Technical Bulletin: ICAR-CSSRI/Karnal/2015/03

Intellectual Property Management and Commercialization of ICAR-CSSRI Technologies for Management of Salt-Affected and Waterlogged Soils of India

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ICAR

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Contents

Introduction

ICAR-Central Soil Salinity Research Institute (CSSRI) is the premier research organization dedicated to pursuing interdisciplinary research on salinity management and use of poor quality irrigation water in different agro-ecological zones of the country. Since its establishment in 1969, the success of ICAR-CSSRI is evident from the rapid spread of reclamation technologies which helped in wide spread adoption of alkali soil reclamation package. It is estimated that about 2.0 million ha of salt-affected area has been reclaimed by adoption of technologies developed by ICAR-CSSRI. This area alone is contributing nearly 16 million tonnes of paddy and wheat annually besides generating on-farm and off-farm jobs for more than 210 million person-days during the last three decades. Over the years, the Institute has grown into an internationally recognized esteemed centre of excellence in salinity research.

Vision

Productive utilization of salt affected soils and poor quality water resources in varying agro-ecological situations.

Mission

Generating new knowledge and understanding of the processes of reclamation and developing technologies for improving and sustaining productivity of salty land and waters.

Mandate

The mandate of the Institute, as approved by the ICAR, is as follows:

- To undertake basic and applied research for generating appropriate agrochemical/biological/ hydraulic technologies for reclamation and management of salt affected soils and use of poor quality irrigation waters and related environmental issues for sustainable production in different agroecological zones.
- To evolve, evaluate and recommend strategies that promote adoption of preventive/ameliorative technology.

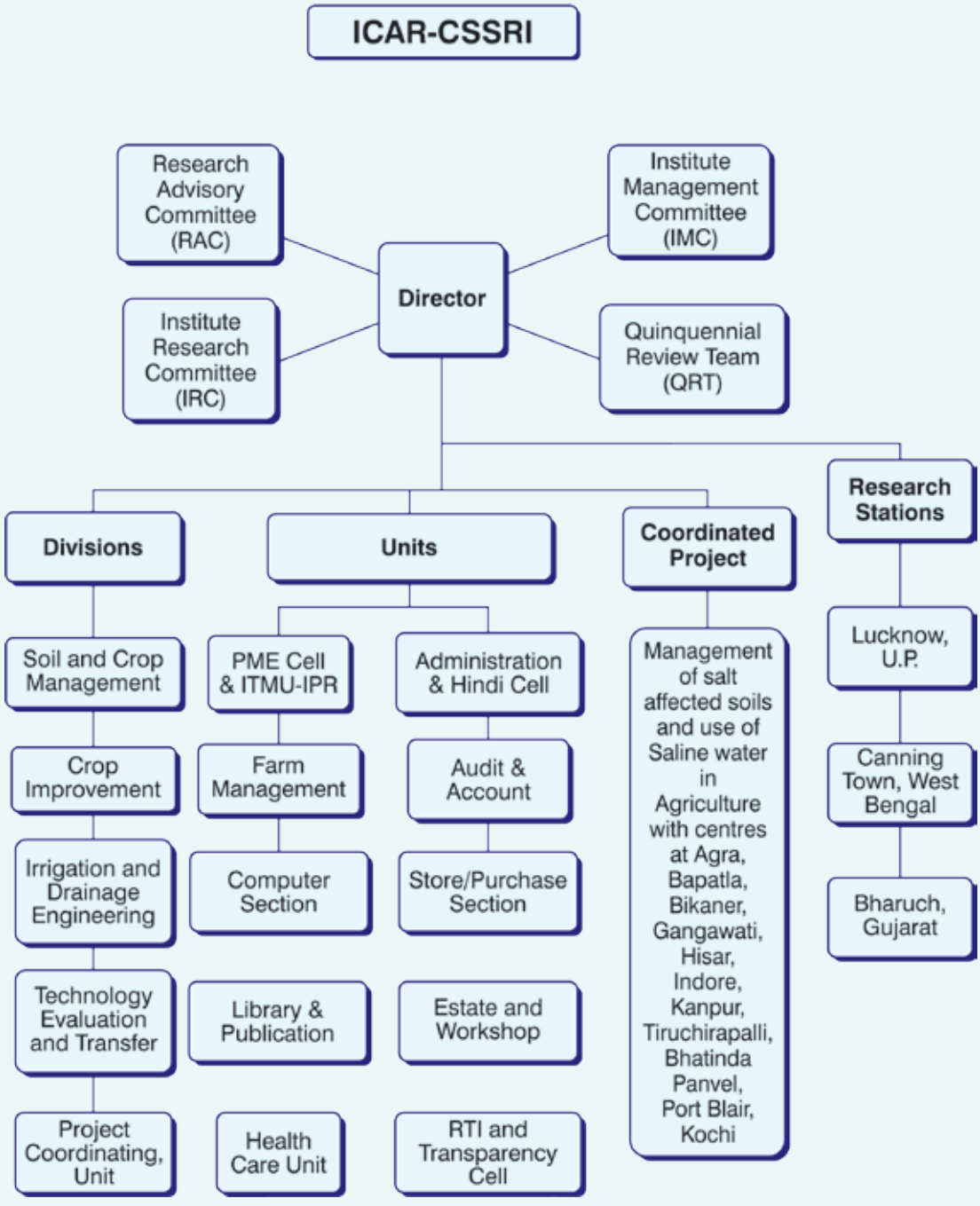
- To be a nucleus of research on salinity management and coordinate/ support the network of research with universities, institutions and agencies in the country for generating and testing location specific technologies.
- To act as a centre for training in salinity researches in the country and region and provide consultancy.
- To act as repository of information on resource inventories and management of salt affected soils and waters.
- To collaborate with relevant national and international agencies in achieving the above goals.

Key Areas

To realize the vision and mission of ICAR-CSSRI, the institute will concentrate on the following key areas with strength drawn from the past researches and extension experiences and providing due consideration to the emerging challenges that are being faced by present day agriculture.

- Resource inventories on waterlogged, salt-affected soils and poor quality waters for land use planning.
- On water quality issues including recycling of sewage and industrial effluents for agriculture.
- Diversification strategies in salt-affected arid lands underlain with poor quality ground water resource.
- Sustaining productivity in post-reclamation phase in relation to soil and water quality vis-à-vis organic matter dynamics and carbon sequestration.
- Breeding for abiotic stresses including soils and waters contaminated with heavy metals.
- Alternate management strategies for waterlogged saline lands, which may include drainage, aquaculture and bio-drainage.
- Multiple use of poor quality water for multi-enterprise agriculture to increase water productivity and farmers' income.
- Bio-saline agro forestry for fuel wood, forage and energy production.

- Groundwater recharge as related to groundwater quality and its management.
- Strategies to ensure double cropping in coastal saline soils.
- Reclamation and management of salt-affected Vertisols.
- Reclamation and management of alkali soils of central and eastern Gangetic plains.
- Technology transfer, impact assessment and human resource development in the emerging areas.
- Impact of climate change on soil reclamation and crop yield.
- Development of suitable varieties with high yield potential and quality fruits having resistance to biotic and abiotic stresses.
- Undertaking basic, strategic and applied research for developing production and post harvest technologies.
- Providing consultancy on soil and crop management.


ICAR-CSSRI
Research Advisory Committee (RAC)
Institute Research Committee (IRC)
Director
Institute Management Committee (IMC)
Quinquennial Review Team (QRT)
Divisions
Units
Coordinated Project
Research Stations
Soil and Crop Management
Crop Improvement
Irrigation and Drainage Engineering
Technology Evaluation and Transfer
Project Coordinating, Unit
PME Cell & ITMU-IPR
Farm Management
Computer Section
Library & Publication
Health Care Unit
Administration & Hindi Cell
Audit & Account
Store/Purchase Section
Estate and Workshop
RTI and Transparency Cell
Management of salt affected soils and use of Saline water in Agriculture with centres at Agra, Bapatla, Bikaner, Gangawati, Hisar, Indore, Kanpur, Tiruchirapalli, Bhatinda Panvel, Port Blair, Kochi
Lucknow, U.P.
Canning Town, West Bengal
Bharuch, Gujarat

1. Intellectual Property Management

The intellectual property right (IPR) regime provides rights to the innovators/ inventors for their novel technology and also facilitates to transfer of IPR enabled technologies for commercialization through commercial, cooperative and public routes. The ICAR guidelines for Intellectual Property Management and Technology Transfer/Commercialization came into effect from October 2, 2006. For this purpose Institute Technology Management Committee (ITMC) has been constituted and ICAR-CSSRI has also established an Institute Technology Management Unit (ITMU) for IPR management.

Importance of IP Management

- In-built incentive for scientists/innovators engaged in knowledge creation/ generation.
- Greater professional recognition.
- Sharing of monetary incentives among staff.
- Faster technological progress will take place.
- It ensures material reward for intellectual property.
- Protection of public sector research.
- It ensures availability of the genuine and original products.
- Improvement in rate of adoption of technology Protection for plant varieties may be availed by a *sui generis* system.
- The provision for Plant Variety Protection (PVP) has been made under the TRIPs Article 27.3(b).
- Commercialization of IPR enables technologies through public-private partnership (PPP).

ITMU has been constituted as per the guidelines of ICAR for management of its IP/deemed IP and transfer/commercialization of technologies for pursuing IP protection, maintenance and transfer/commercialization related matters at institute level. The ITMU reports to the Council through the Zonal Technology Management Unit.

ITMC has also been constituted, as per the ICAR guidelines and chaired by the Director, for Intellectual Property Management and Technology Transfer/ Commercialization that will take appropriate decisions pertaining to Intellectual Property (IP) of the institute. The ITMU acts as a secretariat for the institute's ITMC.

1.1 Intellectual Property Rights

The actual global recognition to the Intellectual Property Rights (IPR) in agriculture came into existence when several countries including India became signatory to World Trade Organization (WTO) and International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) in the recent past. The Indian Council of Agricultural Research (ICAR) has taken several steps towards developing and strengthening the decentralized three-tier IP (intellectual property) management system since the implementation of ICAR Guidelines for Intellectual Property Management and Technology Transfer/ Commercialization' with effect from 2 October 2006. In fact, IPR are legal rights to inventor(s). They provide legal restrictions for use of new developments without the permission of the holder(s) of the rights of the invention(s). IPR also provide avenues for royalties or other fees to the inventor(s) for the use of the invention/technology. There are two broad categories of IPR: first, industrial property covering IPRs such as patents, trademarks, geographical indications and industrial design; second, copyright and related rights covering artistic and literary works, performances, broadcasts and others (*Sui generis*) which include those covering lay-out designs of semiconductor chips, plant breeders' rights etc.

Intellectual property (IP) is a collective term used to describe new ideas, inventions, designs, writings, films etc. that are protected by patents, copyright, trademarks, industrial designs etc. The IP may be stolen if the appropriate steps are not taken to protect it. Under IP system, one (owner) can export just the IP itself, without an accompanying product i.e. license to a company or companies registered overseas, the right to manufacture or sell product. By this way one can earn additional profit while retaining ownership over the

inventions, innovative designs and trademarks. The present bulletin outlines some of the IPR issues for sensitization in agriculture and suggests some strategies to maximize production.

Intellectual Property rights (IPR), are rights granted to creators and owners of works that are results of human intellectual creativity. These works can be in the industrial, scientific, literary and artistic domains. The Importance of intellectual property in India is well established at all levels statutory, administrative and judicial. India ratified the agreement established by the World Trade Organization. Intellectual property rights became a concern in Indian agriculture when India joined the World Trade Organization (WTO) on 1 January 1995 and signed on to WTO's Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement. Historically, systems for the protection of intellectual property were applied principally to mechanical inventions of one kind or another, or to artistic creations. The assignment of IPRs to living things is of relatively recent origin in developed countries. Vegetatively propagated plants were first made patentable in the US only in 1930. And the protection of plant varieties (or plant breeder's rights -PBRs), a new form of intellectual property, only became widespread in the second half of the 20 Century. Thus systems for the protection of plants are derived from the economic structure and circumstances of agriculture that prevailed in developed countries in this period. That such systems came into being reflected the growing interest of private breeders in protecting their intellectual property. Farmers have traditionally replanted, exchanged or sold seed from the previous years' crop which means that breeders have difficulty in recouping the investments made in improved varieties through repeat sales. Patents or PBRs normally impose restrictions on farmers' ability to sell grown seed (and in some cases to reuse it) and thus enhance the market for the breeder's seed. Even in the developed countries, reuse of seeds remains quite common although for many crops annual purchase is now the rule. In developing countries the majority of farmers reuse, exchange or sell informally to neighbors, and annual purchase of new seed is relatively rare in most countries.

With the adoption of the TRIPS Agreement, developing countries have been obliged to adopt protection of plant varieties, by patents or by other means, without any serious consideration being given to whether such protection would be beneficial, both to producers and consumers, or its possible impact on food security. As with medicines, a crucial issue is whether and how intellectual property protection can help promote research and innovation relevant to the needs of developing countries and poor people. And we also need to ask how IP protection affects the cost and access of farmers to the seeds and other inputs they need.

Some Important Intellectual Property Rights (IPR) Acts

SN.	Type of Acts	Year of passing and amendments
1.	Copyright	The Copyright Act, 1957 (amended, 2000)
2.	Patents	The Patents Act, 1970 (amended, 2005)
3.	Trade Marks	The Trade Marks Act, 1999
4.	Designs	The Designs Act, 2000
5.	Geographical Indication of goods	GI Act, 1999
6.	Protection of plant varieties & farmer's rights act	PPV & FR Act, 2001

i) Copyright

Copyright is a set of exclusive rights granted by the law of jurisdiction to the author or creator of an original work, including the right to copy, distribute and adapt work. They are protected irrespective of their quality and they include purely technical guides and engineering drawings. The copyright laws protect only the form of expression of ideas and not the ideas themselves. The total term of protection for literary work is the author's life plus sixty years. For cinematographic films, records, photographs, posthumous publications, anonymous publication, works of government and international agencies the term is 60 years however for broadcasting, the term is 25 years.

The proforma for copyright protection is available on the website, www.copyright.gov.in, which can be used for filling copyright.

ii) Patent

A patent is an exclusive right granted by a country to the owner of an invention to make, use, manufacture and market the invention, provided the invention satisfies certain conditions stipulated in the law. Exclusive right implies that no one else can make, use, manufacture or market the invention without the consent of the patent holder. The first Indian patent laws were promulgated in 1856. These were modified from time to time. New patent laws were made after the independence in the form of the Indian Patent Act 1970. The Act has now been radically amended to become fully compliant with the provisions of TRIPS. The most recent amendments were made in 2005 which were preceded by the amendments in 2000 and 2003. While the process of bringing out amendments was going on, India became a member of the Paris Convention, Patent Cooperation Treaty and Budapest Treaty. The salient and important features of the amended Act are explained here. Management of Intellectual Property Rights from making, using, offering for sale, selling or importing the patented invention without permission, and sue anyone who exploits the patented invention without his or her permission. The patent can be obtained by filing an application to the regional or national Patent Office along with the description of the invention and its comparison with the existing one (Patent forms can be downloaded from website). The term of every patent is 20 years from the date of filing of patent application, irrespective of whether it is filled with provisional or complete specification. Date of patent is the date on which the application for patent is filed in respect of patent applications filed, following aspects will have to be kept in mind:

Claim or claims can now relate to single invention or group of inventions linked so as to form a single inventive concept.

Applicant has to request for examination 12 months within publication or 48 months from date of application, whichever is later.

A provisional specification is usually filed to establish priority of the invention in case the disclosed invention is only at a conceptual stage and a delay is expected in submitting full and specific description of the invention. Although, a patent application accompanied with provisional specification does not confer any legal patent rights to the applicants, it is, however, a very important document to establish the earliest ownership of an invention. The provisional specification is a permanent and independent scientific cum legal document and no amendment is allowed in this. In fact, no patent is granted on the basis of a provisional specification. Subsequently, a complete specification for obtaining a patent for the said invention is must. It is not necessary to file an application with provisional specification before the complete specification. In provisional specification, of the invention, written description, drawings (if necessary) and sample or model (if required) are provided for processing www.ipindia.nic.in.

Provisional specifications

A provisional specification is usually filed to establish priority of the invention in case the disclosed invention is only at a conceptual stage and a delay is expected in submitting full and specific description of the invention. Although, a patent application accompanied with provisional specification does not confer any legal patent rights to the applicants, it is, however, a very important document to establish the earliest ownership of an invention. The provisional specification is a permanent and independent scientific cum legal document and no amendment is allowed in this. In fact, no patent is granted on the basis of a provisional specification. Subsequently, a complete specification for obtaining a patent for the said invention is must. It is not necessary to file an application with provisional specification before the complete specification. In provisional specification, of the invention, written description, drawings (if necessary) and sample or model (if required) are provided for processing.

Complete specification

It may be noted that a patent document is a techno-legal document and it has to be finalized in consultation with an attorney. In case of Patent Co-operation Treaty (PCT) or convention application, applicant can file only the complete

specification. A complete specification has to be filed within 12 months extendable to 15 months from the date of filing of the provisional specification. The complete specification should contain title of the invention, abstract, written description, drawings (where necessary), sample or Model (if required by the examiner), enablement and Best Mode and claims.

Types of patent applications

a) Ordinary application

b) Application for patent of addition (granted for improvement or modification of the already patented invention, for an unexpired term of the main patent).

c) Divisional application (in case of plurality of inventions disclosed in the main application).

d) Convention application, claiming priority date on the basis of filing in convention countries.

e) National phase application under PCT.

Importance of patenting

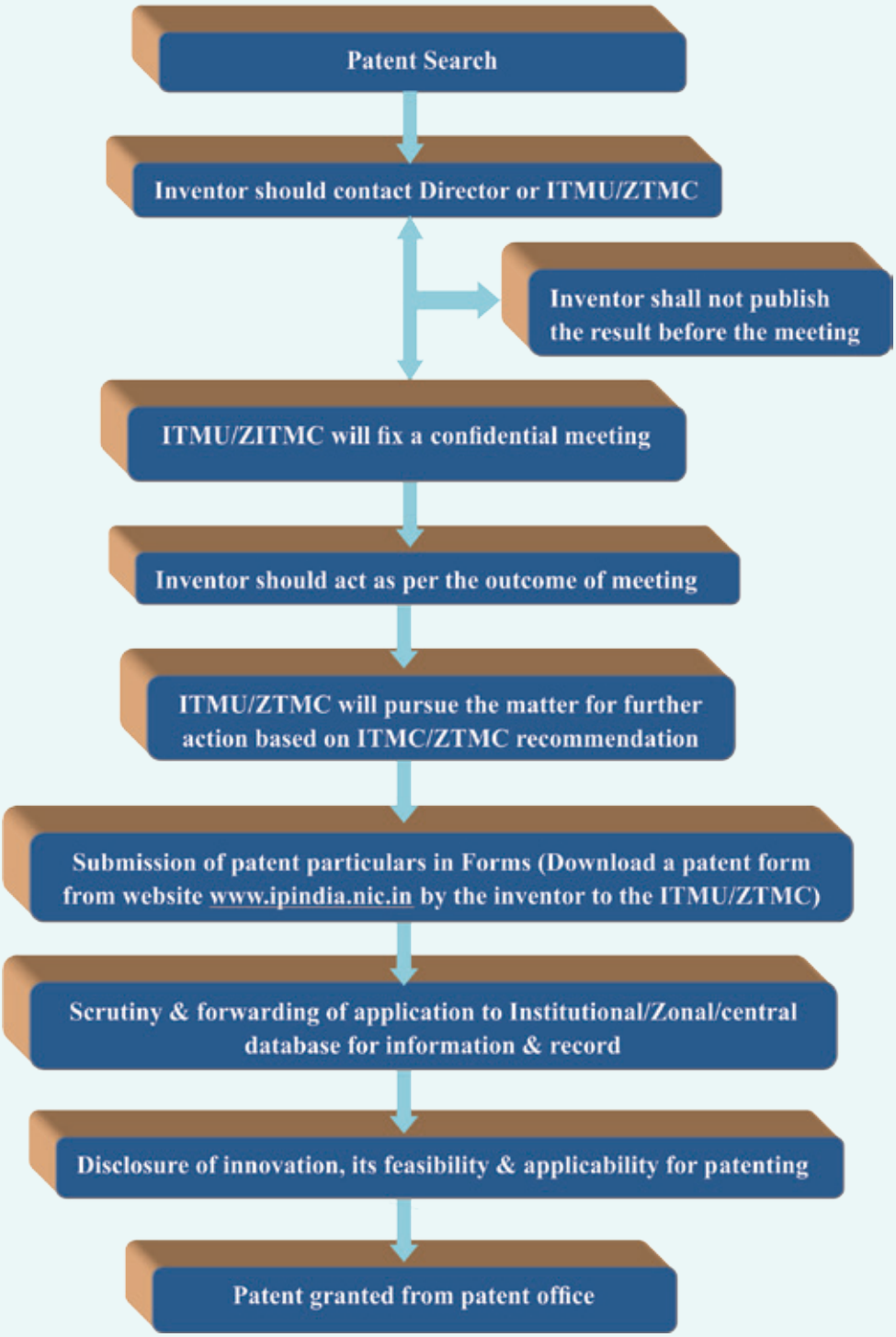
- If the invention has market potential and one thinks that another company could make profits from that invention, it needs protection as a patent.
- A patent gives the right to exclude others from making the same product.
- The patent holder has time to market the invention exclusively without competition on higher prices.
- It gives the right for legal action against the person making or selling the product without permission from the patent holder.
- One can make money from the invention by licensing or selling to someone else.
- It promotes inventiveness by ensuring adequate returns to the investment made.
- Avoids duplication of research.
- Helps improving existing technology to produce cheaper and better.
- Keeps abreast with latest development in technology.

Patentable IP

Research results in any field of technology, processes or products which are new, inventive and useful are patentable under the patent act.

- Micro-organism based formulations (Bio-control agents, bio fertilizers etc).
- Genetically engineered microorganism (Bio-degraders, bio-stimulants, bio protectants) and processes related to their applications.
- Plant based agrochemicals, their purification & testing processes & formulations.
- Diagnostic kits.
- Agricultural machinery, implements and laboratory equipments.
- High value compound from living body.
- New genes from living body, gene primers, etc.
- Information systems & softwares etc.
- Processes leading to development of Genetically Modified Organisms (GMO).
- Recombinant DNA, plasmids and processes of manufacturing thereof are patentable.
- Processes relating to microorganisms or producing chemical substances etc.

Preparatory work for patenting



Patent Offices and their Territorial Jurisdiction in India

There are four patent offices located in different metropolitan cities in India.

Patent office	Territorial Jurisdiction
Mumbai	Maharashtra, Gujarat, Madhya Pradesh, Goa, Chhattisgarh, Daman & Diu, and Dadar & Nagar Haveli
Chennai	Andhra Pradesh, Kerala, Tamil Nadu, Karnataka, Puducherry and Lakshadweep
New Delhi*	Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Rajasthan, Uttar Pradesh, Uttarakhand, Chandigarh and Delhi.
Kolkata	Rest of India

*Address of the Patent Office at New Delhi

Patent Office

Intellectual Property Office Building,

Plot No. 32, Sector 14, Dwarka,

New Delhi-110075

Phone: 011-28034304-05

Fax: 011-28034315

E-mail: delhi-patent@nic.in

Website Addresses:

Some of the important website addresses related to IPR mentioned below can be visited for detailed information.

The ICAR guidelines for Intellectual Property Management and Technology Transfer/ Commercialization is available on Manual of patent practice and procedure 2005, is available on *http://www.icar.org.in; http://www.ipindia.nic.in*

The information for protection of new plant variety is available on *http://www.upov.int; http://plantauthority.gov.in*.

The Website addresses for patent search are as below:

www.wipo.org; *www.uspto.org*: *www.freshpatents.com*; *www.freepatentsonline.com*

iii) Trademark

A trademark is a distinctive sign which distinguishes the goods or services produced or provided by one enterprise from those of another. In general, any distinctive words, letters, numerals, drawings, colors, pictures, shapes, logotypes, labels or combinations of the above used to distinguish between the goods and services of different companies may be considered as a trademark. Thus the main advantages of trademarks are as follows:

A trademark enables a customer to distinguish the product of one manufacturer from the other. The trademark becomes an effective instrument for attract customers. Trademark acquires goodwill of customers by its proper use. A marketing tool and the basis for building a broad image and reputation. Provide an incentive to companies to invest in maintaining or improving the quality of their products. To provide better protection of trade mark for goods and services and also to prevent fraudulent use of the mark. Trade mark valid for 10 years thereafter renewal is required. e.g. Label 'PUSA' by IARI, New Delhi; 'KNOCK WP' (formulation) by DOR, Hyderabad; 'CIFAX' an antibiotic formulation for use in fisheries and aquaculture. One can protect one's trademark by registering it. Registration would prevent others from marketing identical or similar products under the same mark. One may license or franchise one's trademark to other companies. The protection period of trademark is unlimited (initially for ten years and renewal after every ten years). There are five trademark registry offices in Delhi, Mumbai, Kolkata, Chennai and Ahmadabad.

iv) Design

Industrial design generally refers to a product's overall form and function. According to IP law, however, an industrial design refers only to the aesthetic aspects or outward appearance of a product. Industrial design includes technical and medical instruments, watches, jewellery and other luxury items; from household products, toys, furniture and electrical appliances to cars and architectural structures; from textile designs to sports equipment. Industrial design is also applied to product packaging and containers. Industrial design

consists of the three dimensional features such as the shape of a product, the two-dimensional features such as ornamentation, patterns and lines or color, or combination of two or more of these. There are many reasons for business to protect their industrial designs as smart industrial designs are business assets and can increase the commercial value of the company. It plays big role in the successful marketing of a wide variety of products, helping to define the image of a company's brand. A protected design also provide additional source of revenue for its company through licensing out to others, for a fee, the right to use, or by selling the registered design right. The protection period of industrial design is 10 years (renewal after every 5 years). Industrial design generally refers to a product's overall form and function. According to IP law, however, an industrial design refers only to the aesthetic aspects or outward appearance of a product. Industrial design includes technical and medical instruments, watches, jewellery and other luxury items; from household products, toys, furniture and electrical appliances to cars and architectural structures; from textile designs to sports equipment. Industrial design is also applied to product packaging and containers. Industrial design consists of the three dimensional features such as the shape of a product, the two-dimensional features such as ornamentation, patterns and lines or color, or combination of two or more of these. There are many reasons for business to protect their industrial designs as smart industrial designs are business assets and can increase the commercial value of the company. It plays big role in the successful marketing of a wide variety of products, helping to define the image of a company's brand. A protected design also provide additional source of revenue for its company through licensing out to others, for a fee, the right to use, or by selling the registered design right. The protection period of Industrial design is 10 years (renewal after every 5 years).

v) Geographical Indication

A Geographical Indication (GI) is a sign used on goods that have a specific geographical origin and possess qualities or a reputation that are due to that place of origin. The agricultural, natural and manufactured goods are covered under GIs in India. Champagne, Tequila, Darjeeling, Roquefort, Pilsen,

Porto, Sheffield and Havana are some examples of well- known names that are associated throughout the world with products of a certain nature and quality and specific origin. Geographical indications, as a distinct form of IP are not related to ownership/usership interest to ICAR but can be of broader relevance. Likewise trade mark, GI is a form of IPR used in product marketing, represented in words, figures, graphics, diagrammatic presentations or any specific combination of these indications, but it essentially governs a collective rather than individual right that represents a specific link between goods (whether agricultural, natural or manufactured goods) and place of their production. Registration of geographical indications prevents unauthorized use of G by others, promotes economic prosperity of the producers and enables seeking legal protection in other WTO member countries. The protection period of geographical indication is unlimited (renewal after every ten years). The proforma for registration of GI is available on *www.gir-ipo@nic.in.*

vi) Protection of Plant Varieties and Farmers Rights

After establishment of Protection of Plant Varieties and Farmers Rights Authority at New Delhi, new plant varieties can be protected under Protection of Plant Variety and Farmers Rights (PPV & FR) Act, 2001. However, plant varieties cannot be protected through patents. In this act there are also provisions for benefit sharing with farmers, penalty for marketing spurious propagation material and protecting extant varieties. All extant varieties of ICAR, which have not completed 15 years from the date of notification under the Seed Act, 1966 have to be protected under the PPV & FR Act as a priority activity in a time-bound manner. This in turn will enable a more rapid and effective transfer of plant varieties to end users. There are 5 main criteria to arrive at a decision, whether a plant variety is really new or not. These are distinctiveness, uniformity, stability, novelty and denomination. The variety shall be deemed to be distinct if it is clearly distinct from any other variety whose existence is a matter of common knowledge at the time of filing of the application. The variety shall be deemed to be uniform if, subject to the variation that may be accepted from the particular features of its propagation, it should be sufficiently uniform in its relevant characteristics. The variety shall

be deemed to be stable if its relevant characteristics remain unchanged after repeated propagation or, in the case of a particular cycle of propagation at the end of each such cycle. The variety shall be deemed to be new if, at the date of filing of the (PPV & FR) application for breeder's right, propagating or harvesting material of the variety has not been sold or otherwise disposed of to others, by or with the consent of the breeder for the purpose of exploitation of the variety. The variety shall be designated by a denomination, which will be its generic designation. In 2001, in line with the TRIPS guidelines, the government passed the Protection of Plant Varieties and Farmers' Rights Act (PPV&FR Act) with the objectives.

1. To provide an effective system for protection of plant varieties (new/ extants)
2. To protect the rights of farmers and plant breeders
3. To encourage the development of new varieties of plants
4. To stimulate R&D investment and seed industry growth
5. To ensure the availability of high-quality seeds and planting materials to farmers and other agencies.
6. To ensure benefit sharing to farmers.
7. To strengthen seed industry by facilitating research and development.

Registration and protection of extant varieties: ICAR-National Bureau of Plant Genetic Resource takes an action for registration of all varieties developed in different institutes of ICAR.

Registration and protection of new varieties/hybrids/essentially derived varieties (EDV):

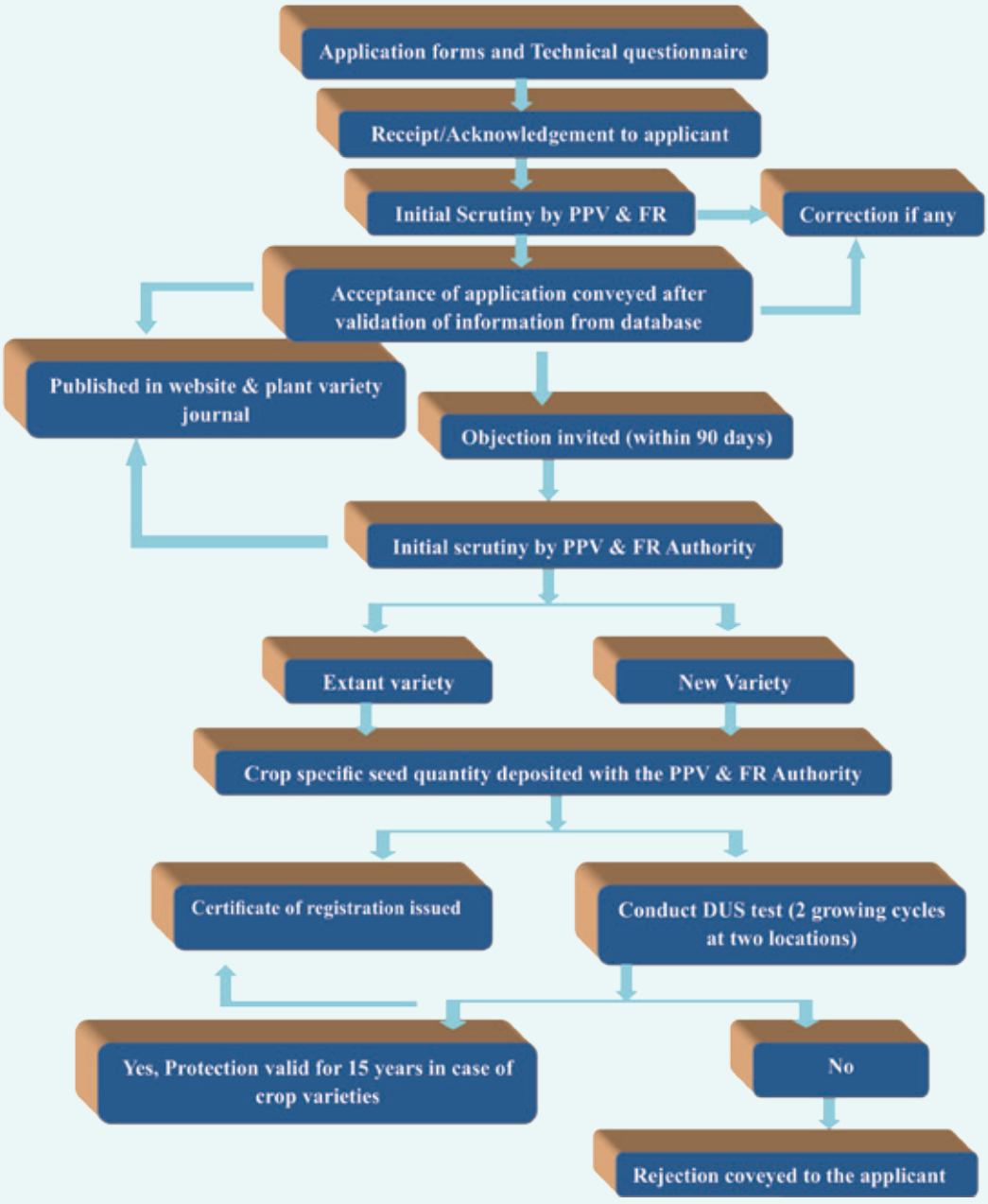
The PI/plant breeder has to inform the respective ITMU/ZITMC after DUS testing as per requirement of PPV&FR Authority.

- The salient DUS particulars of the material developed along with names of most similar varieties need to be provided by PI/Breeder.
- In case of vegetatively propagated crops, the above information has to be provided when the crop is standing in the field.

Follow up action by Institution

- ITMU and ZTMC's will prepare crop wise list of prospective varieties proposed by PI's/breeders and prepare schedule of assessment of these materials in the next crop season involving ITMC&ZITMC and other specialist from within or outside the Institution.
- ITMC/ZITMC will make necessary recommendations for follow up.
- ITMC/ZITMC will also process the case with the conformity of PVP law.
- Performance limit of varieties shall be provided by the breeder after testing under different environments. Maintenance of protected plant varieties - concerned Institute will be responsible for maintenance of varietal purity & ensure the availability to farmers or commercial use.
- Maintenance of title of protection, ITMU/ZTMC's will maintain the PVP titles secured by payment of required fees to the registrar PPV&FRA. Dispute, prevention & settlement ITMU & ZTMC will address the matter to avoid / settle any dispute.

Registration procedure for protection of plant variety under PPV & FR Act



1.2 Commercialization of IP enabled technologies/plant varieties

Technology commercialization deals with technologies developed by public funded research institutions and then transfered and commercialized by the private sector, while the technology commercialization of private sector is aimed at maximizing profit through the commercialization of innovative technology. The ATMC and ZTMCs/ITMUs make efforts with the primary objective of IP enabled technology transfer through commercialization to end users/farmers. Depending upon nature of technology, public need or marketing prospects, scale of technology etc., the competent authority decides whether the technology will be placed in the public domain through open access, or it will be transferred to end users through commercialization. The IP enabled technologies are transferred for commercial purposes with suitable understanding/agreement or contracts with the concerned parties. The ICAR institutions determine the licence and royalty fee and/or sale price of its IPR enabled technologies either on a fixed basis, through negotiations with the licensee, or through an open bidding process as appropriate.

For commercialization of plant varieties, based on national priorities and issues of food and nutritional security, ICAR may decide to place a plant variety solely in the public domain or else it may be licensed for commercial use on exclusive or non exclusive basis. However, registration and protection of all protectable varieties will be ensured under the PPV&FR Act before placing them in public or commercial domain. All the registered varieties will be transferred for cultivation and use through open access or commercialization. No plant variety will be transferred/commercialized before its registration and protection under the PPV&FR Act and as per new ICAR Guidelines for Intellectual Property Management and Technology Transfer/Commercialization (2006).

ICAR-CSSRI's salt tolerant varieties under PPVFRA

IPRs	Application/ Registration No.	Name of Variety	Date of Filing/ Registration
Plant Varieties of Rice	Application No.: E3 OS3 083 Registration No.: 60/2012	CSR-27	Date of Filing : 01/01/2008 Date of Registration : 02/07/2012
	Application No.: E48 OS6707370 Registration No.: 41/2013	CSR-13	Date of Filing : 06/12/2007 Date of Registration : 06/03/2013
	Application No.: E5OS5085 Registration No.:190/2013	CSR-23	Date of Filing: 01/01/2008 Date of Registration: 11/10/2013
	Application No.: REG/2014/335 Registration No.: 68/2015	CSR-30	Date of Filing: 10/02/2014 Date of Registration: 09/02/2015
	Application No.: REG/2014/336 Registration No.: 67/2015	CSR-36	Date of Filing: 10/02/2014 Date of Registration: 09/02/2015
	Application No.: D.L. 33004/99	CSR-43	Date of Filing: 25/01/2014
Plant Varieties of Mustard	Application No.: E15 BJ1612642 Registration No.: 245/2013	CS-56	Year of filing: 2012 Date of Registration: 20/11/2013
	Application No.: REG/2012/641 Registration No.: 203/2014	CS-54	Date of Filing: 19/11/2012 Date of registration: 26/05/2014
Plant Varieties of Wheat	Application No.: E32 TA35 07 277 Registration No.: 94/2009	KRL-19	Year of Filing: 2007 Date of registration: 20/07/2009
	Application No.: N1 TA1 11 84 Registration No.: 654/2014	KRL-213	Year of Filing: 2011 Date of registration: 15/10/2014
	Application No.: N2 TA2 11 85 Registration No.: 816 of 2014	KRL-210	Year of Filing: 2011 Date of registration: 23/12/2014

2. Technologies for Reclamation and Management of Salt-affected and Waterlogged Soils

2.1 Gypsum technology for reclamation of sodic soil

- Land leveling and bunding for rainwater storage and uniform distribution of irrigation water.
- Soil sampling for determination of gypsum requirement.
- Uniform application of gypsum (10 to 15 tonnes per hectare) followed by mixing of surface (10 cm) soil.
- Ponding water for minimum of one week before transplanting of rice.
- Adopting proper agronomic practices.

Impact:

The reclaimed area contributes 14-15 million tonnes of food grains to the National pool. The cost of intervention and output per unit area is about Rs 42,500 per ha**.** Farmers obtained 4 tonnes/hectare rice and 2 tonnes/hectare wheat yield from reclaimed alkali land right from the first year of the reclamation, which increased to 5 and 3 tonnes/hectare during 3rd year onwards, respectively with 135 man-days of employment generated per hectare per year. Its Net Present Worth (NPW) estimated to be Rs. 52,000/ha, Benefit Cost Ratio (BCR) of 1.43 and Internal Rate of Return (IRR) of 25% of the technology.

The technology improved soil health, increased resource use efficiency, raised farm income, reduced poverty, minimized inequity, reduced flood hazards and water logging, recharge groundwater and improve quality of overall environment.

2.2 Gypsum bed technology for poor quality water management

- About 25% of the groundwater resources used for irrigation in India are either saline or brackish or both. In states like Rajasthan and Haryana, 84% and 62%, respectively of the groundwater are of poor quality.
- Irrigation water standards used in the past have been too conservative for the monsoonal climate of the country.
- The institute has developed new techniques for sustainable use of poor quality waters for agriculture. ICAR-CSSRI has prepared and published water quality map of the country.

Impact:

The poor quality water management technology provides sustainability and high yields compared to *rainfed* agriculture, helps to control water logging and soil salinization. Number of amendments and bye-products such as gypsum, pyrites, distillery spent wash and press mud identified. Gypsum bed technology for location specific situations has been developed.

The adoption of new crop and water management strategies will go a long way in augmenting dwindling usable water supplies for agriculture. Thereby, the challenge to the irrigation sector to produce more food by converting more of diverted water into food would possibly be met.

2.3 Auger hole technology for alternate land use system

An auger hole technology for raising forest and fruit tree plantation in salt-affected soils with sub-surface hardpan has been developed and standardized. By adopting this technology, state forest departments have successfully raised tree plantations on salt-affected village community lands, Govt. lands, adjoining roads, railway lines and canals etc. Pit cum auger hole technology is developed to raise fruit trees like aonla (*Emblica officinalis*), karaunda (*Carissa Carandus*) and guava (*Psydium guajava*) in soils having pH_2 10.00 and above, where nothing is possible to grow.

This technology has been adopted by the farmers and the forest department for remediation of salt affected soils. Presently the technology is deployed on about 15000 ha land and successfully used for reclamation or bio-amelioration of salt affected soils. Reclaimed soils are put to cultivation during the last two decades. These lands are being utilized for cultivation of traditional crops and cropping systems including horticultural fruit crops.

Impact:

After one rotation of trees and grasses, the soils get reclaimed to such an extent that the Panchayats have started giving these lands on rent to generate regular income for the overall development of the village. Different agro-forestry models have also been developed, which have shown a B: C ratio of 1.6. Silvi-pastoral model for bio-reclamation of sodic soil (pH_2 > 10) has been developed for production of fuel wood, fodder, pods and honey besides reducing runoff volume, increasing infiltration, reducing soil alkalinity and improving soil fertility.

2.4 Bio-drainage technology

Bio-drainage removes excess soil-water through transpiration by trees. It is an option to prevent the development of waterlogged and saline soils especially in areas having no possibility of disposing saline drainage effluent. There are large areas with water stagnation due to seepage from higher elevation, surface disposal of urban and industrial effluents and floods during rains where conventional system of dewatering through pumping and surface drainage is not possible. Bio-drainage lowers the water table and minimizes salt accumulation in the root zone.

Technology helped in reclamation of salt affected waterlogged areas. In canal command areas, the technology showed its potential in almost all the states of the country. Technology rapidly draw-down the water-table in affected areas. Benefits accrued by increased cropping intensity from 0% to 300%, increased nutrient use efficiency, growing arable crops including pulses and oilseed, which otherwise is not possible on waterlogged soils and increased employment generation.

Impact:

It is an eco-friendly low cost technology, which can easily be adopted by the farmers because it does not require skilled labour. It generates revenue for farmers from the sale of wood besides promoting the area under forests. The technology does not have the problem of disposal of drainage effluent. It can be adopted along with the conventional subsurface drainage to reduce the drainage effluents.

2.5 Sub surface drainage technology

Sub surface drainage (SSD) is an effective technology for amelioration of waterlogged saline irrigated lands in India. The system consists of perforated corrugated PVC pipes, covered with synthetic filter, installed mechanically at a design spacing and depth below soil surface to control watertable depth and drain excess water and salts out of area by gravity or pumping from an open well called sump. The depth and spacing of drainage system are governed by rainfall, irrigation, hydro-geology, texture and salinity of soil and outfall conditions in the affected area. The technology developed by ICAR-CSSRI during 1980s initially for Haryana has been widely adopted and replicated in Rajasthan, Gujarat, Punjab, Andhra Pradesh, Maharashtra and Karnataka.

During the last two decades, SSD has been implemented in 10,000 ha waterlogged saline area by Department of Agriculture in Haryana where annual loss due to waterlogging and soil salinity has been estimated at more than Rs. 200 crores. About 40,000 ha waterlogged saline soils have been reclaimed in different states of India through subsurface drainage technology. The cost of intervention and output per unit area is Rs. 60000/ ha in alluvial soils of North West India & Rs. 75000/ ha for heavy textured soils of Maharashtra and Karnataka.

Impact:

Due to notable increase in crop yields, the technology results in 3 fold increase in farmers' income. The technology also generates around 128 man-days additional employment per ha per annum.

Subsurface drainage has resulted in 25- 100 % improvement in cropping intensity and significant enhancement in crop yields (upto 45 % in paddy, 111 % in wheat and 215 % in cotton) in different parts of India.



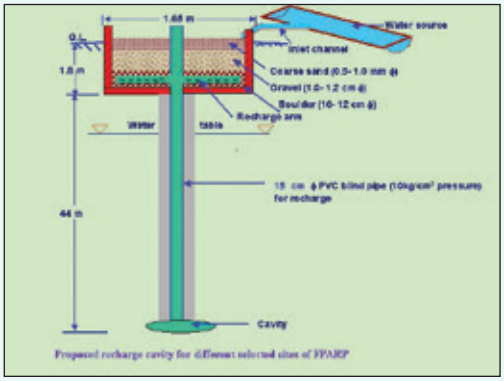
2.6 Farmer based recharge structure

Individual farmer based groundwater recharge structures have been developed and implemented at 52 sites in farmers' fields in Haryana, Punjab, Uttar Pradesh and Gujarat during 2008- 2011. The structures involve passing of excess rain and canal water under gravity through a bore well to subsurface sandy zones coupled to a recharge filter consisting of layers of coarse sand, small gravel and boulders in a small brick masonry chamber. The recharge structures can be installed at any low lying location prone to surface water flooding. Being individual farmer oriented and of small size, these structures have relatively better chances of success due to ease of cleaning the clogged recharge filters by farmers themselves. Based on the quality and impact of this work, ICAR-CSSRI was bestowed with Groundwater Augmentation Award of MoWR (GoI) during 2011.

The estimated cost of 30-45 m deep recharge structures in Haryana and Punjab at 2008 prices is ₹ 30000- 50000. The current cost of a 50 m deep structure at Rs. 1.2 lakh is considerably higher due to steep rise in the cost of coarse sand and gravel. The capital investment cost has been worked out @ ₹ 3.5 to Rs. 2.1 / m^3 recharge water for locations collecting runoff from 12- 20 ha area.

Impact:

Based on the analysis of reduced damage to basmati rice due to recharge of submerged water, the payback period of the recharge structures in Haryana and Punjab has been estimated as 1-2 years. The prolonged availability and improvement in groundwater quality in recharge wells of Gujarat increased farmers' income by ₹ 30000- 75000/ha in mango, papaya and banana plantations.



Proposed recharge cavity for different selected sites of FPARP

2.7 Multi-enterprise agriculture model for reclaimed alkali soils

A multi-enterprise model evaluated for sustaining livelihood on reclaimed saline soils in small and marginal land. It is developed for reclaimed sodic land for crop diversification and to increase resource use efficiency of water, nutrients and energy besides providing regular income, employment and livelihood to farmers owning small farm holdings. For sustaining livelihood on reclaimed saline soils in small and marginal land holdings, a multi-enterprise model is being evaluated on 5 ha area.

The model provides net annual income of Rs. 2.65 lakh, out of which half of the net income comes from crop components and remaining half from the subsidiary components. If scaled on daily basis, the model provides a total gross income of Rs. 400-700 and net income of Rs. 250-500 can be generated from about 1.0 hectare land area when fisheries, dairy, horticulture, poultry, duckery and mushroom cultivation are integrated and byproducts of these enterprises are recycled within the system. Cultivation of vegetables on the dykes of the fish pond yielded about Rs. 100-400/week throughout the year. The model revealed that animal dung from the dairy component can be used as feed for fish, to generate biogas and electricity and to make compost to practice organic agriculture. Biogas produced (2 m^3 per day) in the Model is adequate enough to full fill energy requirements of Farmer's family. The synergy-based integration of multiple components is energy efficient, as the model conserves about 11% energy due to net reduction in input energy as compared to conventional rice-wheat system. The model is closely integrated with domestic activities, so the labour requirement is minimum. Recycling of resources in the farm help restore soil health and quality.

Impact:

It helps to improve the economic conditions of resource poor farmers and provide better opportunities for employment at farm level by producing food, feed, fodder, fibre, fuel, etc. and facilitates to increase productivity and profitability through integrated use of water, nutrient, and energy in small farms.

2.8 Bio growth enhancer (CSR-BIO)

It is a low cost multiplication technology of salt tolerant bio-growth enhancers (CSR-BIO) for increasing productivity of agri-horti crops in normal and sodic soils. The technology is developed to produce microbial consortia of beneficial microbes which have universal applicability, higher shelf-life and lower cost of production. The consortium of microbes enhances the growth, productivity, nutrient mobilization and support the establishment of plantlets. Due to its growth enhancing traits serves as a promoter of growth for crops grown in sodic soils as well as normal soils. The low cost, bio-degradable dynamic media support the growth by increasing the photosynthetic and bio-chemical activity of the leaves.

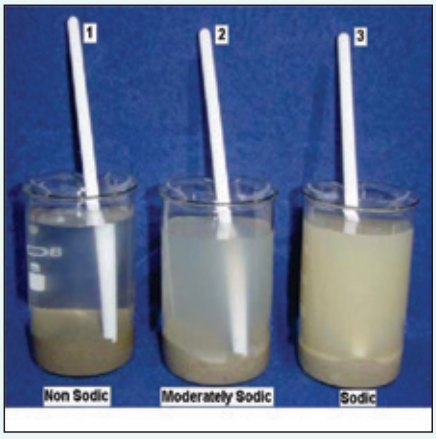
It is eco-friendly cost effective and highly economical. The formulation has multiple role in the ingredients of growth medium is widely available. The live count in liquid medium is constant for over 3 months. It takes care of most of the problems concerned with crop growth and development also imparts immunity and protection to plants against diseases.

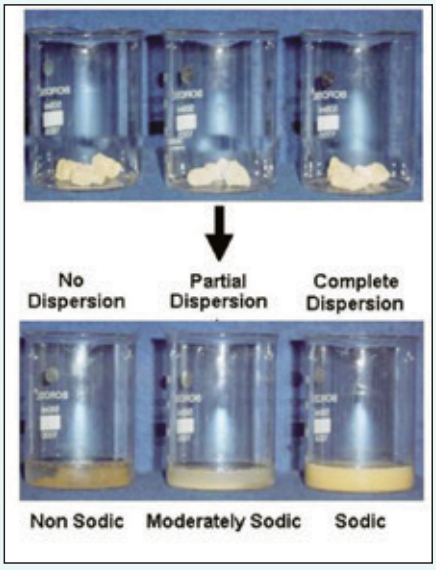
Impact:

The CSR-BIO has been commercialized with license to the industrial units viz. M/S Krishicare Bioinputs, Tamil Nadu, M/S Jai Visions Agri-Tech, Ghaziabad, U.P. and M/S Alwin Industries, Bhopal, Madhya Pradesh for its multiplication and these industrial unit has been producing in liquid as well as solid medium and till date more than 40 tones has been produced and marketed by the industrial units.

The bio-stimulant acts as a nutrient mobilizer, soil vitalizer, plant protectant against soil born diseases and growth enhancer for crops grown in normal and salt-affected soils. It prevents environmental pollution caused due to indiscriminate use of fertilizers and pesticides and creates profitable livelihood security to poor farmers owning sodic and marginal lands.

2.9 Soil sodicity field kit





For the reclamation of sodic soils, gypsum (@10-15 tonnes/ha) have been recommended based upon the soil test value of pH and gypsum requirement (GR). The economic conditions of the farmers inhabited in the sodic areas is so poor that they are unable to get their soil samples analysed for pH and GR values in any soil testing laboratory and apply indiscriminant amount of gypsum to their fields, if available. The scarcity of soil testing laboratory in the vicinity also adds to this problem. Therefore, a "soil sodicity kit" was developed by ICAR-CSSRI-RRS, Lucknow on the basis of turbidity test, dispersion test and swelling test that helps the farmers of sodic areas in judging the quality/type of their soil and can quantify the amount of gypsum to be applied based on the degree of sodicity. The kit clearly demarcate between non sodic, moderately sodic and sodic soils based on the turbidity test, dispersion test and swelling test as shown below:

Turbidity Test

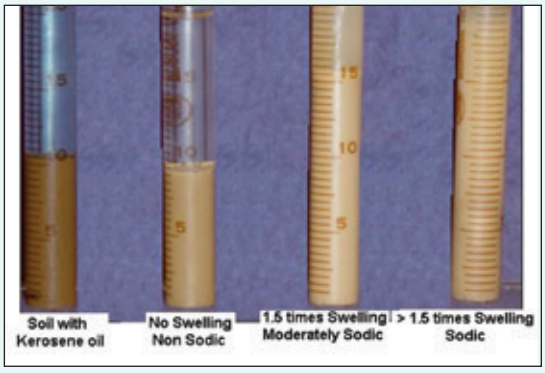
Take 100 g of surface or sub-surface soil in to a clear beaker of 600 ml capacity. Gently pour 500 ml of rain water or distilled water. Gently invert the beaker and return to its original position. Place a white plastic spoon or spatula in the centre of soil suspension. Allow it to stand for 4 hrs. Compare the visibility with the figure and score the turbidity.

1. Clear visible – Non Sodic
2. Partial visible – Moderately Sodic
3. Not Visible – Sodic

Dispersion Test

Select three aggregates or fragments of soil about a size of bean and place them carefully in the beaker as shown in figure. Carefully add enough rain or distilled water from the side to cover the aggregates. Leave the container for 20 hours and carefully assess dispersion. Group it as clear water (no dispersion), partly cloudy (partial dispersion) and very cloudy (complete dispersion)

Swelling Test



Take two graduated test tubes marked with marked with coloured pencil at each centimeter interval. Fill both the tubes with ground and sieved soil upto 1/3rd level. Add rain or distilled water slowly in one test tube and kerosene oil to other. Give turn by putting thumb on the top in order to mix thoroughly and finally make soil and water/kerosene oil ratio 1:1. Keep it for 24 hours. Compare the gel thickness in the test tube with water to that of kerosene and categorize the soil as follows:

1. No to slight swelling – Non Sodic
2. 1.5 times swelling of soil in water as compared to that of Kerosene oil – Moderate Sodic
3. More than 1.5 times swelling of soil in water as compared to Kerosene oil – Sodic

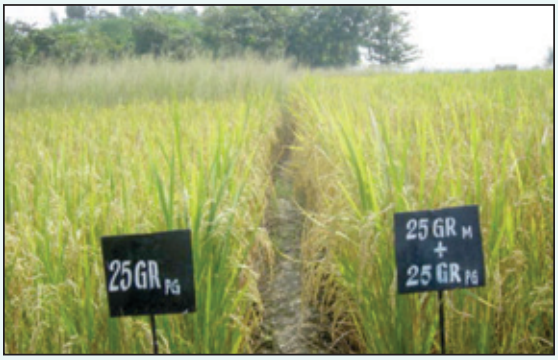
Impact:

The field sodicity kit was distributed among the extension workers and farmers for judging the degree of sodicity at field level. It is being used by farmers and extension workers in rural areas where there is lack of soil testing facility. The application of gypsum requirement for the reclamation of the sodic soil based on the soil test value was almost at par with the conventional method of determining soil test value.

2.10 Phospho-gypsum

Phospho-gypsum (PG) is basically a by-product of the phosphate fertilizer industry that emanates from the production of phosphoric acid and exists as huge stock pile at the manufacturing site posing environmental threats. As the stock of mined gypsum is diminishing day by day and safe disposal of PG has become a public concern, phospho-gypsum could be used as a chemical amendment to the sodic soil. This is possible because the chemical composition of this by-product is similar to gypsum.

The application of phospho-gypsum equivalent to 50 GR (mineral gypsum) showed greater reduction in soil pH and comparatively higher yield over mineral gypsum. The PG treatment resulted greater reduction of pH and exchangeable sodium percentage (ESP) because of its higher solubility over mined gypsum, which makes soluble calcium permeates to the lower depth and causes reduction in ESP. The benefit: cost ratio revealed that in rice-wheat, it was highest for phosphogypsum @ 50 GRPG and were 1.07, 1.14 and 1.16 in different years at different locations. Phosphogypsum application @ 25 GRPG even resulted higher benefit cost ratio for both the rice and wheat over 50 GRM. The average reclamation cost was about Rs. 30,000/- per ha.



Impact:

Due to the dwindling scenario of mineral gypsum which is being used so far as an amendment to the sodic soil, its availability have become scarce due to its unaffordable price for the resource poor farmers. As a result, poor and marginal sodic land holding farmers are unable to reclaim their land for getting higher per unit area income. The phosphogypsum may be a boon for them in increasing their land productivity, as this industrial by-product is quite cheap and available in plenty.

2.11 Technology with reduced gypsum and salt tolerant varieties

The field experiments were initiated to develop low cost technologies for the resource poor farmers by integration of gypsum and salt tolerant varieties of rice and wheat cropping system. The grain yield of rice and wheat under 25 % plus salt tolerant varieties was at par with 50 GR plus normal cultivars. The cost of technology is likely to be Rs.40, 000/- per ha.

The integration of salt tolerant varieties of rice and wheat with 25% of gypsum requirement produced at par yield of 50% gypsum requirement. Through adoption of this technology, the farmers can save 25% cost of the gypsum. The low cost reclamation technology will be effective in sodic soil reclamation particularly for small and marginal farmers and with the increase of productivity; the economic security of the farmers will also increase.

Impact:

The investment on gypsum would be reduced to half (25% GR) when salt tolerant varieties were grown instead of locally available high yielding varieties. The B:C ratio of 1.7 was recorded in 25 GR with salt tolerant varieties of rice and wheat. Time frame for the replacement of salt tolerant varieties with normal high yielding varieties was also worked out and it was established that salt tolerant varieties of rice can be replaced after 4 years. For wheat the replacement of salt tolerant varieties could be after 3 years.

2.12 Subsoil sodicity management technology for cultivation of banana

The technology for banana cultivation under reclaimed sodic soil (pH > 9) through sub-soil management technology using combination of ameliorant, vermicompost and native isolate of *Psuedomonads aeruginosa* (CSR-P-1) from sodic soils of pH 9.8 was developed. It was found that gypsum/phosphogypsum reclaimed the soils in the pit and their combination with vermicompost and CSR-P-1 strain of *Psuedomonads* decreased salt stress and increased bunch weight to 22.0 kg/plant and 24 kg /plant, respectively. The sodium adsorption ratio (SAR) of soil was reduced. The Na/K ratio was reduced and increased the micronutrient content in leaves. The enzymatic activities such as peroxidase (PO), polyphenol oxidase (PPO), phenyl alanine lyase (PAL), suproxy dismutase (SOD), proline and phenols in the roots of treated plants also increased. The results showed that the combination of 25% GR gypsum or phosphogypsum with CSR-P-1 and vermicompost protects the plants against sodic environment and helps to reclaim the sodic soils. The approximate average input cost was 70,000/-per ha and the average output was 2.5-3.0 lakh per ha.

Impact:

In the growing economy apart from providing food security, it is obvious to provide economic and nutritional security to the small and marginal farmers. Most of the small and marginal farmers of Uttar Pradesh adopt rice-wheat or rice-mustard cultivation for years. Banana is a sustainable medium duration cash crop with high return in irrigated lands.

2.13 Pond based farming system technology in waterlogged sodic soils

About 0.35 million ha sodic lands suffer from shallow water table conditions in Sharda Sahayak Canal Command and are not suitable for cultivation even after conventional method of gypsum based reclamation. This has led to diminishing land and water productivity and loss of livelihood for the farm families in this command. Seepage from the canal is one of the main reasons for development of waterlogged sodic soils on a large scale in the canal command.

To tackle such a situation, and to harness the productivity potential of the seepage water in the canal command area, a land reclamation model for 1 ha based on the concept of physical land reclamation and pond based integrated farming system has been developed at village Kashrawan, Raebareily district.

The basic concept of utilizing the bottom soil whose pH was less than 9.0 for crop cultivation was adopted and therefore while digging the pond the top soil was sent to bottom and bottom soil to top. The model comprised of 0.40 ha fish pond up to 1.75 m depth, 0.2 ha cereal crop, 0.15 ha fruit crop, 0.10 ha for vegetable and 0.10 ha for forage crops. The excavated soil was spread over the 0.6 ha land so that field can be raised at least 2 m from the water table. Through intervention of above land modification technique the productivity of the land and water increased many folds.

Impact:

On seeing the success of the 2 farmers, 10 more farmers have expressed their readiness to take up the technology with help of bank finance. The government of Uttar Pradesh has also requested the scientists to take up large scale demonstration of this technology for which it would provide financial support.

2.14 Raised and sunken bed technology in waterlogged sodic soils

Since majority of sodic lands in U.P. are with resource poor medium to small land holders. Therefore, for them a system of raised and sunken bed was evolved using land modification technique in Sarda Sahayak canal command area. In raised and sunken bed system the area is divided into number of strips of desired width. Raised and sunken beds are constructed alternatively by digging soil from one strip and putting it on the other. Design criteria of raised and sunken bed should be such that

- It should allow agricultural production from raised as well as sunken bed.
- It should minimize capillary rise to avoid salt deposition in the root zone.
- Minimum or no use of amendments for lowering pH.
- Ease in using available farm machinery equipments and turning ease at the corner of the raised and sunken beds.
- A minimum width of raised bed was taken as 2.0 m and the height of sunken bed was 1.0 m above ground surface. The average depth of sunken

bed was 0.50 m below ground surface and side slope was 1:1. Vegetable crops like tomato, brinjal, bottle gourd, bitter gourd, ridge gourd, sponge gourd, okra, chilly, tinda, pumpkin, cucumber, etc, were grown on the beds during kharif, rabi and summer seasons. Tissue culture banana plantlets were taken on the raised beds. The entire water requirement of the banana plants was met from the water from sunken beds and also through seepage. An average of 22.5 kg of banana was obtained from 140 plants taken on two beds. Deep water rice and water chestnut was cultivated in the sunken beds.

Impact:

The B:C ratio for this system varied according to the season and the crops taken by the farmers. The average B:C ratio was about 3.45. The average input cost is about Rs. 0.75 to 1 lakh. The model will be helpful in minimizing the negative impact of the seepage water on ecological system of the canal command areas.

2.15 Cotton-pulse intercropping on moderately saline Vertisols

Salt-affected Vertisols (Black cotton soils) cover an area of approximately 0.80 million hectares in the country, of which 0.12 million hectares are estimated to occur in Gujarat. Due to high clay content and other physic-chemical properties, soils are adversely affected even at low salt concentration and exchangeable sodium contents. Restoring the productivity of these lands, once they become salinized will be much more difficult as compared to alluvial sandy loam soils of Indo-Gangetic Plains. Farmers of the Bara tract in Amod, Vagra and Jambusar talukas and other parts of the state, who take cotton as *rainfed* mono-crop, do face crop losses due to salinity development at later stages of crop growth. Under such situations, intercropping with pulses provides some remuneration to farmer in the event of failure of cotton crop.

The system would fetch about 16000/- per hectare from cotton and further the pulses due to their nitrogen fixing ability enrich the soils with nitrogen. Cotton as well as pulses can be taken as rain fed crops, providing saline water irrigation, if available further boosts the crop yields. Use of saline water in cotton has been proved beneficial on saline black soils. Because of pulse crop, application of soil nitrogen can be minimized and thus reduce the input costs.

Impact:

The farmers in the Bara tract area particularly in Vagra and Amod talukas have been adopting the cotton intercropped with pulse technology for maximizing the production. This technology while enhancing on farm income and helps in enrichment of soil nitrogen because of pulse crop introduction.

2.16 Dill (*Anethum graveolens*) on saline Vertisols

Dill (*Anethum graveolens*), a non-conventional seed spice crop has been identified as potential crop for cultivation on saline black soils having salinity up to 6 dS m^{-1} in rabi season with the residual soil moisture. It has multiple uses viz., pot herb, leafy vegetable, seeds used as condiments and seed oil for aromatic and medicinal purposes. The herb contains Vitamin-C as high as 121.4 mg/100g.

The oil of dill seeds and its emulsion in water (Dill water) are considered to be aromatic, carminative and effective in colic pains and possesses anti-pyretic and anti-helmenthic properties.

The crop gives fairly good yield on saline black soils having salinity of 4-6 dS m^{-1}. The crop responds well to saline water irrigation. Three critical stages for saline water irrigation have been noticed ie., vegetative, flowering and seed formation stage. A substantial increase in yield can be obtained by using saline ground water in conjunction with best available surface water. Under saline water irrigation, crop would yield net returns of Rs. 16500/- ha^{-1} with Rs. 6000/- per hectare as cost of cultivation. The benefit: cost ratio works out to be 2.75.

Impact:

Non-conventional crop like dill can be grown using residual moisture resulting in 2.6 q/ha seed yield with net returns of ₹ 8000/-. This crop forms an ideal option for the state in general and the region in particular, which by and large faces water scarcity problems. This crop thus would help farmers of the region to go for the second crop in rabi season on lands, which hitherto remain fallow due to water and salinity constraints. Thus dill crop can be taken up using residual moisture and/or with saline ground water. The green harvest can be used as leafy vegetable, an additional source of income.

2.17 *Salvadora persica* on highly saline Vertisols

Salvadora persica L. (Meswak), a facultative halophyte which is a potential source for seed oil has been identified as a predominant species in highly saline habitats of coastal and inland black soils (ECe >30 dS/m). This species is a medicinal plant of great value and its bark contains resins and an alkaloid called Salvadoricine. The seeds are good source of non-edible oil rich in lauric (C12) and myrestic (C14) fatty acids having immense applications in soap and detergent industries. This species gives economic returns for the highly saline black soils with salinity values up to 50 dS m^{-1}, also provides eco-restoration through environmental greening and thus forms a niche for highly saline black soils. Planting of Salvadora persica would fetch about Rs. 7000/- per hectare.

Impact:

This species was found to grow and yield well on saline black soils having salinity up to 65 dS m^{-1}. Based on the studies conducted, the National bank for Agriculture and Rural Development (NABARD), Mumbai in association with the Station has developed a bankable model scheme for cultivation of *Salvadora persica* on salt-affected black soils for the restoration of highly saline soils through the project sponsored by NABARD. It is adopted by the farmers, NGOs and Govt. Institutions like Gujarat State Land Development Corporation (GSLDC) on a large scale in Gujarat. This species is useful in regreening of highly saline black soils that cannot be put under arable farming. Reduction in salinity by 4th year onwards that enables to take up intercropping with less tolerant crops/forages. Apart from this, the species provide a dwelling place for birds and enhances the environmental greening.

Salvadora on highly saline black soil

2.18 Forage grasses on saline Vertisols

Cultivation of forage grasses, *Dichanthium annulatum* and *Leptochloa fusca* in a ridge-furrow planting system with 50 cm high ridge and 1 m between midpoints of two successive ridges was found ideal in saline black soils having salinity up to 10 dS m^{-1}. For maximizing forage production, *Dichanthium* on ridges and *Leptochloa* in furrows form ideal proposition. Nitrogen @ 45 kg ha^{-1} (in the form of urea) at the time of rooted slip planting boosts forage production and improves forage quality traits. *Dichanthium* has been found most suitable for saline black soils, as it possessed well-defined salt compartmentation, wherein the roots act as potential sinks for ions like sodium and chloride, making the shoot portions relatively salt free.

Dichanthium is having both well-defined salt exclusion mechanism and osmotic adjustment which makes it salt tolerant. Leptochloa fusca also gave maximum forage yield. Furrow method of planting is suitable for cultivation of this grass. Cultivation of salt tolerant grasses like Dichanthium annulatum and Leptochloa fusca on moderate saline soils result in 1.9 t ha^{-1} and 3.2 t ha^{-1}, respectively. The Unit cost is about Rs. 3000/- per ha in the first year for planting, fertilizers and labour input. The grasses used to give 3-4 cuts and together gave economic returns of about 10000/- per hectare.

Impact:

The technology has been widely adapted in the Bhal areas covering Tarapur, Dholka, Dhandhuka talukas and also through the NGOs in Coastal saline villages in Cambay taluka and also taken up by National Tree Growers Federation, Anand in Cambay taluka. These grasses being perennial in nature, while providing fodder also bring up the environmental stability in the area which is extremely fragile in nature.

2.19 Lime technology for acid sulphate soil in coastal areas

Acid sulphate/ acid saline soils (pH < 4.0) are highly under-utilized and show very poor yield of crops. Good yield can be obtained from such soils by applying lime @ 50% of recommended dose and higher P fertilizer (double or more of recommended dose) along with green manure or other organic manures. Oyster shell can be used as locally available cheap source of lime. Rock phosphate can be used as cheap alternative source of phosphorus.

Possible to increase the yield of rice and other crops by 100% or more. Enhancement of productivity of low producing acid sulphate /acid saline soils. Its likely cost of intervention is about Rs.22, 000 per ha. Social status of the farmers will be enhanced due to improving their farm income. Environment degradation will be less as a result of less release of acidity from this type soil following management of acid sulphate soil.

Impact:

It is a very low cost technology and it has ability to increase the productivity by 100% or more. Hence, the farmers will be economically benefited by adopting this technology.

2.20 Mulching/cover crop for coastal saline soils

The salinity build up in soil can be controlled by:

i. Growing crops with large foliage cover rather than leaving fallow.

ii. Mulching of soil during dry season with rice husk and straw, organic farm waste or any other suitable materials as mulch.

iii. When mulching materials are not available, the soil is to be kept ploughed instead of leaving unploughed.

iv. Ploughing of soil on initiation of pre-monsoon shower and sowing of green manuring like *Sesbania.*

Impact:

The economic status of the farmers in the coastal region will be improved due to enhancement of farm productivity following reduction of soils salinity build up.

The Performance results with respect to efficiency, sustainability are:

i) Less build up of soil salinity

ii) Increase in yield of kharif crops by 25-30%

iii) Improvement in soil fertility

The Likely cost of intervention is about Rs. 5,000/- per ha.

Social status of the farmers will be enhanced due to improving their farm income. Environment will be safe due to less build of soil salinity.

2.21 Farm pond technology

About 20% of the farm area is converted into on-farm reservoir (OFR) to harvest excess rainwater. The dug-out soil is used to raise the land to form high and medium land situations besides the original low land situation in the farm for growing multiple and diversified crops throughout the year instead of mono-cropping with rice in Kharif season. The pond is used for rainwater harvesting, irrigation and pisciculture. Poultry/ livestock farming can also be practiced in the farm along with crops and fishes with the use of pond water. Simultaneous cultivation of rice and azolla is recommended for higher crop yield.

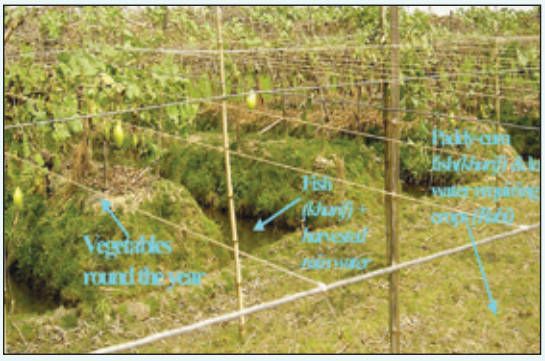
The Performance results with respect to efficiency, sustainability are: Storage rainwater can be used to irrigate 80 % of farm land Improvement of surface drainage (about 75%), Scope for cultivating crops in rabi/summer season under salt affected soils, Multi-cropping with crops, fishes and or livestock, less risk of single crop failure and better soil health. The likely cost of intervention is about Rs. 99,000 per ha for soil excavation.

Impact:

The coastal agriculture is less profitable due to degraded (saline) soil and water quality, mono-cropping with traditional rice in *kharif* and scarcity of good quality irrigation water. The farm pond technology provides the scope for practicing diversified cropping round the year and integrated farming, creating irrigation facility, reducing salinity and improving drainage condition. Thereby, this technology enhances the livelihood security by increasing farm income and employment generation.

2.22 High ridge and deep furrow technology

About 50% of the farmland is shaped into alternate ridges (1.5 m top width ×1.0 m height × 3m bottom width) and furrows (3m top width × 1.5 m bottom width × 1.0 m depth). These ridges remain free of waterlogging during *Kharif* with less soil salinity build up in dry seasons (due to higher elevation and presence of fresh rain water in furrows). Remaining portion of the farmland including the furrows is used for growing more profitable paddy-cum-fish cultivation in *Kharif*. The rainwater harvested in furrows is used for irrigation. The remaining portion of farmland (non-furrow and non-ridge area) is used for low water requiring crops during dry (*rabi*/summer) seasons. The rain water stored in furrows is used for initial irrigations during *rabi*.



The water stored in furrows is also used for fish cultivation and supplementary irrigation in *Kharif*. The ridges are used for cultivation of vegetables and other horticultural crops round the year instead of monocropping with rice in *Kharif*. The rain water stored in furrows keep the root zone soil relatively saturated with fresh water during the initial dry months after *Kharif*, thus reduces upward capillary flow of brackish water from shallow subsurface layer and thereby reducing the salinity build up in soil. The furrows provide better drainage and protect the crops from damages due to occasional heavy rains in *rabi*/ summer due to climatic disturbances. Water harvested in furrows from such rains also provides additional source of irrigation. This technology can be adopted in areas where farm pond technology cannot be adopted due to presence of acid sulphate soil at shallow soil depth. The likely cost of intervention is about Rs. 49,000/- per ha for soil excavation.

Impact:

This technology enhances the livelihood security by increasing farm income and employment generation.

2.23 Paddy-cum-fish cultivation technology

Trenches (3 m top width × 1.5 m bottom width × 1.0 m depth) are dug around the periphery of the farmland leaving about 3.5 m wide outer from boundary and the dugout soil is used for making dikes (about 1.5 m top width ×1.0 m height × 3.0 m bottom width) to protect free flow of water from the field and harvesting more rain water in the field and trench. The dikes are used for vegetable cultivation round the year. Remaining portion of the farmland including the trenches is used for more profitable paddy-cum-fish cultivation in *kharif*. The land (non trench and non dike area) is used for low water requiring crops during dry (*rabi*/ summer) seasons with the rain water harvested in furrows. Presence of deep furrows in the field provides better drainage condition in the field during the non-monsoon months.

The Performance results with respect to efficiency, sustainability are:

- Less drainage congestion.
- Storage of rain water in the trenches for irrigation.
- Multiple & diversified crop cultivation round the year.
- Simultaneous paddy and fish cultivation for higher income.
- Less risk of crop failure.
- Integrated cultivation of crops and fishes.
- Higher farm income and employment.

The likely cost of intervention is about Rs. 32,000/- per ha for soil excavation.

Social status of the farmers will be enhanced due to improving their farm income. Environment will be protected due to reducing soil salinity, improving drainage, harvesting fresh rain water.

Impact:

This technology enhances the livelihood security by increasing farm income and employment generation.

2.24 Paddy-cum-fish cultivation technology with brackish and fresh water

In this technology land is shaped as in paddy-cum-fish cultivation and crops and fishes were grown as in paddy-cum-fish cultivation during wet season. However, during winter/ summer seasons the land was used for more remunerative brackish water fish cultivation with the ample supply of surface and sub-surface brackish water available in the area. After brackish water fish cultivation, the same land was also used for normal paddy-cum-fish cultivation during wet season on allowing few initial pre-monsoon showers to wash away the salts from soil. This model can be used only to the farm situation where there is good provision of outlet for pumping out brackish water from the field after brackish water fish cultivation and the wash out of the field from pre-monsoon rains.

The Performance results with respect to efficiency, sustainability are:

- Less drainage congestion.
- Storage of rain water in the trenches for irrigation.
- Multiple & diversified crop cultivation round the year.
- Simultaneous paddy and fish cultivation for higher income.
- Less risk of crop failure.
- Integrated cultivation of crops and fishes.
- Utilization of ample supply of brackish water.
- Higher farm income and employment.

Social status of the farmers will be enhanced due to improving their farm income. Environment will be protected due to reducing soil salinity, improving drainage, harvesting fresh rain water.

Impact:

This technology enhances the livelihood security by increasing farm income and employment generation.

2.25 Shallow furrow & medium ridge technology

About 75 % of the farm land is shaped into medium ridges (1.0 m top width ×0.75 m height × 2.0 m bottom width) and furrows (2.0 m top width × 1.0 m bottom width × 0.75 m depth) with a gap of 3.5 m between two consecutive ridges and furrows. As in high ridge and deep furrow above the furrows are used for rainwater harvesting and paddy-fish-cultivation during *Kharif*. The cropping schedule is similar to that followed in DF except rice can be grown in furrows in *Rabi*/summer with lesser supplementary irrigation. This technology can be adopted when acid sulphate soil layer is present at shallow depth due to which other land shaping technologies cannot be adopted.

The Performance results with respect to efficiency, sustainability are:

- Increasing the productivity of poorly drained salt affected coastal lands by 30-35%.
- Scope for multiple cropping with crops and fishes.
- Creation of irrigation resource with harvested rainwater.

The likely cost of intervention is about Rs. 39,000/- per ha for soil excavation.

Social status of the farmers will be enhanced due to improving their farm income. Environment will be protected due to reducing soil salinity, improving drainage, harvesting fresh rain water.

Impact:

This technology enhances the livelihood security by increasing farm income and employment generation.

3. Salt Tolerant Varieties for Enhancing Productivity

3.1 Rice varieties

i. CSR 10

- It acts as biological amendment for highly deteriorated sodic and inland saline soils.
- It can tolerate sodicity up to pH_2 ~10.0 and salinity up to 11 dS/m.
- It has a plant height of about 85 cm and matures in 120 days.
- It has short bold grains.
- It is recommended for the area having highly deteriorated sodic and inland saline soils.
- It is excellent under high stress condition
- Its grain yield in normal soils is 6.0 tonnes/ha and in salt affected soils is 3.0 tonnes/ha

ii. CSR 13

- It has a plant height of about 115 cm.
- It matures in 145 days.
- It has long slender grains.
- It can tolerate sodicity up to pH_2 ~10.0 and salinity up to 9 dS/m.
- It is recommended in area with sodic and inland saline soils of U.P. Haryana, Gujarat and Maharashtra.
- It is highly acceptable and excellent under normal and moderately deteriorated salt affected soils.

- Its grain yield in normal soils is 6.0 tonnes/ha and in salt affected soils is 3.0 tonnes/ha

iii. CSR 23

- It has a plant height of about 115 cm
- It matures in 130 days.
- It has long slender grains.
- It can tolerate sodicity up to pH2 ~9.9 and salinity up to 10.0 dS/m.
- It is recommended in sodic soils of Uttar Pradesh, Haryana, and coastal saline areas of Gujarat, Maharashtra, Tamil Nadu, Kerala and West Bengal.
- It is excellent under normal and moderately deteriorated affected soils.
- Its grain yield in normal soils is 6.5 tonnes/ ha and in salt affected soils is 4.0 tonnes/ ha

iv. CSR 27

- It has a plant height of about 115 cm
- It matures in 125 days.
- It has long slender grains.
- It can tolerate sodicity up to pH_2~9.9 and salinity up to 10.0 dS/m.
- It is recommended for sodic and coastal saline areas of India
- It is excellent under normal and moderately deteriorated salt affected soils
- Its grain yield in normal soils is 6.5 tonnes/ ha and in salt affected soils is 4.0 tonnes/ ha

v. CSR 30 (Basmati)

- It has a plant height of about 155 cm.

- It matures in 155 days.
- It has extra long slender grains.
- It can tolerate sodicity up to pH_2 ~9.5 and salinity up to 7.0 dS/m.
- It is the first salt tolerant basmati variety, developed by ICAR-CSSRI and is recommended for sodic areas of UP, Haryana and Punjab. It performs very well in normal soils also.
- It is excellent under normal and moderately deteriorated sodic soils.
- Its grain average yield in normal soils is 3.0 tonnes/ ha and in salt affected soils is 2.0 tonnes/ ha

vi. CSR 36

- It has a plant height of about 110 cm.
- It matures in 140 days.
- It has long slender grains.
- It can tolerate sodicity up to pH_2 ~9..9 and salinity up to 11.0 dS/m.
- It is recommended for sodic soils of Uttar Pradesh, Haryana and Pondicherry
- It is excellent under normal and deteriorated salt affected soils.
- Its grain yield in normal soils in 6.5 tonnes/ ha and in salt affected soils is 4.0 tonnes/ ha

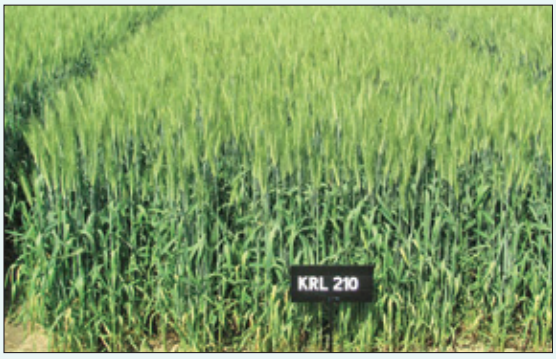
vii. CSR 43

- It has a plant height of about 95 cm.
- It matures in 110 days.
- It has short bold grains.

- It can tolerate sodicity up to pH_2 ~10.0 and salinity up to 7.0 dSm^{-1}.
- It is recommended for salt affected soils including sodic soils of UP.
- It is excellent under normal and deteriorated salt affected soils.
- Its grain yield in normal soils is 6 tonnes/ha and in salt affected soils: 3.5 tonnes/ha

3.2 Wheat varieties

i. KRL 210



- It is a semi dwarf variety
- It takes about 143 days to mature.
- Its grains are amber in colour, bold in size and contain about 11% protein.
- It is resistant to yellow and brown rusts, loose smut, Karnal bunt and flag smut.
- It has also shown tolerance to shoot fly.
- The hectolitre weight of the grain is 77 Kg with sedimentation value of 39.
- It is recommended for salt affected soils of NWPZ and NEPZ
- Its cultivation has environmental impacts as it reduces use of chemicals for soil amendment.
- The yield potential in normal soils is 5.2 tonnes/ha and in salt affected soils (having pH up to 9.3 and EC up to 6 dS/m) is 3.5 tonnes/ha.

ii. KRL 213

- It is resistant to yellow as well as brown rusts, leaf blight, Karnal bunt and hill bunt.

- It has an excellent plant type (semi dwarf), 97 days for days to flowering, 145 days to maturity in NWPZ. However in NEPZ the variety attains flowering and maturity at 91 and 128 days, respectively.
- It has amber coloured grain with 11% protein content, 77 Kg hectoliter weight and sedimentation value of 29.
- It is recommended for salt affected soils of NWPZ and NEPZ.
- It has been specifically bred for salt tolerance to saline (EC_e 6.0 dSm^{-1}) as well as alkaline soils (up to pH_2 9.2) conditions. It also does well in areas where the groundwater is either brackish and/or saline (EC_{iw} 15 dSm^{-1}; RSC 12-14 meq l^{-1}).
- Its cultivation has environmental impacts as it reduces the use of chemicals for soil amendment.
- The yield potential in normal soils is 5.1 tonnes/ha and in salt affected soils (having pH up to 9.2 and EC up to 6.4 dS/m) is 3.3 tonnes/ha.

iii. KRL 19

- It is resistant to yellow and brown rusts as well as for Karnal bunt resistance.
- It is highly responsive to fertilizers as well as resistant to lodging and shattering even under high input, irrigated and timely sown conditions.
- Even moderately late sowing does not affect the yield significantly.
- It has amber grain colour with good grain appearance, high protein content (12%), hectoliter weight (77.4) and sedimentation value (47.4).

- It has been specifically bred for salt tolerance to saline (EC_e 5-7 dSm^{-1}) as well as alkaline (pH_2 9.3 to 9.4) soil conditions. It also does well in areas, where the ground water is either brackish and/or saline (EC_{iw} 15-20 dSm^{-1}, RSC 12-14 meq l^{-1}).
- Its cultivation has environmental impacts as it reduces the use of chemicals for soil amendment.
- The yield potential in normal soils is 4.5 tonnes/ha and in salt affected soils (having pH up to 9.3 and EC up to 7.0 dS/m) is 3.0 tonnes/ha.

iv. KRL 1-4

- It is a dwarf type variety with 145 days of maturity.
- The grain texture is hard, medium bold and amber in color.
- It also tolerates the salinity stress up to EC_e 7.0 $dSm^{-1.}$
- KRL 1-4 was the first wheat variety released for saline and sodic soils of the north western plain zones of the country.
- It has environmental impacts as it reduces the use of chemicals for soil amendment.
- The yield potential in normal soils is 4.0 tonnes/ha and in sodic soils (having pH up to 9.3) is 3.0 tonnes/ha.

3.3 Mustard varieties

i. CS 52

- It grows up to a height of 170-180 cm.
- It matures in about 135-145 days.
- Its seeds are brown in colour and medium in size with 1000 seed weight more than 4 g.

- By growing in saline soils and even irrigating with saline water, 38% oil content has been determined from the seeds of this variety.
- It can grow economically in saline soils up to a soil salinity level (ECe) 9.0 dS m^{-1} and in alkali soils up to pH_2 ~ 9.3.
- It is highly suitable for saline and sodic soil conditions.
- The yield potential in normal soils is 20 quintal/ha and in salt affected soils (having pH_2 up to 9.3 and soil salinity upto 9.0 dS/m) is 15 tonnes/ha.

ii. CS 54

- It grows up to a height of 160 cm.
- It takes about 45 days for 50% flowering and matures in about 121 days.
- Its seeds are brown and bold with 1000 seed weight more than 5.3 g.
- Its main shoot length is around 65-70 cm and it has more than 14 seeds per siliqua.
- It yields around 40% oil content even under salt stress conditions.
- It is recommended for saline soils up to soil salinity level (ECe) of 6-9 dS m^{-1} and in alkali soils up to pH_2 ~ 9.3.
- It is highly suitable for saline and sodic soil conditions
- The yield potential in normal soils is 24 quintal/ha and in salt affected soils (having pH up to 9.3 and soil salinity upto 9.0 dS/m) is 1.9 tonnes/ha.

iii. CS 56

- It grows up to a height of 202 cm.
- It matures in about 132 days.
- It is moderately tolerant to *Alternaria* black spot, black leg (leaf, root and stem rot), white rust, *Sclerotinia* stem rot, mildew and aphids.
- Its oil content percent is 37.
- It is suitable in late sown irrigated conditions and in Rice –Mustard cropping system
- It is recommended for Haryana, Uttar Pradesh, Madhya Pradesh, Gujarat and Rajasthan
- The yield potential in normal soils is 26 quintal/ha and in salt affected soils (having pH up to 9.3 and soil salinity upto 9.0 dS/m) is 1.9 tonnes/ha.

4. Advisory Services for Farmers

Kisan Melas

ICAR-CSSRI, Karnal organizes Kisan Mela twice every year known as *Kharif Kisan* Mela and *Rabi* Kisan Mela.

***Kharif* Kisan Mela**
♦ *Kharif* Kisan Mela organized in the month of October every year for one day on the farmers' field with following major attractions:
♦ Demonstration of Institute technologies.
♦ Display of farm equipments and machinery.
♦ Free soil and water testing, analysis and interpretation
♦ Display and sale of seed, pesticides and fertilizers by Govt. /private agencies.
♦ Direct interaction between scientist and farmers (Kisan gosthi).
♦ Scientists' visit to farmers' fields.
♦ Progressive farmers' meet.
♦ Awards to Progressive farmers

***Rabi* Kisan Mela**
♦ *Rabi* Kisan Mela organized every year in the month of March at ICAR-CSSRI, Karnal with following major attractions:
♦ Field visit and kisan gosthi to solve emerging agricultural problems
♦ Display of farm equipments and machineries
♦ Free soil and water testing, analysis and interpretation
♦ Exhibition and sale of seed, pesticides and fertilizers by Govt./private agencies
♦ Demonstration of Institute technologies.
♦ Farmers' visit to experimental fields
♦ Students visit to institute museum

Commercialisation of Technologies/Varieties

For further information on commercialization of IP enabled technologies/ varieties, the Director may be contacted at the following address.

Seed Availability

Farmers can obtain the seeds of salt tolerant varieties developed by the Institute from the Farm Unit at ICAR-CSSRI Campus (Phone: 0184-2209340) from 9.30 AM to 5.00 PM on all working days. Seed can also be purchased during kisan melas.

Contact Address

Director,
ICAR- Central Soil Salinity Research Institute
Zarifa Farm, Kachhwa Road,
Karnal-132001 Haryana, India
Phone: +91-184-2290501
Fax: +91-184-2290480
Email: director.cssri@icar.gov.in
Website: www.cssri.org

ICAR-CSSRI Regional Research Stations

- **ICAR-CSSRI Regional Research Station**
  Canning Town,
  Distt. South 24 Parganas–743329 West Bengal
  Phone: +91-3218-255241/255085
- **ICAR-CSSRI Regional Research Station**
  Opposite Jyoti Nager Water Tank,
  Zadeshwar Road, Maktampur P.O.
  Bharuch – 392012 Gujarat
  Phone: +91-2642-225673/225688
- **ICAR-CSSRI Regional Research Station**
  Near Kanshiram Smarak, Jail Road, P.O. Dilkusha,
  Lucknow – 226002 Uttar Pradesh
  Phone: +91-522-2464664

5. Useful Information for Farmers

Kisan Call Center, CSSRI's Toll Free No. 18001801014

Agriculture Related Weight and Measurement Information	
1 Hectare = 10,000 m^2	1 m^2 = 1,000 Litre
1 Hectare = 2.471 Acre	1 Hectare-cm water = 1,00,000 (1 Lakh) litre
1 Hectare = 50 Nali	1 Quintal = 100 kg
1 Acre = 0.4047 Hectare	1 Tonne = 1,000 kg
1 Acre = 4,840 $Yard^2$	1 PPM = 1 milligram per kg
1 Nali = 200 m^2	1 Percentage = 100^{th} part of quantity

Important Agro-Chemicals

Insecticide	Fungicide	Bactericide	Herbicide
Malathion	Copper sulphate	Agrimycin	Isoproturon
Monocrotophos	Carbendazim	Kasu-B (Kasugamycin 3% SL)	Butachlor
Chlorpyriphos	Copper oxychloride	Sheathmas (Validamycin 3% L)	2,4-D
Carbaryl	Thiram	Validamycin	Anilophos
Quinalphos	Sulphur dust	Tetracycline	Atrazine
Phorate	Mancozeb	Streptomycin	
Imidacloprid			
Indoxacarb			
Cartap hydrochloride			

Agro-Chemicals Banned or Restricted For Use In India

Banned		
Copper acetoarsenite	Phosphamidon (85% SL)	Aldrin
Phenly Mercury Acetate	Methomyl (24%L)	Chloride
Carbofuran 50% SP	Methomyl (12.5%L)	Nitrofen
Captafol 80% powder	Dibromochloropropane	Aldicarb
Ethlyene Dibromide	Paraquat Dimethyl Sulphate	Dieldrin
Trichloro Acetic Acid	Sodium Methane Arsonate	B.H.C.
Toxafen	Maleic hydrazide	Heptachlor
Tetradifon	Ethyl parathion	Chlordane
Pentachloro Nitrobenzene	Chlorobenzilate	Ethyl Mercury
Menazon	Endrin	Nicotin sulphate
Restricted		
D.D.T.#		
Aluminium phosphide#		
Methyl Parathion (2% powder) & 50% E.C. #		
Methyl Ethyl Mercury chloride (Recommended only as pre-sowing treatment of potato & sugarcane)		
Methyl Bromide		
Endosulfan		
Lindane		
Sodium cyanide		
Monocrotophos (Banned in vegetable crops)		

Notes

Notes

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch

ICAR-CSSRI Regional Research Stations

Canning Town, West Bengal

Bharuch, Gujarat

Lucknow, Uttar Pradesh