world, finding that using collaborative tools like a wiki can encourage learners to become more self-directed, thereby enriching the classroom environment. It gives scope to self-directed learners. Andragogy helps in designing and delivering the solution focused instructions to self-directed. The methods used by Andragogy can be used in different educational environments (e.g. adolescent education).

Differences from pedagogy

Here are some of the main differences between pedagogy and andragogy:

	PEDAGOGY	**ANDRAGOGY**
LEARNER:	• The learner is dependent on the instructor, the teacher schedules all the activities; determining how, when and where they should take place • Teacher is the one who is responsible for what is taught and how it is taught • Teacher evaluates the learning	• Learner is self-directed and moves towards independence • Learner is responsible for the learning • Self-evaluation is seen
LEARNER'S EXPERIENCE	• There is little experience which could be gained from this kind of learning • Method is didactic	• There is large quantity of experience gained • Method used is problem solving, discussion, service-learning[17]
READINESS TO LEARN	• Standardized curriculum set which will be based on societal needs	• Curriculum is more application based and it revolves around life
ORIENTATION TO LEARNING	• Here, it is a process of acquiring subject matter	• Here learning is for performing tasks and solving problems
MOTIVATION	• Motivation is by external pressure, and there is lot of competition for grades	• It is driven by internal motivation. Includes self-actualization, self-confidence etc.

What are the Principles of Training

Introduction:

It is important to set the objectives at the very beginning of Designing a Training program

At the end of this session participants will be able to:

- Setting the objectives of a training program
- Using cognitive verbs

Learning objectives:

- Improved and updated know-how
- Methods of knowledge dissemination to various stake holders
- Updating of knowledge and skill sets
- Recognition from the department
- Improved communication skills

Learning outcomes:

- Knowing the Odisha Bhoochetana project objectives, strategy and activities better
- Enhancing productivity and input use efficiency among the local farming communities
- Improved staff competence for the department

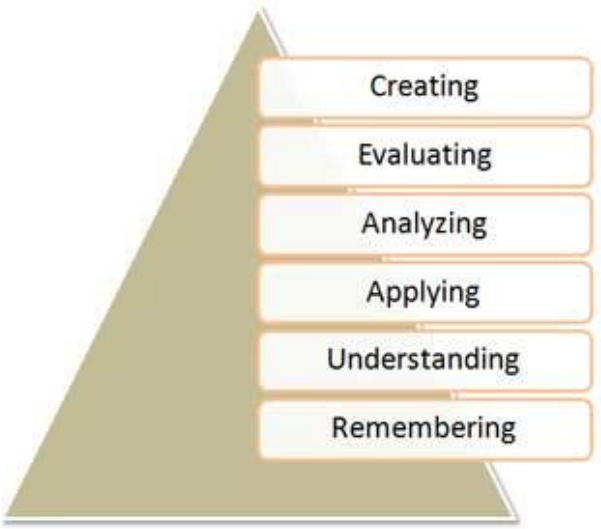


Figure 4.1: Bloom's Taxonomy of Learning Domains.

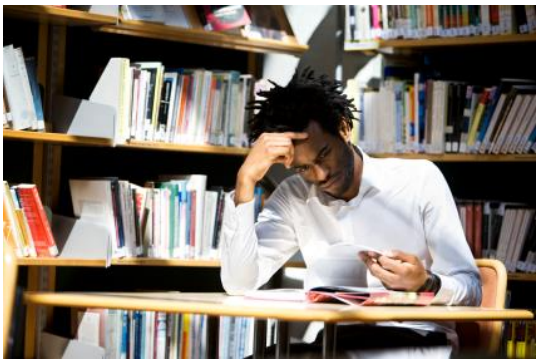
Bloom's Taxonomy was created in 1956 under the leadership of educational psychologist Dr Benjamin Bloom in order to promote higher forms of thinking in education, such as analyzing and evaluating concepts, processes, procedures, and principles, rather than just remembering facts (rote learning). It is most often used when designing educational, training, and learning processes.

The Three Domains of Learning

The committee identified three *domains* of educational activities or learning (Bloom, *et al.* 1956):

- **Cognitive**: mental skills (*knowledge*)
- **Affective**: growth in feelings or emotional areas (*attitude or self*)
- **Psychomotor**: manual or physical skills (*skills*)

Cognitive Domain



The cognitive domain involves knowledge and the development of intellectual skills (Bloom, 1956). This includes the recall or recognition of specific facts, procedural patterns, and concepts that serve in the development of intellectual abilities and skills. There are six major categories of cognitive processes, starting from the simplest to the most complex

- Knowledge
- Comprehension
- Application
- Analysis
- Synthesis
- Evaluation

Remembering

- Exhibit memory of learned materials by recalling facts, terms, basic concepts, and answers.
- Knowledge of specifics – terminology, specific facts
- Knowledge of ways and means of dealing with specifics – conventions, trends and sequences, classifications and categories, criteria, methodology
- Knowledge of the universals and abstractions in a field – principles and generalizations, theories and structures
- Questions like: What are the health benefits of eating apples?

Understanding

Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating the main ideas

Translation

Interpretation

Extrapolation Questions like: Compare the health benefits of eating apples vs. oranges.

Applying

Using acquired knowledge. Solve problems in new situations by applying acquired knowledge, facts, techniques and rules.

Questions like: Would apples prevent scurvy, a disease caused by a deficiency in vitamin C?

Learners should be able to use information to solve problems, identify connections and relationships and how they apply. It is important for students to be able to use prior knowledge in new situations. For example, a student should be able to apply a method used in their own lives.

Analyzing

Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations

- Analysis of elements
- Analysis of relationships
- Analysis of organizational principles

Questions like: List four ways of to conserve moisture and explain which ones have the highest benefits. Provide references to support your statements.

Analysis is being able to break down information into component parts, and determine how the parts relate to one another. An example of analysis is having students summarize something and then analyzing why certain things happened.

Synthesizing

Builds a structure or pattern from diverse elements; it also refers the act of putting parts together to form a whole (Omari, 2006). Compile information together in a different way by combining elements in a new pattern or proposing alternative solutions

- Production of a unique communication
- Production of a plan, or proposed set of operations
- Derivation of a set of abstract relations

Questions like: Convert a wrong way to conserve rain water to replace a correct way replacing the choice of options. Explain the benefits of using the right way chosen vs. the original ones.

Evaluating

Present and defend opinions by making judgments about information, validity of ideas or quality of work based on a set of criteria

- Judgments in terms of internal evidence
- Judgments in terms of external criteria

Questions like: Which kinds of potatoes are best for frying and why?

The highest level is evaluating which requires critical thinking.

Examples, key words (verbs), and technologies for learning (activities) Categories	
Remembering: Recall or retrieve previous learned information.	**Examples**: Recite a policy. Quote prices from memory to a customer. Recite the safety rules. **Key Words**: defines, describes, identifies, knows, labels, lists, matches, names, outlines, recalls, recognizes, reproduces, selects, states **Technologies**: book marking, flash cards, rote learning based on repetition, reading
Understanding: Comprehending the meaning, translation, interpolation, and interpretation of instructions and problems. State a problem in one's own words.	**Examples**: Rewrite the principles of test writing. Explain in one's own words the steps for performing a complex task. Translate an equation into a computer spreadsheet. **Key Words**: comprehends, converts, defends, distinguishes, estimates, explains, extends, generalizes, gives an example, infers, interprets, paraphrases, predicts, rewrites, summarizes, translates **Technologies**: create an analogy, participating in cooperative, taking notes, storytelling, Internet search
Applying: Use a concept in a new situation or unprompted use of an abstraction. Applies what was learned in the classroom into novel situations in the work place.	**Examples**: Use a manual to calculate an employee's vacation time. Apply laws of statistics to evaluate the reliability of a written test. **Key Words**: applies, changes, computes, constructs, demonstrates, discovers, manipulates, modifies, operates, predicts, prepares, produces, relates, shows, solves, uses **Technologies**: collaborative learning, create a process, blog, practice
Analyzing: Separates material or concepts into component parts so that its organizational structure may be understood. Distinguishes between facts and inferences.	**Examples**: Troubleshoot a piece of equipment by using logical deduction. Recognize logical fallacies in reasoning. Gathers information from a department and selects the required tasks for training. **Key Words**: analyzes, breaks down, compares, contrasts, diagrams, deconstructs, differentiates, discriminates, distinguishes, identifies, illustrates, infers, outlines, relates, selects, separates **Technologies**: Fishbowls, debating, questioning what happened, run a test
Evaluating: Make judgments about the value of ideas or materials.	**Examples**: Select the most effective solution. Hire the most qualified candidate. Explain and justify a new budget. **Key Words**: appraises, compares, concludes, contrasts, criticizes, critiques, defends, describes, discriminates, evaluates, explains, interprets, justifies, relates, summarizes, supports **Technologies**: survey, blogging
Creating: Builds a structure or pattern from diverse elements. Put parts together to form a whole, with emphasis on creating a new meaning or structure.	**Examples**: Write a company operations or process manual. Design a machine to perform a specific task. Integrates training from several sources to solve a problem. Revises and process to improve the outcome. **Key Words**: categorizes, combines, compiles, composes, creates, devises, designs, explains, generates, modifies, organizes, plans, rearranges, reconstructs, relates, reorganizes, revises, rewrites, summarizes, tells, writes **Technologies**: Create a new model, write an essay, network with others

Session 5: The components of a Training program

At the end of the session you will be to

- Characterize your audience
- Decide on a curriculum
- Need for training
- Writing content
- Decide on the tools to be used
- Judging the performance of the participants
- Decide on a system of course feedback
- Delivering a training program
- Quality of a Good Trainer

Audience characterization- know your audience

Before you start planning for a training program you must know who are your trainees or participants. Try to find out the background, their livelihood (specially for farmers) what they do, their problems, their experience and their expectations, educational background. Most of our programs we never do this and we only try to find out all these on the day the program starts. Obviously this needs an advance planning much ahead of the actual event so that the Training can be designed accordingly, subject matter can be decided and delivery mechanisms can be planned.

< Q – Ask the participants their experience. What are their problems when you do not know who the participants are and what their background is >

This can be done in two ways.

1. Meeting the participants with a set of questions
2. Or meeting in a group to gather information

Decide on a curriculum

The most important exercise is what should be the area of training, what topics, what participants will learn (learning outcome) how much can be taught. The biggest question is where to start.

< Ask participants where they would start >.

Most of our program even at National level has a top down approach. We take it for granted what we are going to teach is what they require. Often there is a mismatch resulting in a very poor executed program. Building capacity is not an easy job. If it has no impact, whatsoever, the whole exercise becomes futile. The question then arise how do we find out what they need or the "Training Need ". Again this needs advance planning, a structured exercise with stakeholders through well designed survey instrument (TNS) and analyze the information. More on it later.

Once we know our audience thoroughly and we have analyzed the NEED the next step is to decide on the Curriculum. This should be planned well and clearly, state the topics /area to be covered, list major objectives and learning outcomes. It should also a have session plan with timeline, tools required (more later), select competent resource persons and many more. In fact this is the blue print or Master Plan of a training program. A well-developed curriculum will help to decide further impacts and should be the broad overall plan to guide the program further on. An example is appended.

<**How many of you have done this exercise, show an example of the present program >**

Training need survey (TNS)

We have already talked about this. This should be planned much ahead of actual training program

1. Map the stakeholders first before you take this exercise. Who are your target group, their experience, age group, their livelihood etc.

   <showSujala mapping exercise in the PPT >

2. Design a survey instrument which should capture essential information
3. Fill it up by actually meeting the stakeholders, specially if the target group is farmers in their own environment.
4. Analyze the data
5. Design the program starting with the curriculum
6. Often this is called The Training Need Survey and the analysis as the Training Need Assessment

< Show the instrument for Sujala project, append in the Manual>

Designing a Training program

Once the curriculum is ready decide on a session plan with realistic timeline for each session. The plan should have brief outline of each session. Once this is finalized the timeline (time allotted to each session) should be adhered to strictly. The common danger is when a resource person does not adhere to the time allotted to him, as a result the whole program is disturbed. Training Coordinator's role is important in smoothly running the program.

Documentation

A trainig program must document all the activities as well as documenting the training materials for record as well as for posterity. The " Manual " is the most important document with the following information

- Background of the program, why it is planned. What is the necessity, what it will do for whom it is planned.
- What are the Objectives of the program**.< how to write an objective- Blooms taxonomy>**
- Detailed session plan as discussed earlier
- Appropriate content which is the supporting information on the new knowledge

- Description of each session with learning outcomes, references if any, list of tools that will be used
- In the age of Digital Agriculture the Manual can be in digital format provided participants have access to computers or Tabs.. Otherwise a print version will be an ideal format.

Writing the "Content "

What is the content in a manual. This is the most important part of a manual as this should be the "New "knowledge which is being transferred to the stakeholders for building their capacity. Therefore lots of attention must be given to writing the Content. It is an Art in itself.

The trainer needs to look at the curriculum which is the blue print of any training program as emphasized earlier. Look at the learning outcome of the session and write the content describing, principles, concepts and the new knowledge supporting the learning outcomes. The content may include statements, scientific information supported by data, graphs, charts, pictures to drive home the important assumptions.

<an example – a session plan and the contents from the main manual >

For any capacity building program the content is the new scientific knowledge based on solid proven research data and not just stories. Therefore this needs competent resource persons with sound knowledge of the scientific knowledge that is being transferred.

What are the tools

Once you have written the content for all the sessions you need to decide how you are going to present this to the audience. In other words what are the tools that can be used for presenting a session. Normally in a Lecture Mode of presentation the most commonly used tool is the Power Point Presentation in a digital format. Therefore it has graphical presentation with pictures, written statement, and can include graphs and charts. Some of the other tools are

- PPTs, computer graphics, videos, movies
- Posters, paper cutouts, any other form visuals(remember visuals are the most effective tools for retaining information)
- Samples, exhibits
- Games, role plays
- Visually important tools in participatory process (VIPP)
- Skits, dramas
- Exposure visits

Do remember that your tools must support the learning outcomes and they are designed to help a trainer to present his session. These have to align with the content. Therefore tools have to be innovative and not just copy of the content. In case of a program involving stakeholders at farm level one has to plan for tools in a village surrounding, especially when the participants are all women, may be form a self-help group. Framer generated video production is an innovative tool for dissemination of knowledge by the NGO Digital Green with great success. Therefore the tool will have to be prepared for the participants depending on their background etc.

Performance of the participants

How do we judge whether the participants have acquired and retained the new knowledge or understood the presentations. Most of our training program we never try to evaluate the performance, hence training becomes a ritual and number game to attain the target rather than real transfer of knowledge.

The easiest way to evaluate is to use a set of questions at the beginning and one at the end and analyze the results to see the progression. Most of the times it is positive with usual variation but at times there can be negative progression as we have seen a couple of times. This happens when some participants do not participate wholeheartedly.

<example from the last course with NGO partners >

Course feedback

It is equally important to know a honest feedback from the participants about the program through an appropriate questionnaire This should be a honest feedback and not just good words.

< Discuss the feedback for this program >

The feedback should be analyzed, shared with the participants or their organization so that any shortcomings can be addressed in any future program. What people liked and not liked, which topics were discussed well, which resource person was good or mediocre and needs improvement are important criteria for any course feedback. This will help to design and conduct a program better in future.

Back on the job application

What is this? This is a short session on how this program can be utilized by a participant when he goes back to his normal duties. This is an area seldom given thought and discussed with the participants <**More when the PPT is presented, >**. This should include a structured action plan and how the training can be used in his normal DUTIES, WHAT CAN BE DONE AND WHAT CANNOT BE DONE.

Delivery of program or conducting a program

Delivery of program is like a stage performance or a drama by a group of Artists. After a long planning and rehearsals the drama is performed on a stage in front of an eager audience. After all the planning exercise is over, manuals are prepared, tools are designed, questionnaires are ready comes the physical delivery of the program. Some of the essential components are

- Venue of the program with facilities available such as class room, fields for any experiential session
- Seating arrangement- should be a “U” shaped for better interaction with the participants. Never arrange a Theater style seating arrangements for obvious reasons.
- Projection facilities, computers, audio equipment if the hall is large
- Place for any poster presentations
- Refreshment arrangements
- Participants stay arrangements if the program is Off Campus
- Standby power connections

- Reprographic facilities
- Area for any Hands on Training
- White board , flip charts and markers

It is important for resource persons to be familiar with the venue and facilities available and rehears his presentation specially to keep to the time allotted to him. (How to be a good trainer – later)

The program will require Coordinators to coordinate the activities for a smooth running of a program. A small secretariat will be a good idea for support services during the full duration of the program. Plan for any experiential learning and exposure visit also.

How to maintain quality of a program

This is an area quite neglected. Poor quality of training material including tools, bad program delivery, and poor quality of trainers with poor communication abilities will contribute towards a very poor program indeed and the resources will be wasted. Therefore each component of a program design and delivery has to be of high standards which is easier said than done. The quality can be easily judged once the course feedback is analyzed from the participants.

Who is a good "Trainer "

Qualities of A Great Trainer

Most of us conduct Training Programs for the Developmental projects on a regular basis for our stakeholders at various level- from District level departmental staff to the grassroots level – farmers, user associations ,community organizations and so on. The enormity of the challenge of a good training program hinges on the quality of the training material, how well the program is designed and delivery mechanism so that the expected outcomes are achieved. Central to all these is the "Trainer "who actually delivers the program. One cannot be a superlative trainer overnight. It needs effort; understand the nuances of training and commitment. How you can be a Good Trainer". After all the success or failure of a program depends on how well the program was delivered.

Current scenario

Most of the programs that we deliver are treated like a seminar. The trainer takes a superior posture like a school teacher and treats the participants like a bunch of school children. But in all development projects the participants of training programs are adults- whether they are farmers or departmental staff. They come with some expectation, their varied experience, and their problems. Their age, qualification, experience varies widely because of their livelihood patterns, their economic status etc. Before conducting a program for a group of adult one must ask the following question. Therefore they must be treated as adults and use the Adult learning techniques which is called Andragogy.

- Who are the participants – their age, experience, livelihood
- Their educational profile
- What are the expected problems they may have
- What could be their expectation
- Is the program tailor-made to address their problem and meet their expectation
- Is the design of the program will meet the expected outcome and will have an impact

As a trainer one must know the answers as far as possible beforehand so that one can design the program suitably

What are some of the top qualities every trainer should have?

A great trainer has all of the following things:

1 ***A command of the material.*** A good trainer knows the material, lives it, breathes it, and can infuse their own experience into it. They may not know every facet, **but they know where to get answers if they don't.**
2. ***Preparation and practice.*** A good trainer makes delivering a class look easy and seamless. You don't want the learners to see "behind the curtain." Many instructor will look at his notes frequently or look at the slide and talk. He will be lagging on timing, and ran out of song before the routine was over.
3. ***Rhythm and energy***. There are ebbs and flows in energy in a class. A great trainer is attuned to his or her own energy level and that of the class. A good trainer knows when the more dry or factual content is coming up and adjusts delivery accordingly. A good trainer takes note of when learners are tuning out, antsy, restless or distracted
4. ***Readiness to allow and encourage participants*** *to learn from themselves and the class in order to create as many organic learning moments as possible*. In many professional learning classes, there is a wealth of knowledge in the classroom and cross-pollination can be an effective way to illustrate the material and provide new perspectives.
6. ***An excellent organization supporting them.*** There were people who will do their jobs well despite obstacles, but it won't be unusual to find yourself in a pilot with a trainer who read the slides and notes word for word.

How do you make your lessons interesting?
Try to "tell a story" through the materials, make the course relevant, interesting and fun. Additionally, to ensure that the delivery serves the materials well, create what you have found to be the most extensive facilitator guide.

Characteristics of a trainer

It is common experience that trainers, when they get together, often wonder what the characteristics of a trainer are. This is often a poser by those who aspire to be a trainer. Often, persons having the necessary attributes are not sure about the qualities that make a good trainer. It is in this context that it is necessary to identify some of the significant qualities that go to enhance the performance of a trainer. Some of these qualities are: -

Empathy: This is the ability to put oneself in the shoes of another. It is the faculty for recognizing the fears and uncertainties in the minds of trainees when learning additional techniques or skills. Empathy enables a trainer to point out personal difficulties encountered by him in similar learning situations, so as to put the learners at ease.

Honesty: This is the courage to recognize personal strengths and weaknesses and to be frank about these aspects to the personnel being trained, for their own benefit.

Patience: This is shown in the willingness to compliment slow progress and refrain from the anger when mistakes are made. It includes the techniques of repeating instructions, breaking down a task into small units and allowing time for learners to try out.

Pace: This is closely integrated with empathy and patience. This is an external speed governor, which acts more to slow down than to speed up. It is far better to move slowly and attain complete mastery, than to push for rapid and sloppy completion.

Democracy: This refers to the kind of atmosphere created when learning takes place. The trainer should be supportive and non-threatening in presentation. The tone of voice and facial expression should lead the learners to feel comfortable in raising questions, offering suggestions, reinterpreting instructions and generally to feel relaxed while they learn.

Purpose: This emphasizes the element of tenacity in achieving the training goals. A good trainer conscientiously moves a group of learners along to a pre-set destination. There may be stops and shifts, but the eye is always fixed on certain performance standards and levels.

EXCELLENT COMMUNICATION SKILLS

It may sound obvious, but trainers should have great communication skills. The best trainers can break down complex ideas and explain them clearly to trainees. They also need to be able to listen actively, but also be sensitive enough to pick up on non-verbal communication.

The training environment must also maintain open lines of communication, so trainees are comfortable enough to ask questions. Any extra training material must also be easy to follow and actually helpful to the trainee.

Nobody looks forward to 'yet another training session'. To get around this, trainers should use different methods to get trainees excited about taking the course. Whether it's changing the delivery format or the type of course material handed out, you should always aim to make your courses lively.

To keep training courses upbeat, great trainers always encourage participation. Asking questions during training will keep trainees engaged, and it also helps trainers assess how much of the material the participants are assimilating. Adults learn best when they can practice what they learn. To be considered effective, training sessions must include practice segments.

POSSESSES INDUSTRY KNOWLEDGE

Good trainers understand the concepts and nuances that prevail in the industry. They know what makes the workforce and customers tick, and they also have an eye on its trends. This knowledge is crucial as delegates can quickly spot a trainer who's only reading from a prepared slide.

Having adequate knowledge also helps with designing an effective training programme. It can help trainers choose which training medium to use, the type of activities to include, etc. An added bonus is that a well-read trainer can always find an angle to make even the most boring topic lively.

PASSIONATE ABOUT LEARNING

Trainers who are passionate about learning understand that it is an ever-evolving process. Recognizing the value of learning in their own lives, they spend time developing themselves as

well. The passion they devote to honing their skills is reflected in the quality of the training they offer.

Their continuous learning exposes them to different methods of engaging trainees and learning styles, too. By keeping abreast of the latest insights in training, good trainers will remain in demand.

HIGH LEVEL OF PROFESSIONALISM

The best trainers understand that people learn at different speeds and in different ways. Regardless of how fast trainees pick up on the concepts taught, the trainer must always remain patient. They also create time to interact with each delegate to make sure they understand the material before moving on.

Excellent trainers are also open-minded and willing to listen to different points of view. They don't assume they know everything and will never talk down to their trainees.

Unfortunately, not every trainer is effective, and that is because not every trainer possesses these characteristics. It is not enough to simply talk to the trainees - a trainer must also be insightful, charismatic, passionate, and above all, have exceptional communication skills.

Without these characteristics, trainees won't be engaged and the training session will not be worthwhile. But a trainer who does have these characteristics will have the ability to convey clear messages, help people develop and potentially change someone's entire mind-set for the better.

Characteristics of a Good Trainer VS Bad trainer

A good trainer	**A bad trainer**
• He will be energetic, enthusiastic and will try the Program make it interesting • He will be confident, show empathy with the participants • He will present innovative training material, will not read from the slide, pace his presentation and keep within time • Will allow questions and discuss will try understand their problem and give answers	• He will be boring Dull and will show no interest in the program • He will be floundering, as he may not be thoroughly conversant with the subject • Will be a monologue, no modulation of voice, no humor and avoid questions

Hints on preparing your material- most of us prepare slide for our presentation. Here are some Dos and Don’ts which will make your presentation lively, attract attention of the viewers.

- Restrict the number of slides to minimum- remember the slides will have points for elaboration and discussion. Therefore you can’t put too much material in your slides which will be boring and the audience will go to sleep.

- As a rule of thumb for a 40 minutes presentation you should not have more than 20 slides.
- Ideally each slide should not have more that 7-8 bullet points with fonts big enough so that the last bench can read it.
- Use minimal color combinations- ideally use contrast colors for background and your bullet points. The best are Black against white, Yellow against blue or vice- versa.
- Do not use pastel colors – they may be difficult to read
- Use graphics wherever possible to make the slides interesting
- If you are presenting a Table your columns should not be more than five and rows not more than five.
- **Do not read from the slides**- your material in the slide is to highlight important points
- Do not put chart /graph and table for the same data unless you want to show a trend
- Modulate your voice so that the verbal part of the presentation is interesting- idea is to keep the attention of the listeners to you.
- Keep eye contact with your audience- do not look at the ceiling and talk.
- Your slides should exactly follow your content that you have included in the Manual
- Divide your presentation in to subsections and allot time for each while planning for your presentation.
- Ask questions to keep audience glued to your talk.
- **If you do not have an answer to a question immediately never try to bluff, admit that you do not have an answer but will get back with the answer- this is very important to establish your credibility with your audience.**
- If you are in outdoor and your audience are the farmers of the project, prepare charts, graphs, videos, models and other VIPP material as you may have people who may not be literate.

Session 6: Group Exercise- Designing a Training Program for DOA staff in Odisha

This exercise is to design a Training program for DOA staff in your district in Odisha.

The group should be divided into district wise representation (2-3 persons)

Task:

- Write a Curriculum for a two day program at for your district
- Give a structure of a Manual
    - Session plan for two days
    - What will be the learning outcomes
    - What will be the content
    - What will be the tools
    - Plan any experiential learning session
    - Design a feedback questionnaire

Session plan for the Training program

Monday, 8 July 2019		
0830-9000	Registration	Chaitanya/Lakshmi/ Bhavani
Session 1	Inaugural Session	
0900-0910	Opening remarks	Pooran Gaur/ Sreenath Dixit
0910-0920	Overview of Odisha Bhoochetana	Girish Chander
0920-0930	Objectives of training program	Kapil Raje
0930-1000	Ice breaker and expectations	Kapil Raje/SK Dasgupta
1000-1010	*Group photo*	
1010-1030	*Health break*	
1030-1100	Pre-training Evaluation	MT team
1100-1230	Climate of Odisha	AVR Kesava Rao
1230-1330	*Lunch break*	
Session 2		
1330-1415	Developing Soil Nutrient Maps of Odisha state using Geostatistics and Geographic Information System	Mukund Patil
1415-1500	Referral laboratory: SOPs and Applications	Pushpajeet Choudhari
1500-1630	CRAL lab visit	Pushpajeet Choudhari
Tuesday, 9 July 2019		
0830-1030	Field visit- FES, Heritage watersheds, polyhouse, aerobic composting etc.	Aviraj Datta/Rajesh P/ Rohan Khopade
1030-1100	*Recap, Health break*	
1100-1130	Soil sampling methods and nutrient management	Vijay Jakkula
1130-1230	Brainstorming session: Challenges and possible strategies to improve soil health	Girish Chander/ Pushpajeet Choudhari/ Vijay Jakkula
1230-1330	*Lunch break*	
1330-1630	Discussions	
Wednesday, 10 July 2019		
0900-1000	Basics of Training Pedagogy	Aviraj Datta/Prakash Rathod/ SK Dasgupta
1000-1030	*Health break*	
1030-1130	Training pedagogy (cont.)	Aviraj Datta/ Prakash Rathod/ SK Dasgupta
1130-1200	Course feedback, response from Participants	
1200-1230	Closing session	Pooran Gaur/ Sreenath Dixit
1230-1315	*Lunch*	
1330	Departure begins	

Notes:

Notes:

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ICRISAT works in agricultural research for development across the drylands of Africa and Asia, making farming profitable for smallholder farmers while reducing malnutrition and environmental degradation.

We work across the entire value chain from developing new varieties to agri-business and linking farmers to markets.

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