Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

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Agriculture Skill Council of India

Participant Handbook

Sector
Agriculture and Allied

Sub-Sector
Agriculture Crop Production

Occupation
Field Crops Cultivation (Food Crops)

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NSQF Level 4

Paddy Farmer

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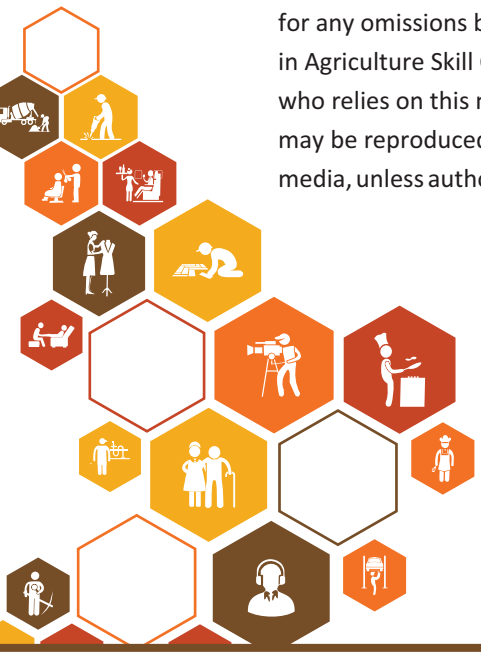

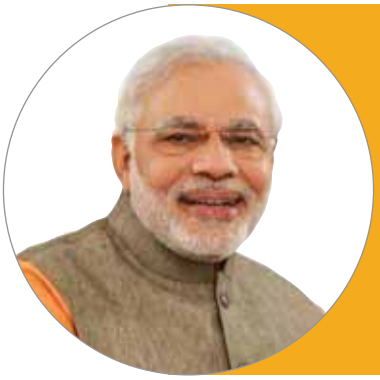

> Skilling is building a better India. If we have to move India towards development then Skill Development should be our mission.

Shri Narendra Modi
Prime Minister of India

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for

SKILLING CONTENT: PARTICIPANT HANDBOOK

Complying to National Occupational Standards of
Job Role/ Qualification Pack: **'Paddy Farmer'** QP No. **'AGR/Q0101 NSQF Level 4'**

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It is expected that this publication would meet the complete requirements of QP/NOS based training delivery, we welcome the suggestions from users, Industry experts and other stakeholders for any improvement in future.

About this book

This book is the knowledge resource to the paddy farmer for sustainable paddy farming. This book is the complete knowledge and skill based crop solution for the paddy farmer. The entire books is developed as per the Qualification pack and National Occupational Standards approved by National Skill Qualification Committee. A Paddy Farmer is responsible to cultivate paddy on a given piece of land and is responsible right from procurement of seed material to the sale of farm produce in the market. The trainee will enhance his/her knowledge under the guidance of the trainer in the following skills:

- **Knowledge and Understanding**: Adequate operational knowledge and understanding to perform the required task
- **Performance Criteria**: Gain the required skills through hands on training and perform the required operations within the specified standards
- **Professional Skills**: Ability to make operational decisions pertaining to the area of work.

Symbols Used


Key Learning Outcomes


Steps


Time


Tips


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Unit Objectives


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1. Introduction

Key Learning Outcomes

At the end of this module, you will be able to:

- Understand the general discipline in the classroom
- Understand and study the scope and opportunities of Paddy cultivation
- Understand the role of paddy farmer
- Analyse agro-climatic conditions required for rice cultivation
- Compare different high yielding varieties of rice, hybrid rice, aromatic rice, boro rice
- Understand farmers' rights under PPVFR Act

UNIT 1.1: Maintaining Classroom Discipline

Unit Objectives

At the end of this unit, you will be able to:

- Understand the general discipline in the classroom

1.1.1 Maintaining Classroom Discipline

These instructions need to be circulated in advance to all participants.

For teaching to be effective, classroom management and discipline is very important.

Many new teachers and even some experienced ones, find it extremely difficult to maintain discipline in their classrooms. There are a number of reasons why discipline in the classroom is such a challenge for trainers and the trainee participants, both.. There are a number of steps which a trainer should take for ensuring a proper interactive atmosphere so that the trainer and the trained have matching wavelength and the learning process is meaningful.

Needless to say that the importance of discipline is applicable to both the parties. Both should come to class in time and well prepared, trainer to deliver the essentials in a lucid style and the trainee with a bend of mind that is receptive and responsive to the enquiries that the trainer may likely raise. The responsibility has to be shared willingly and pro-actively.

The subject matter to be shared in soft or hard copies must be prepared and shared in advance and reasonable time be given to participants to go through the material. The trainer must ensure as to the level of knowledge of the group and try to give information what they need to get and not what trainer may feel he needs to pass on, within the overall scope of the training. If this principle is followed a rapport is created at the outset itself and the whole exercise of interaction becomes worthwhile.

Here are some tips, do's and don't's, which can be quite helpful to create or generate a proper learning environment that would he conducive the objectives of the assignment.

Do's and Don't's for Participants

- DON'T: procrastinate on homework
  DO: stay organized
- DON'T: get lazy keep good posture
  DO: exercise arms, feet legs outside class room or pranayaam
- DON'T: be afraid of your professor
  DO: ask questions or comment and interact
- DON'T: just stay in your comfort zone
  DO: adjust to new things you will experience
- DON'T: worry if you don't know
  DO: feel excited about finding what is new or what you want
- DON'T: feel incompetent
  DO: feel confident but not overly confident.
- DON'T: go on a crazy over differences
  DO use it as motivation to do better and to settle down

- DON'T give or expect disrespect
  DO respect difference of opinion
- DON'T digress
  DO be relevant

Do's and Don't's for Trainers

Do's

- Be fair, positive and consistent : Keep rules simple
- Provide a list of standards and consequences
- Keep your classroom orderly. Maintain facilitations well and disposition as cheerful
- Get to know participants. Spend time and give attention with participants one to one
- Let them feel you care. Determine jointly behavior and achievement yes and no.
- Treat students with the same respect it is a give and take at equal level
- Learn the meaning of terms, especially slang, used by students.
- Begin class on time and in a professional manner.
- Praise good work, good responses and good behavior.
- Be mobile, moving around the room as students work or respond to instruction.
- Keep your voice at a normal level.

DON'T's

- Don't threaten or use sarcasm. Never use threats or humiliation to enforce discipline.
- Enter arguing with students.
- Don't waste your energy reprimanding every small misbehavior
- Don't talk about the misdeeds or weakness of individual participants
- Don't discourage participant to tell his or her side of the situation
- Don't take it personally when a student lashes out.
- Don't Force participants to answer too many questions or perform too many tasks.
- Don't Judge too early Give time before judging - it takes time to adjust
- Don't have the classroom too decorated. Consult and make it modest.

In the *Guru-shishya parampara* of this country's classical teaching style, the outstanding feature has been a question-answer format. In fact the questions have been raised by the Gurus and shishyas have been asked first to try and find answers themselves before the guru gives a final answer satisfactory to the shishyas. The relevance of this system still applies deeply and intensively to the question-answer methodology which is one of the best ways to make the learning sessions interactive and to make a lasting knowledge impact on the participants.

Notes

UNIT 1.2: Scope and Opportunities of Paddy Cultivation

Unit Objectives

At the end of this unit, you will be able to:

- Understand and study the scope and opportunities of Paddy cultivation

1.2.1 Scope and Opportunities of Paddy Cultivation

India is a land of diversity not only in terms of language, culture, agro-climatic conditions, etc., but also in terms of rice cultivation which differs from region to region, season to season, food habits or preferences, economic value, product utilization and so forth, across different parts of the country. West Bengal in the east, Punjab in the west, UP in the north and AP in the south are the four highest producers of rice in the country. What else could be a better picture of diversity, importance and scope of rice cultivation in the country?

The rice production technology is also diverse to a myriad extent. There are traditional broadcast wetland rices, broadcast upland rainfed rices, there are the widespread wetland transplanted rices and then, to provide a contrast, there is the *System of Rice Intensification* (SRI). That is not the end of the list. We have the emerging technologies getting more and more popular day after day – the Direct Sown Rice and aerobic rice technologies, to combat the ever-present threat of limiting water availability in the future. That still is not the end of the list as **hybrid rice** makes its presence felt. To top it all, Basmati rice gives India the pride of the place in international exports of this World No ! most widely consumed grain exclusively as food,

With the annual rate of rice consumption rising in India at 2.5 % per annum, a population growth of 2.1 % per annum, an export potential rising @ a whopping 32 % in the second quarter of 2017, rice has the kind of future prospects that any important crop can boast of. Private seed industry, milling industry as well as government backed APEDA make for excellent prospects for rice export and if India has some conscientious quality rice producers, they are well poised to gain from the current growth scenario of the rice crop.

The frequency and speed with which new high yielding hybrids and varieties of rice, in different maturity range, suited to diverse cropping systems, are coming up, the new varieties of basmati rice are being provided by plant breeders, the blast resistant varieties are making their appearance (and presence felt) - it all adds muscle to the prospects of a rice farmer. What makes for further strength of this versatile food crop is the expanding and diversifying scenario of processing industry's exploitative adventures into investments that have hitherto been moderate but are set to increase phenomenally.

There are, though, the flip factors such as the abominable “Climate Change” for which rice crop itself has to bear a lot of blame. The receding water table, the unpredictable vagaries of monsoon, the drought and flood patterns, the rising cost of inputs make the task of rice farmer difficult indeed. And yet it can be said in conclusion that given the challenges, the resources and the worthiness of a rice farmer, rice cultivation is poised for a bright future.

Notes

UNIT 1.3: Role of Paddy Farmer

Unit Objectives

At the end of this unit, you will be able to:

- Understand the role of paddy farmer

1.3.1 Role of Paddy Farmer

Agriculture is a predominant sector of Indian economy, inspite of the fact that its contribution to national GDP has declines in the last two decades from 29.7 to 18.6 percent. While government is doing its best to reach out to the farmers of India with progressive policies and programs, the implementation is hampered by the field staff who are responsible for the tardy progress of the agricultural development programs. Farmer on the other hand, is always looking for ways and means to increase his income and to enlarge his resource and income base, to be able to raise the level of living and livelihood of his family.

There may be an unending and unresolved conflict between the government and the farming community with regard to the facilities being made available for betterment of the farm resources, farming environment and livelihood options available to the farmer. But the government's facilities are in any case, still available to the farmers and they should take pro-active steps to be able to avail of them.

Soil & fertilizer management and water management are two areas where a rice farmer is grossly concerned and should strive to make best use of facilities available for soil analysis, soil health card and specific need-based fertilizer application, a practice, which should be diligently adopted. Insisting on balanced fertilizer management is not only good economics, but is a long term investment in consistent betterment of the soil as a production environment. Maximizing the use of organic fertilizers (green manuring, wormicompost, bacterial fertilizers, FYM, etc.,) for soil enrichment, avoiding burning of residues, using straw as mulch, and similar technology adoptions are warranted on the radar screen of farmers, embedded in the calendar of operations and their budget sheets without delay.

The application of integrated management principles is also highly desirable. Today, rice varieties with resistance characteristics are widely available and consequently, efforts on minimization of use of pesticides should be exercised. This can be tied to government support schemes related to Integrated farming systems, sustainable agriculture, watershed management schemes where liberal grants are available.

Water management especially conservation of monsoon water, recharge of local water bodies and wells, land leveling and bund making for higher on-farm water use efficiency, SRI, DSR, aerobic rice technology, hybrid and basmati rice are areas where more indulgence of rice farmers is deemed profitable.

Farmers can and should join hands if a handicap or two are coming in the way of successfully availing of these provisions. Seed production, quality seed multiplication and creating seed banks as well as community nurseries need to be given much more attention.

Women's Collectives and Producer Organization platforms have made significant advances in the last few years but the urge, enthusiasm amongst the young farmers to aggressively participate in these areas and undergo training for skill or professional enterprise is largely missing. Active approach in these directions will bring a kind of fiscal and technological revolution that can take rice farming forward in a big way. Warehousing facilities for which government has big plans and provisions must be exercised by rice farmers to consistently command best market prices at all times. Farm credit and crop insurance facilities can be better managed for groups which should be receive attention and be adopted. The potential offered by food processing industry, food parks, value addition at farm gate, value chain participation and joining shareholder and stakeholder groups deserves to be exploited in the interest of earning market prices, hitherto not possible for farming communities. Paddy farmers can play a leading role and set local examples for this movement to progress at a rapid pace.

Notes

UNIT 1.4: Status of Rice

Unit Objectives

At the end of this unit, you will be able to:

- Infer where rice cultivation started and how it spread across the world
- Understand why rice is such an important crop

1.4.1 Origin and History of Rice

The origin and domestication of rice are two different events and should be looked at in that order only, though some researchers have confused the issue.

As recently as in 1996, a team of Japanese and Chinese archaeologists carried out radiocarbon testing of 125 samples of rice grains and husks, as well as of rice impressions in pottery, from sites located along a specific portion of the Yangtze unanimously indicate a median age of over 11,000 years. Thus the origin of Rice is pushed back by almost 8 millenia by radiocarbon technology as compared to theories based on biological inferences

The domestication and cultivation of rice *Oryza Sativa,* is one of the most important events in history of this planet that has had the greatest impact on the most people because rice is such an important food crop for more than half of the area of this planet and more than half of the human population here. Rice, is widely associated with wet, humid climate but today rice is the second most widely and most commonly consumed food grain in the world after wheat, having earned titles like "*Staff of Life*", "*Hallmark of Civilization*" etc. Some say that the word rice is derived from the Tamil word *arisi*.

Rice is first mentioned in the Yajur Veda (1500 BC) and then is frequently referred to

in Sanskrit texts.. Rice is often directly associated with prosperity and fertility; hence there is the custom of sprinkling rice during various pooja ceremonies and also at newlyweds. In India, rice is almost always the first food offered to the babies when they start eating solids or to husband by his new bride, to ensure they will have bonny children.

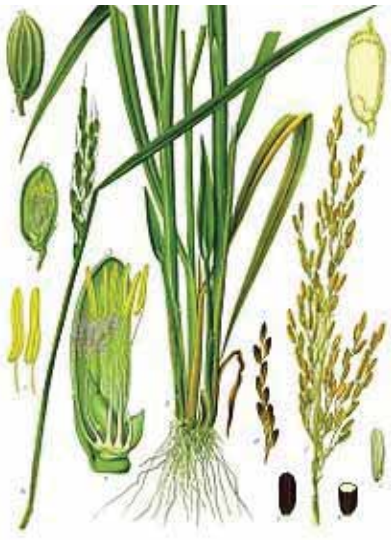

Fig 1.4.1 Origin and History of Rice

According to some schools of thought, rice is probably a descendent of wild grass that was cultivated in the foothills of the Eastern Himalayas and the upper tracts of the Irrawady and Mekong river basins. Another school of thought believes that the rice plant may have originated in southern India and then spread to the north of the country. Yet another belief states that the rice plant may have originated in the high hills of Amarkantak, near the origin of rivers Narmada and Sonbhadra. From India, the plant spread to China and then onwards to Korea, the Philippines (about 2000 B.C.), Japan and Indonesia (about 1000 B.C.). The Persians are known to have been importers of this grain. From there its popularity spread to Mesopotamia and Turkestan. It is believed that when Alexander the Great invaded India in 327 B.C., one of the priced possessions he carried back with him was rice. Arab travelers took it to Egypt, Morocco and Spain and from there it traveled all across Europe. The Portugese and Hollanders took rice to their colonies in West Africa. From Africa it traveled to America through the 'Columbian Exchange' of natural resources - rice being a gift from the Old World to the New. Rice has been cultivated in the United States of America for the last three hundred year.

Alexander invaded India in 327 BC and likely took rice over to Greece. Arab travelers may have taken it to Egypt, Morocco and Spain and all across Europe. Portugal and Netherlands took rice to their colonies in West Africa and then it moved to America through the presumed 'Columbian Exchange' of natural resources. To take root in the Americas, rice took a long time for a wide domestication, estimatedly close to two centuries after Columbus. Only in beginning of 17th century did rice become an important food crop in the west. Indians tend to believe that cooked grains of rice should be like two brothers – close, but not sticky.

India is an important centre of rice cultivation and occupies the first position in the orld for area under rice cultivation. It is an essential component of the daily meal in most parts of India and a major agriculture and economic product for the people of this country, covering more than a quarter of the cultivated land (2012-13). It is. In the northern and central parts of the subcontinent also, where wheat is commonly eaten, rice holds its own importance in daily diet as well as on festivals and special occasions.

Historians believe that while the *Indica* varieties of rice were first domesticated in the area covering the foothills of the Eastern Himalayas (i.e. north-eastern India), stretching through Burma, Thailand, Laos, Vietnam and Southern China. The *japonica* variety seems to have been domesticated from wild rice in southern China which was later introduced to India. *Perennial wild rice* still grows in West Bengal, Assam and Nepal, with variations like black rice, salt tolerant coastal rice, etc. It seems to have appeared around 1400 BC in southern India after its domestication in the northern plains. It then spread to all the fertilsed alluvial plains watered by rivers.

1.4.2 Importance of Rice

Rice & India's Green Revolution

Rice as a primary agent of Green Revolution in South and South-East Asia : At the core of Green Revolution package, stand the short, stout stalks of semi-dwarf HYVs. Early efforts to improve yields ran into problems when increased grain weight caused plants to lodge (bend or topple over). Plant breeders searched out short (dwarf) varieties of rice (and independently in wheat) to cross with their high-producing existing cultivars. Other desirable characteristics were early maturity and photo-insensitivity. First breakthrough in rice came from crossing a semi-dwarf variety from Taiwan, ***Dee-geo-woo-den*** (DGWG), with a 1940, tall, vigorous Dutch strain ***Peta*.** The resulting cross, known officially as IR-8-288-3 and popularly as IR 8, tillered profusely in response to applications of nitrogen, producing numerous heavy panicles of grain. Its thick culms and great straw strength prevented lodging. In field trials at IRRI, IR 8 produced yields of up to 10.13 tons of paddy per hectare.

Area and Production of Rice in India

Our country has the largest area under rice cultivation and is f the leading producers of this crop. Trends in area, production and productivity of rice (Table 1) indicate considerable increase in India since 1950-51 to 2016-17. The production has increased by about five times while the productivity has increased by about four times since 1950-51 to 2016-17 (Within a span of 66 years). This enhanced production could be achieved due to increased inputs, high yielding varieties and production technologies.

Table 1.4. 1 : Area, Production and Productivity of Rice in India

Year	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2010-11	2016-17
Area (Million hectares)	30.8	31.1	37.6	40.1	42.7	44.7	42.86	43.38
Production (Million metric tonnes)	20.6	34.6	42.2	53.6	74.3	85.0	95.97	104.32
Productivity (kg/hectare)	668	1,013	1,123	1,336	1,740	1,901	2,239	2,404

(Annual Report 2016-17, DAC)

is used in foods of various kinds, including ice-creams, baked foods. Starch derivatives have diverse industrial uses in medicines, biodegradable plastics, fabrics and so forth. Cooking procedures can reduce the richness of vitamins and minerals in rice, and in fact, cooking is usually done with water which is then neglected and much of these nutrients dissolve in water and get wasted. Rice is strongly recommended in preparing specific diets against sto -mach and intestinal disease processes as well as feeding the infants and old people due to its good digestible character.

Nutritional Value of Rice

Rice is a nutritionally endowed staple food Its most important component is carbohydrate (starch) which provides instant energy. But it is not so rich in protein or fat content, the average composition of these substances being only about 8% and fat content or lipids being still lower, i.e., 1% or thereabouts. It is not considered as a complete food as a diet but is light on the stomach with easy digestibility. Rice flour is rich in starch and is used for making various food preparations. Starch in fact is a very versatile chemical ingredient and the variability of composition and characteristics of rice is really broad and depends on variety and environmental conditions under which the crop is grown. In husked rice, protein con-tent ranges in between 7per cent to 12per cent. The use of nitrogen fertilizers increases the percentage content of some amino acids.

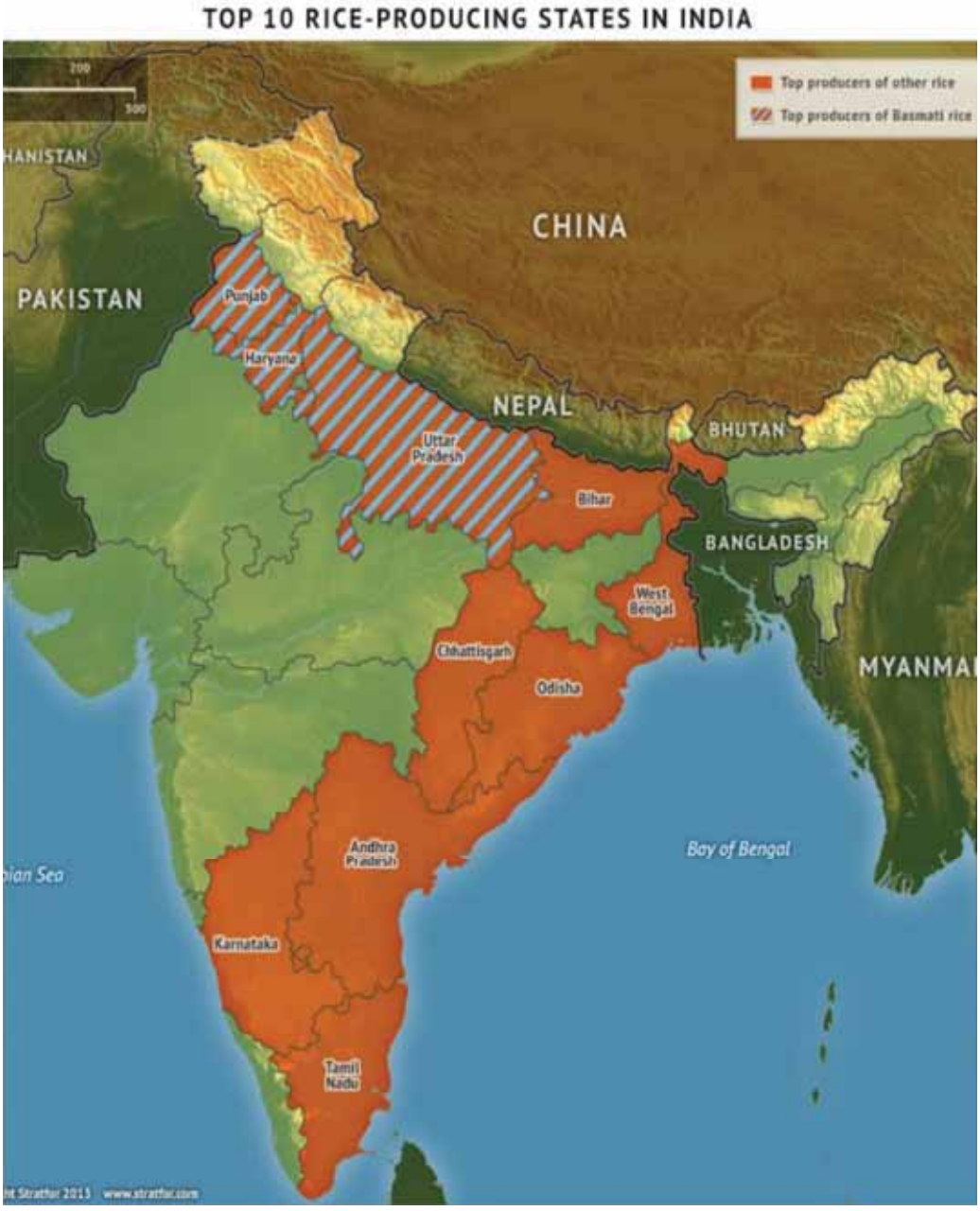

Fig 1.4.2. Top ten states in rice production in India

Notes

UNIT 1.5: Rice Growing Regions in India

Unit Objectives

At the end of this unit, you will be able to:

- Compare the regional distribution of rice in India
- Understand the diversity in cultivation pattern of rice in India

1.5.1 Regional Cultivation of Rice

Rice is grown under so diverse soil and climatic conditions that it is said that there is hardly any type of soil in which it cannot be grown including alkaline and acidic soils. Rice crop has also got wide physical adaptability. Therefore, it is grown from below sea-level (Kuttanad area of Kerala) upto an elevation of 2000 metres in Jammu & Kashmir, hills of Uttarakhand, Himachal Pradesh and North-Eastern Hills (NEH) areas. The rice growing areas in the country can be broadly grouped into five regions as discussed below

North-Eastern Region: This region comprises Assam and North eastern states.

In Assam rice is grown in the Basin of Brahmnaputra River. This region receives very heavy rainfall and rice is grown under rain- fed conditions.

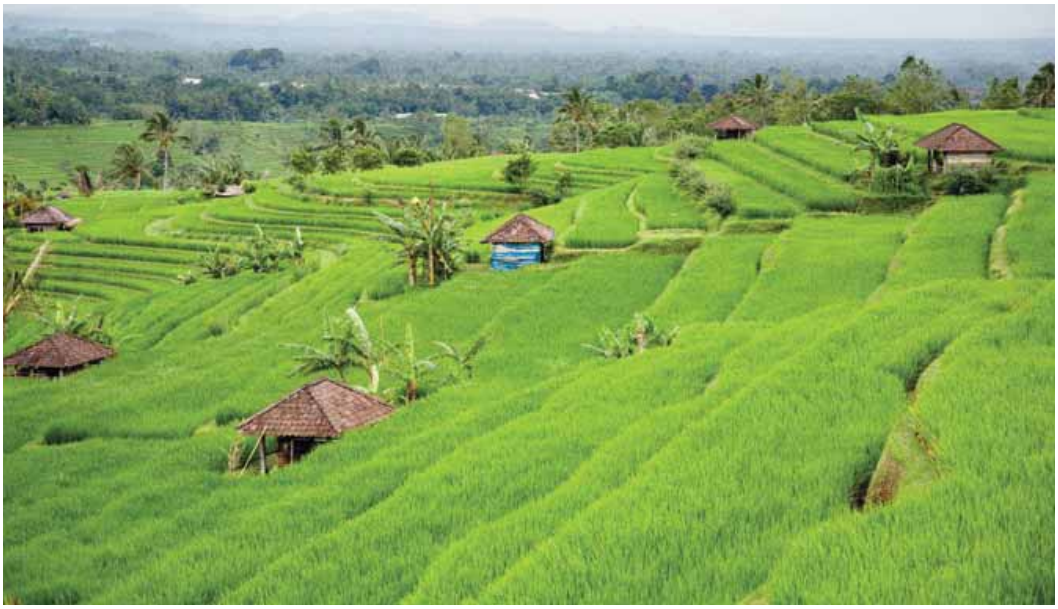

Fig 1.5.1 Terrace farming of rice in the hilly regions

Eastern Region: This region comprises of Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Orissa, Eastern Uttar Pradesh and West Bengal. In this region rice is grown in the basins of Ganga and Mahanadi rivers and has the highest intensity of rice cultivation in the country. This region receives heavy rainfall and rice is grown mainly under rain fed conditions.

Northern Region: This region comprises of Haryana, Punjab, Western Uttar Pradesh, Uttrakhand, Himachal Pradesh and Jammu & Kashmir. The region experiences low winter temperature and single crop of rice from May-July to September-December is grown.

Western Region: This region comprises of Gujarat, Maharashtra and Rajasthan. Rice is largely grown under rain fed condition during June-August to October – December.

Southern Region: This region comprises of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu. Rice is mainly grown in deltaic tracts of Godavari, Krishna and Cauvery rivers and the non-deltaic rain fed area of Tamil Nadu and Andhra Pradesh. Rice is grown under irrigated condition in deltaic tracts.

In India rice is grown under widely varying conditions of altitude and climate. Rice cultivation in India extends from 8º N to 35º N latitude and from sea level to as high as 3000 meters above mean sea level. Rice crop needs a hot and humid climate. It is best suited to regions which have high humidity, prolonged sunshine and an assured supply of water. The average temperature re-quired throughout the life period of the crop ranges from 21 to 37º C. Maximum temp which rice can tolerate 40^{0} C to 42^{0} C.

Temperature requirements of rice at different stage

Minimum temperature for sprouting is10^{0}C, at the time of tillering, the crop requires a high temperature than for growth. Minimum temperature for flowering range from 22-23^{0}C. Temperature requirement for blooming is in the range of 26.5 to 29.5º C. Minimum temperature for grain formation from 20-21^{0}C at the time of ripening the temperature should be between 20-25ºC. Photo periodically, rice is a short- day plant. However, there are varieties which are non-sensitive to photoperiodic condition.

1.5.2 Important Growing Ecology of Rice

Rice farming is practiced in several agro ecological zones in India. No other country in the world has such diversity in rice ecosystems than India. Because the rice cultivation is so widespread in India, four distinct rice ecosystems have been recognized. These are:

- Irrigated Rice Eco System
- Upland Rice Eco System
- Rainfed Lowland Rice Eco System
- Flood Prone Rice Eco System

Irrigated Rice Eco System: Irrigated ecosystems are the primarily found in East Asia. Irri-gated ecosystems provide 75per cent of global rice production. In India, the total area under irri-gated rice is about 22.00 million hectares, which accounts about 49.5per cent of the total area under rice crop in the country. Rice is grown under irrigated conditions in the states of Punjab, Haryana, Uttar Pradesh, Jammu & Kashmir, Andhra Pradesh, Tamil Nadu, Sikkim, Karnataka, Himachal Pradesh and Gujarat. Irrigated rice is grown in bunded (embanked) paddy fields.

Rainfed Upland Rice Eco System: Upland zones are found in Asia, Africa, and Latin Ameri-ca. In India, the total area under upland rain fed rice in the country is about 6.00 million hectares, which accounts13.5per cent of the total area under rice crop in the country. Upland rice areas lies in eastern zone comprising of Assam, Bihar, Eastern M.P., Orissa, Eastern U.P., West Bengal and North-Eastern Hill region. Upland rice fields are generally dry, unbunded, and directly seeded. Land utilized in upland rice production can be low lying, drought-prone, rolling, or steep sloping.

Rainfed Lowland Rice Eco System: Rainfed low-land rice is grown in such areas as East In-dia, Bangladesh, Indonesia, Philippines, and Thailand, and is 25per cent of total rice area on global basis. In India, low land rice area is about 14.4 million hectares, which accounts 32.4 per cent of the total area under rice crop in the country. Production is variable because of the lack of technology used in rice production. Rainfed lowland farmers are typically challenged by poor soil quality, drought/flood conditions, and erratic yields

Flood Prone Rice Eco System: Flood-prone ecosystems are prevalent in South and Southeast Asia, and are characterized by periods of extreme flooding and drought. Yields are low and vari-able. Flooding occurs during the wet season from June to November, and rice varieties are cho-sen for their level of tolerance to submergence.

Notes

UNIT 1.6: Crop Production Methodology

Unit Objectives

At the end of this unit, you will be able to:

- Understand rice cropping systems
- Understand relay cropping, sequential cropping , inter-crops,
- Understand integrated farming system for diversified income,

1.6.1 Rice Based Cropping Systems

Rice based cropping system can be described as mix of farming practices that comprises of rice as the major crop followed by subsequent cultivation of other crops. Inter-cropping of rice and other compatible crops is also widely practiced in many regions. Rice based cropping system is a major cropping system practiced in India, which include the rotation of crops involving rice, pulses, oil seeds, cotton, sugarcane, green manures, vegetables, etc. Various rice based cropping systems have been reported from different parts of India ranging from rice-rice-rice to rice followed by different cereals, pulses, oil seeds, vegetables and fibre crops. Rice based cropping systems may include lowland and upland crops. So far, most people have been focussing on individual crops disregarding the fact that each crop is only a component of a cropping system.

Cropping Systems of Northern India : Cropping patterns are dynamic in nature and the farmer's anticipation of market conditions for the next crop, what will get him the best economic returns is what generally determines the choice of crop by the farmer. The experience across the middle indo-gangetic plains shows several cropping patterns

- *Rice-Lentil-Maize*
- *Rice-wheat*
- *Rice-berseem,*
- *Rice-wheat-mungbean,*
- *Rice-wheat- cowpeas,*
- *Rice-Onion*
- *Rice-lentil,*
- *Rice-sunflower*
- *Rice-muistard-mung*
- *Rice-Wheat- dhaincha (green manure)*

According to one study, based on combined energy, environmental and economic criteria, Rice-Garlic, Rice-Onion and Rice-Lentil-Maize were more profitable systems.

Also, Rice-Lentil-Mung, and Rice-Wheat-Maize (green cobs) are the most energy, environmentally and economically efficient.

The mean technical efficiency scores of farms indicated a considerable potential of reducing energy inputs (18-34%), without compromising the economic return.

The commonly practiced eco-efficient Cropping Systems with modern production technologies are in sync with rice-wheat cropping pattern. According to another study, increase in paddy yield with Rice-Lentil-Maize was statistically at par with the paddy yields received from rice-wheat- mungbean (3.57 t/ha) and rice-berseem (3.52 t/ha) cropping pattern. The yield of succeeding wheat crop was also higher in case of green manuring (sesbania) and leguminous crops (mungbean and cowpeas.

The results clearly indicated that introduction of green manuring or leguminous crops in the existing rice-wheat system not only increased grain yields but also improved the physio-chemical properties, organic matter contents and nutrients availability in the soil. Increase of NPK over initial soil fertility was N (0.12 %), P (2.8 ppm), and K (52 ppm). Soil pH lowered from 8.2 to 7.8 and organic carbon increased from 0.67 % to 0.72 %

1.6.2 Rice Based Cropping Systems in South India

Rice based cropping systems in South India

Rice inter cropping with millets and pulses dominates the cropping systems practiced by farmers in **Kerala** rice intercropping with red gram, finger millet, little millet, maize and cowpea is quite common. Little millet, cucumber and pumpkin are also grown as border crops.

Other mixed farming practices are

Rice-rice-pulse/oil seeds; Rice-pulse-vegetable; Rice-rice-fallow and rice-vegetable pattern

Rice-fish system (as per the exchange of info from Indonesia where Keralites have a good presence).

In **Tamilnadu**, which has a long history of growing rice due to very favourable climatic conditions the important rice based cropping patterns observed in the major growing districts of Thanjavoor, Thiruvaroor and Nagapatnam is: Rice-rice-pulse/oil seeds.

The first crop starts during June-July and is harvested in October and this crop is known as *Kuruvai;* followed by this the second crop which starts in October-November and is harvested during January-February. The second crop is known as *Thaladi*. After the second crop, farmers broadcast pulses like black gram, cow pea, horse gram, and oil seeds such as sesame, etc in the paddy lands.

Other Mixed farming practices are:

Rice-pulse-green manure ; Rice-pulse/oilseeds; Rice-rice-rice

In **Karnataka,** rice is grown in a range of agro ecological zones like arid lands, hilly areas, wet lands and coastal plains. The major rice based farming systems in Davangare, Haveri, Shimoga, Mysore, Mandya districts are :

Rice-rice; Rice-pulse/green manure; Rice-pulse/millets; Rice-other cereals/millets

In **West Bengal** rice is grown with varying climatic and hydrological conditions ranging from waterlogged and poorly drained areas to well-drained soils. Aman – sown in the rainy season (July-August) and harvested in winter. India produces aman rice mainly. Aus – rice sown in summer along with the pre- monsoonal showers and harvested in autumn is called ausrice. The quality of this rice is rather rough. Boro – rice sown in winter and harvested in March to April depending on variety. Along with rice, various other crops like pulses, oil seeds, vegetables and jute are grown in most suitable areas compatible with various seasons.

Rice- vegetable-jute; Rice-pulse/oilseed-jute; Rice-fish system

Notes

UNIT 1.7: Rice Cultivation Practices

Unit Objectives

At the end of this unit, you will be able to describe:

- Understand SRI
- Understand Wetland cultivation
- Understand Direct-Seeded Rice Crops
- Understand Aerobic cultivation
- Understand Winter rice, upland rice, Biasi method

1.7.1 System of Rice Cultivation (SRI)

In India rice is mainly grown in ***two types of soils*** i.e.

- uplands and
- low lands.

The methods of cultivation of rice in a particular region depends largely on factors such as situation of land, type of soils, irrigation facilities, availability of labourers, intensity and distribution of rainfalls. The crop of rice is grown with the following methods:-

Dry or Semi-dry upland cultivation

- Broadcasting the seed
- Sowing the seed behind the plough or drilling.

Wet or lowland cultivation

- Transplanting in puddled fields.
- Broadcasting sprouted seeds in puddled fields.

Selection of Seeds

The use of quality seeds in cultivation of rice is an important factor to get better crop yield. Therefore, proper care has to be taken in selecting the best quality seed of the recommended variety. A complete list of varieties released in last 10 years is given at the end of this handbook

Seeds intended for sowing should satisfy the following requirements:

- The seed should belong to the proper variety, suitable to the agroclimatic conditions of the farmer's field.
- The seed should be clean, mature, well developed and plump, have a high germinating capacity and free from obvious mixtures of other seeds.
- Before sowing the seed should be well protected against soil-born fungi and also give a
- boost to the seedlings establishment and growth. This would include fungicides, pesticides, bacterial cultures and the necessary coatings as per recommended treatments for the area of cultivation and the variety selected for planting.

Origins and Principles of SRI

To put the context in proper perspective, it may be stated at te outset that average paddy yield worldwide is about 4 tons per hectare. Even with the use of fertilizer, average yields are usually not more than 8 tonnes/ha. The world record yield for paddy rice production is not held by an agricultural research station or by a large-scale farmer from say United States, but by a farmer in the state of Bihar in northern India. Sumant Kumar, who has a farm of just two hectares in Darveshpura village, holds a record yield of 22.4 tons per hectare, from a one-acre plot. This feat was achieved with what is known as the system of Rice Intensification (SRI). Sumant Kumar's success was not a fluke. Four of his neighbours, using SRI methods for the first time, matched or exceeded the previous world record from China - 19 t/ha.

SRI was started by accident in the 1960s in Madagascar by a French priest — Fr. Henri de Laulanié, S.J. , when the time of planting arrived when his replanted nursery, carrying only a fraction of normal seed rate, was also much younger at 12 days as compared to 20 days (normal). He planted a single seedling at a hill instead of the normal 3 and with attendant extra care for the crop ended up getting fantabulous level of yield not expected when this nursery was planted.

System of Rice Intensification has shown remarkable capacity to raise smallholders' rice productivity under a wide variety of conditions around the world. From tropical rainforest regions of Indonesia, to mountainous regions in northeastern Afghanistan, to arid conditions of Timbuktu on the edge of the Sahara Desert in Mali and to fertile river basins in India and Pakistan, SRI method has proved adaptable to a wide range of agro-ecological conditions.

With SRI management, paddy yields are usually increased by 50–60 percent as compared to normal wetland rice, but sometimes by more (like 100%), even up to the super-yields of Sumant Kumar. Requirements for seed are greatly reduced (by 70 - 80 percent), as are those for irrigation water (by 25–40 percent). It is strongly recommended that inorganic fertilizer is required minimally and sufficient organic matter must be provided to soil but all in all, the nutrient requirement must be met if fuil yield potential is to be realized. Plant protection is likewise necessary as per recommendations even though it is claimed that SRI plants are also generally healthier and better able to resist biotic and abiotic stresses.

Fig 1.7.1 SRI methods frequently result in dramatically improved plant and root growth (SRI rice, left- conventional rice, right). Photo: Amrik singh.

SRI methodology is based on four main principles that interact in synergistic ways:

- Establish plants early, nurturing their root potential (root dip before transplanting) Reduced plant populations, single plant per hill, and more space to grow above and below Ground;
- Enrich the soil with organic matter, well-aerated with low water level in field and
- Intermittent draining to encourage profuse tillering and more aerobic soil biota;
- Crop care for healthy ways particularly mechanical weeding (cono weeder) that favor
- Plant-root and soil-microbial growth, cutting flooded (anaerobic) soil conditions to minimum
- Control weeds with mechanical methods that break up the soil's surface. This actively aerates the root zone

The cumulative result of these practices is to induce the growth of more productive and healthier plants (phenotypes) from any type of rice variety. The differences in yield by SRI over traditional transplanted wetland paddy are large and are certainly significant agronomically. Surprisingly, research scientists took several years to accept it as an agronomic advance wich can push yield at minimum cost of inputs, especially small farmers which can use family labour to derive max benefitr. Using SRI methods, smallholding farmers in many countries are starting to get higher yields and greater productivity from their land, labour, seeds, water and capital, with their crops showing more resilience to the hazards of climate change.

The adaptation of SRI experience and principles to other crops is being referred to generically as the System of Crop Intensification (SCI), encompassing variants for wheat (SWI), maize (SMI), finger millet (SFMI), sugarcane (SSI), mustard (another SMI).

1.7.2 Direct Seeded , Aerobic Rice – Package of Practices

A model package has been proposed based on the series of on-station and on farm field experiments across the gangetic plains from 2006-2010 under a research project “Zero tillage rice establishment and crop weed dynamics in rice and wheat cropping system in India and Australia” at Punjab Agricultural University, Ludhiana.

Laser Leveling and Field Preparation : Precise leveling is pre-requisite for direct seeding. Preferably laser leveling should be done at least a month before sowing. After laser leveling, the field should be irrigated to identify uneven areas in the field which can be taken care of through fine leveling again. This irrigation also stimulates weed and previous rice crop seed germination, which can be killed before seeding rice. To prepare a fine seed bed, plough the field twice with disc harrow followed by two cultivations with cultivator and one planking.

Soil Type : Direct seeding should be done on medium to heavy textured soils as direct seeded crop in light soils suffers from iron deficiency which causes remarkable reductions in yield.

Sowing Time : Sowing time varies with location to location. First fortnight of June is the optimum time for direct seeding of coarse rice in north-west India. For direct seeded basmati rice, optimum sowing time is second fortnight of June. As a general rule, seeding time of DSR should be as close as possible to the time of nursery sowing for the PTR.

Seed Drill : Among various seed drills used for direct seeding (viz., conventional seed cum fertilizer drill, zero till drill, Inverted T-tyne zero-till seed – cum-fertilizer drill,Vertical plate metering mechanism and inclined plate metering mechanism), machines with inclined plate metering mechanism are most suitable for DSR. This types of machines help in maintaining row to row and seed to seed spacing with little breakage. The sowing depth for dry DSR should be 2-3 cm and 3-5 cm for DSR after pre-sowing irrigation. The row to row spacing should be 20 cm.

Seed Rate and Treatment : Seed rate @ 20-30 kg /ha is adequate, when using planters with precise seed metering systems. Treat the rice seed with fungicides like streptocycline 1 g+bavistin 10 g/10 kg seed to reduce seed and soil borne diseases like bacterial leaf blight, sheath blight, brown leaf spot and other diseases.

Nutrition : The recommended doses of P, K and Zinc for DSR and PTR are same and apply these at the time of sowing. Apply K on soil test basis. Apply N @ 150 kg /ha in 4 splits 2, 4, 7 and 10 weeks after seeding. In case of basmati rice, apply 25% higher N dose in direct seeding as compared to transplanted crop.

Varieties : Short and medium duration rice varieties should be preferred. PR 115 variety of coarse rice and Pusa Basmati1121, Punjab Mehak 1, CSR 30, Pusa basmati 1 and Taraori basmati varieties are most suitable for direct seeding of basmati rice.

Irrigation Management : In heavy textured soils, DSR crop is commonly established by farmers with pre-sowing irrigation.First post-sowing irrigation can be delayed from 7-15 days with subsequent irrigations at an interval of 5-10 days.Water stress must be avoided during critical stages of seedling emergence,active tillering, panicle initiation and flowering.

Weed Management : Effective weed control is pivotal for DSR. Cultural methods of weed control like stale seed bed technique, use of surface mulch, cover crops (viz., Sesbania rostrata, Phaseolus radiatus and Vigna unguiculata) and brown manuring can help to reduce weed pressure.Pre-emergence treatment with pendimethalin (0.75 kg /ha) followed by post emergence application (15-25 days after sowing) of bispyribac (0.025kg /ha) for controlling grasses,broadleaf as well as sedges, azimsulfuron(0.020kg /ha) for controlling broad leaf and sedges including Cyperus rotundus and Fenoxaprop+ safener (0.067-0.083kg /ha) for effectively controlling grasses except Echinochloasp.

Yield : Yields of DSR (2.2-8.7 t /ha) vary from farmer to farmer depending on the proficiency and care associated with the effort and the appropriate machinery available. But yields comparable to existing wetland system are possible only in 35 percent of cases.

The favourable features of DSR can be seen as follows:

- DSR sowing is more cost effective technology as B: C varies from 2.29-3.12 as compared to transplanting (1.93-2.66).
- Water productivity is high in DSR and exceeds corresponding values in transplanting by >25%.
- Labour saving in DSR ranges from 13-37%.
- Pre-emergence spray of pendimethalin 0.75 kg /ha followed by post-emergence
- spray of bispyribac 0.025 kg /ha provides excellent control of weeds.
- Seed priming is the promising approach to overcome poor crop establishment.
- DSR is technically and economically feasible, eco-friendly alternative to conventional
- puddled transplanted rice.

Future Outlook : Development of new rice varieties for direct seeding along with proper management practices can help in adoption of DSR.

The change in the weed flora associated with switching over from PTR to DSR can be tackled by systematic weed monitoring program in association with integrated weed management strategies on sustainable basis. Proper management of microelements is also desirable since availability of microelements is reduced by direct seeding of rice.

Selection of proper soil type along with precised levelling can help to enhance WUE and productivity. Further, the selection of crop varieties with characters like early crop vigour and short statured cultivars with short duration can further increase WUE.

In direct seeding culture, WUE and productivity may improve if appropriate soil types from levelled land are selected. The various features of the crop like early crop vigour, short stature and short duration also helps in increasing WUE.

Seed priming technology can help to get rid of the problem of poor establishment of crop and can be further improved.

Strategies to reduce NO_2 emissions can be worked out.

Biotechnology can help to resolve the minor issues like lodging, nematode infestation, diseases, etc.

Despite of the numerous controversies, comparable grain yields may be obtained from DSR if properly managed as compared to PTR. Thus, in the present scenario of global scarcity of water and increasing labour wages, when the future of rice production is at stake, DSR is the most viable option for getting sustainable yields without any overexploitation of the available natural resources.

1.7.3 Improved Biasi (bueshning) Method of Rice Cultivation

Biasi or bushenening is basically a method of broadcasting seeds in dry or wet soils after normal field preparation. The rice plants as well as weeds grow simultaneously up to 30-40 days and there-after ploughing (single or cross with a desi plough) is done in standing rice crop in presence of 5-10 cm of water. This operation is called **biasi**. After ploughing, the rice plants are made to stand somewhat erect and gap flling is done by local (within the field) uprooting and transplanting system, manually. Simultaneously, majority of weeds are buried in the soil during this process. The process of making the rice plants to stand and removing weeds in the soil is known as ***chalai*** operation.

Important note: The above three practices (SRI, DSR aerobic, Biasi) in fact represent a small or even a major deviation from the most prevalent method of wetland cultivation or traditional upland rice cultivation. These two find a detailed treatment in the later part of this handbook

Notes

UNIT 1.8: Farmers' Rights

Unit Objectives

At the end of this unit, you will be able to:

- Understand your consumer rights seeds

1.8.1 Farmers' Rights

One of the seed companies during mid 1990s, came up with plant variety carrying a "*terminator*" gene, which made it difficult for this crop to germinate in the next generation. The plant breeder or the company felt that under intellectual property rights, they were entitled to retain this leverage so that the seed could be sold and not exploited for ever, after once it was purchased by someone. It would obviously amount to the fact that every time, if a farmer wanted to grow this variety, he would have to buy fresh supplies from the market.

This kind of approach and attitude by plant breeders or the seed company, was construed as an infringement on the farmers ability to grow what they wanted. And this was considered not fair or reasonable by the farmes, and hence was labeled "not acceptable". The plain argument was that seed companies in the first place, had the privilege to access the genetic diversity of germplasm of different crops which they used as basic material for variety improvement, had, over mellenia been maintained, protected and perpetuated by farmers only. In the absence of that protection and perpetuation, the companies would not have had an access to germplasm diversity they are using as raw material for their enterprise, especially that germplasm which the farmers made suitably adapted to large scale cultivation itself. The farmers had consciously or unconsciously been "breeding" these germplasms, bringing them up to the present level.

To address plant breeders in respect of their own intellectual property rights which would indirectly infringe upon the above mentioned heritage and rights of farmers and farming communities, a ***Protection of Plant Varieties and Farmers' Rights Act (PPVFR Act)*** was enacted by India in 2001.

This regulation seeks to address the rights of plant breeders and farmers on an equal footing. It affirms the necessity of recognizing and protecting the rights of farmers with respect to the contribution they make in conserving, improving and making Plant Genetic Resources available for the development of new plant varieties.

The PPVFR Act also deems it equally necessary to protect Plant Breeders' Rights (PBRs) to stimulate investment for research and development, both in the public and private sector, for the development of new plant varieties. Under the Act, PBRs allow breeders to hold exclusive rights to produce, sell, market, distribute, import or export the propagating material of a registered variety. The PPVFR Act recognizes the multiple roles played by farmers in cultivating, conserving, developing and selecting varieties.

Accordingly, farmers' rights encompass the roles of farmers as users, conservers and breeders. Farmers are granted nine specific rights, which are briefly described below.

Right 1: Access to seed: Farmers shall be entitled to save, use, sow, re-sow, exchange, share or sell their farm produce, including seed of protected varieties, in the same manner as they were entitled to before the coming into force of the PPVFR Act. However, farmers shall not be entitled to sell branded seed of a variety protected under this Act.

Right 2: Benefit-sharing: All Indian legal entities who provide PGR to breeders for developing new varieties, including farmers, shall receive a fair share of the benefits from the commercial gains of the registered varieties. Out of all the national plant variety protection laws enacted since 2001, the PPVFR Act is the first that integrates a provision for access and benefit-sharing (ABS) along with PBRs. Legal accession of the genetic resource used in breeding is not addressed in the Act; this falls instead under the Biological Diversity Act, 2002. However, the PPVFR Act requires a breeder to make a sworn declaration on the geographical origin of the genetic resources used in the pedigree of the new variety, and how they were accessed.

Right 3: Compensation: Registered seed must be sold with full disclosure of their agronomic performance under recommended management conditions. When such seed is sold to farmers but fails to provide the expected performance under recommended management conditions, the farmer is eligible to claim compensation from the breeder through the office of the PPVFR Authority.

Right 4: Reasonable seed price: Farmers have the right to access seed of registered varieties at a reasonable price. When this condition is not met, the breeder's exclusive right over the variety is suspended under the provision concerning compulsory licensing, and the breeder is obligated to license the seed production, distribution and sales of the variety to a competent legal entity. Most of the laws for plant variety protection have provisions on compulsory licensing of protected varieties to ensure adequate seed supply to farmers, and several of them also use unfair pricing as grounds for compulsory licensing.

Right 5: Farmers' recognition and reward for contributing to conservation: Farmers who have been engaged in PGR conservation and crop improvement, and who have made substantial contributions in providing genetic resources for crop improvement, receive recognition and rewards from the national gene fund. The gene fund receives resources from the implementation of the Act, which in turn are complemented by contributions from national and international organizations. The expenditures of the fund are earmarked to support the conservation and sustainable use of PGR, and in this way it can be considered to be a national equivalent to the global benefit-sharing fund operating within the ITPGRFA, as described by Andersen (MODULE 6.2). Since 2007, the plant genome saviour award, associated with the national gene fund, has been rewarding farming communities and individual farmers for their contribution to in situ conservation on-farm and to the selection of PGR (Bala Ravi and Parida, 2007). 318 S.P. Bala Ravi

Right 6: Registration of farmers' varieties: The Indian PPVFR Act allows for the registration of existing farmers' varieties that fulfil requirements for distinctness, uniformity, stability and denomination, but does not include that of novelty. This right provides farmers with a one-off opportunity for a limited period of time, from the moment when a crop species is included in the crop portfolio under the PPVFR Act for registration. Once registered, these varieties are entitled to all PBRs.

Right 7: Prior authorization for the commercialization of essentially derived varieties: When farmers' varieties, whether extant or new, are used by a third party as source material for the development of an essentially derived variety, the farmers need to provide prior authorization for its commercialization. Such a process can allow farmers to negotiate the terms of authorization with the breeder, which may include royalties, one-off payments, benefit-sharing, etc.

Right 8: Exemption from registration fees for farmers: Under the PPVFR Act, farmers have the privilege of being completely exempt from paying any kind of fees or other payments that are normally payable for variety registration; tests for distinctness, uniformity and stability (DUS), and other services rendered by the PPVFR Authority; as well as for legal proceedings related to infringement or other causes.

Right 9: Farmer protection from accidental infringement If a farmer can somehow prove before court that he or she was not aware of the existence of any rights at the time of an infringement on any such rights, as detailed in the PPVFR Act, he or she will not be charged. This provision is made in consideration of the centuries-old unrestrained rights that the farmers had over the seed of all varieties, the novel nature of the PPVFR Act and the low legal literacy of farmers

Notes