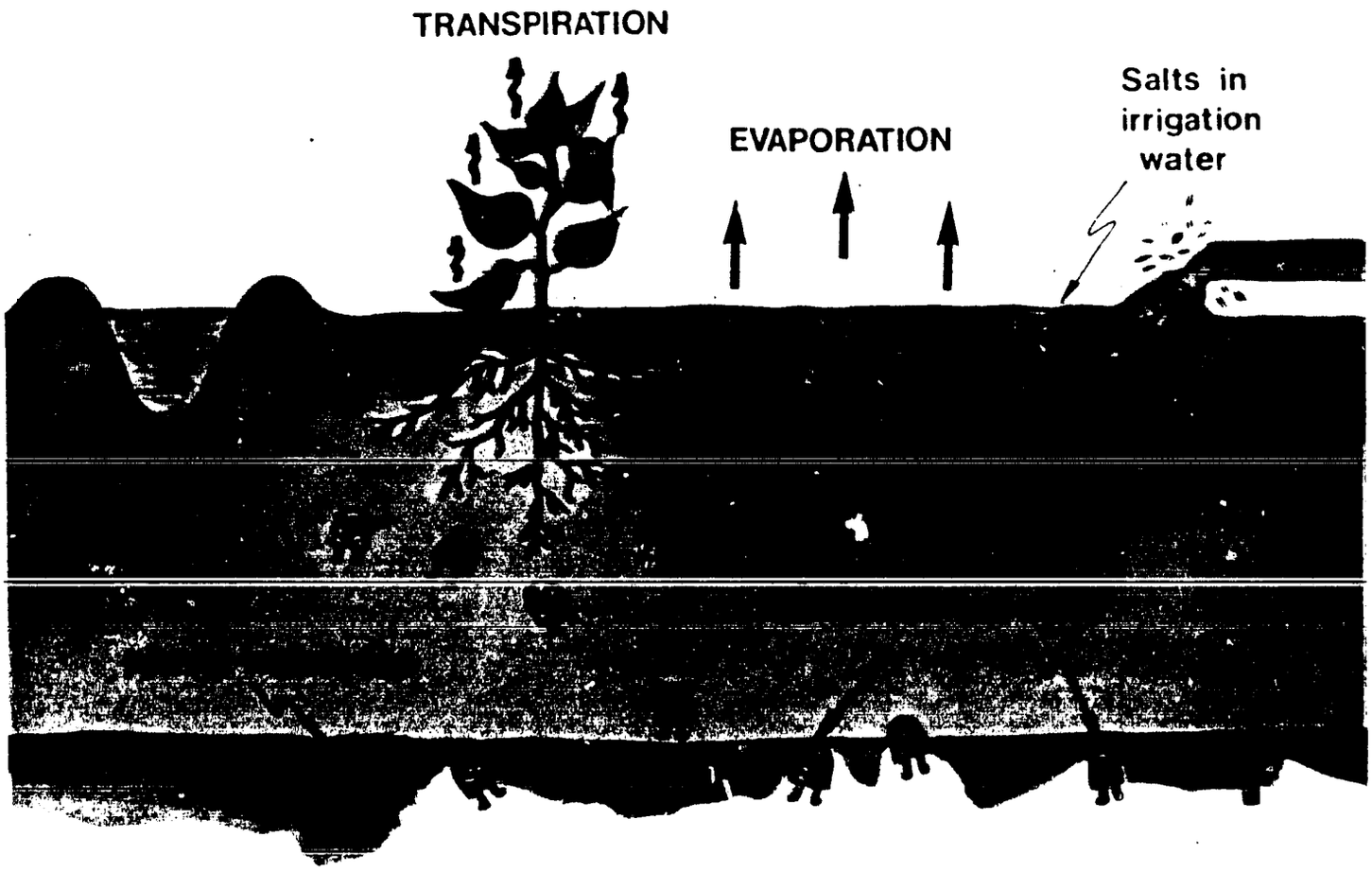
PN-ABS-756 ISN 90627

COPING WITH INLAND SALINITY & WATERLOGGING



PN-ABS-756

Irrigation Research and Management Improvement Organization
Central Water Commission

United States Agency for International Development

Water Resources Management and Trainyng Project
IRRIGATION MANAGEMENT AND TRAINING PROGRAM

"COPING WITH INLAND SALINITY AND WATERLOGGING"

Louis Berger International, Inc.
Water and Power Consultancy Services (India) Ltd.

May, 1991

INSTRUCTIONS TO TRAINERS

The following script is contained on audio cassette to accompany the slide set "Coping With Inland Salinity and Waterlogging".

The program is approximately 35 minutes in length.

- Trainers should follow the written script while the program is presented to guide them when to advance each slide.
- It is recommended to stop the tape after slide # 50. This is to allow discussion on Surface and Subsurface Drainage before going on to the other three groups of practices covered in the presentation.

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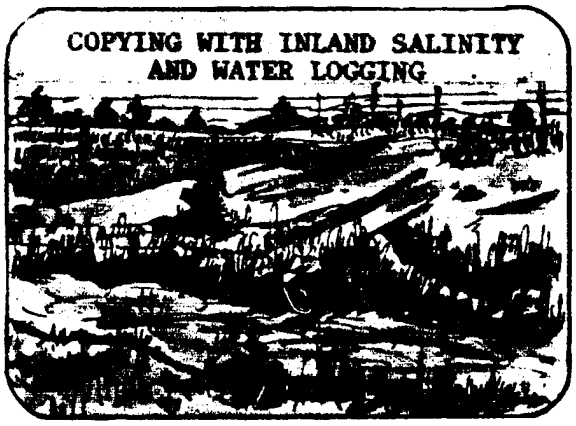
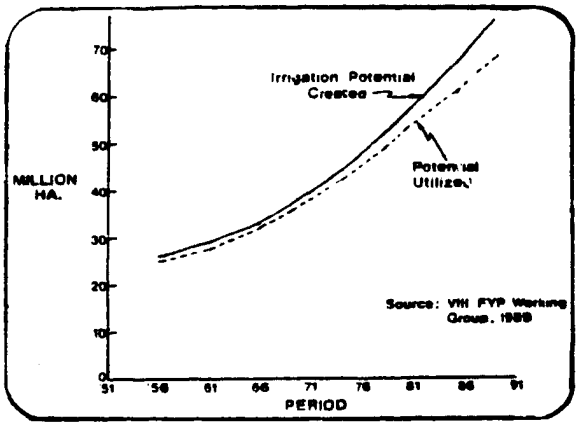
COPING WITH INLAND SALINITY & WATERLOGGING

1. (Opening music/sound of water flowing in a canal.)



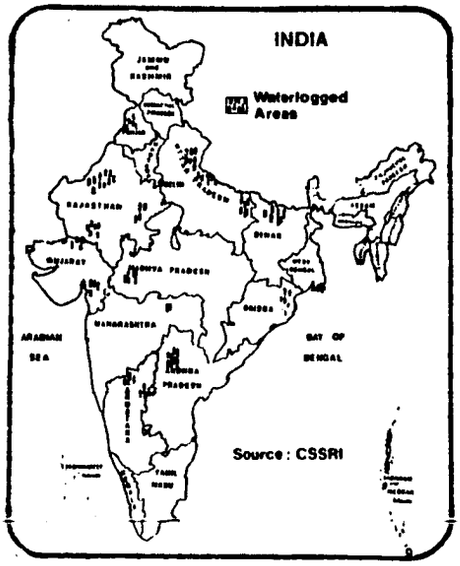
2. The massive post-independence development of irrigation has given India the largest irrigated area in the world. Starting with 22 million hectares at the time of independence, the irrigation potential is nearly 80 million hectares today. And in the eighties, the net irrigated area passed 70 million hectares. The prime sources of irrigation water are canals, tube wells, open wells and tanks.



3. This rapid development has brought irrigation water to millions of farms for the first time. It was a major factor for enhancing food production in irrigated areas, and for India reaching self-sufficiency in cereal grains today.

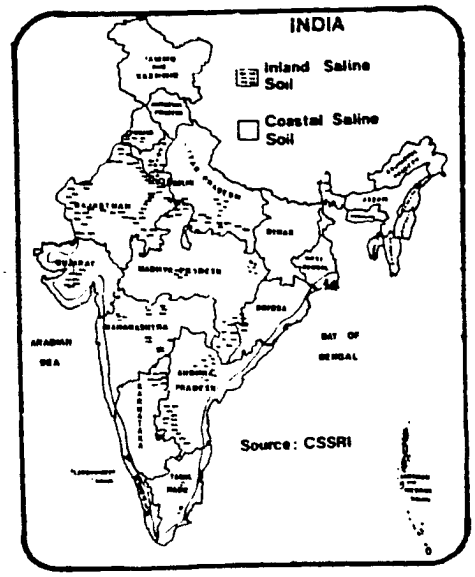
4. However, this success is not unblemished. In many canal commands, there has been a rise in the water table and consequent degradation of soils through waterlogging and secondary salt build-up. This has resulted in millions of hectares of land gradually going out of production. Some causes for this include faulty planning, deteriorating water distribution systems, and improper on-farm water management. Besides these, natural factors such as erratic rainfall for leaching purposes, high evaporative demand, and high salt content in the irrigation water, also cause salt accumulation in the topsoil.

5. Large areas of prime agricultural land in India are constantly waterlogged, while others are only affected in the post-monsoon season. The varying degrees and frequencies of water-logging make it difficult to estimate the scope of the problem. However, some estimates are that at least 8.5 million hectares are affected with the menace of salinity or alkalinity, and 4.4 million hectares are waterlogged.

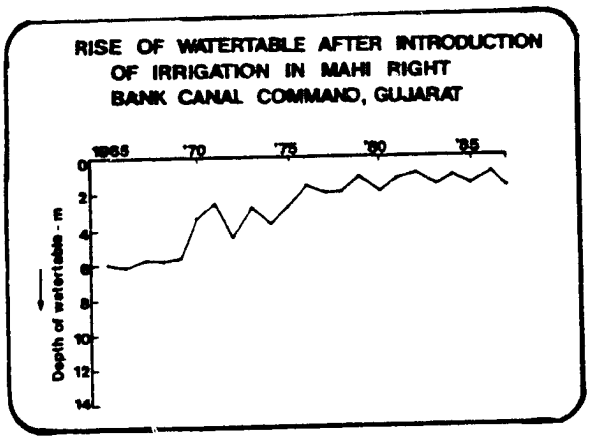


In some of the irrigation projects, for example in the Ramganga, Gandak and Sriram Sagar projects, the area under waterlogging and soil salinity has been increasing at a rapid rate.

6. Inland saline soil areas are widespread in arid and semi-arid regions of the country. These are primarily in Andhra Pradesh, Gujarat, Haryana, Karnataka, Punjab, Maharashtra, Rajasthan, Tamil Nadu and Uttar Pradesh. They include areas under dry-land farming conditions as well as irrigated lands.

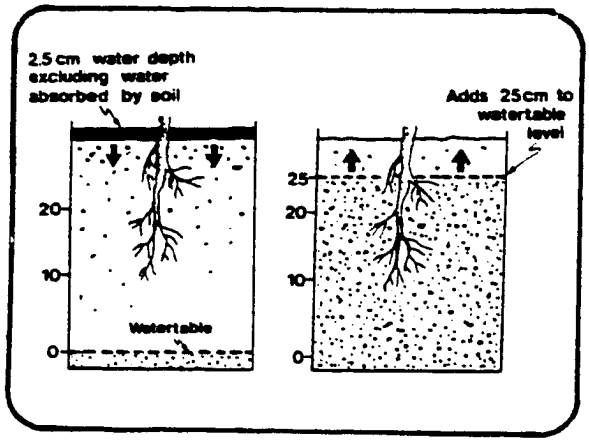


7. For irrigated areas, the gradual drop in productivity due to salinity and water-logging often comes as a shock to farmers, who had enjoyed high yields for years following the introduction of canal irrigation. This is because the gradually rising water table is a silent and unseen threat until it reaches a critical stage, which is less than 2 meters from the surface. As seen here, the rising water table in this command took almost 20 years before it reached damaging levels. The most common range in many commands is only 15 to 20 years.



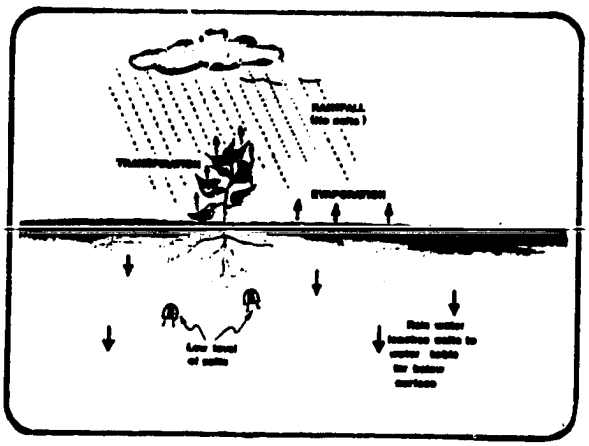
8. This rise is due to water seepage from canals, distributaries, water courses and field channels. Farmers also unknowingly aggravate the problem by over-irrigating their fields, in the mistaken belief that the more they irrigate the higher the yield per acre will be.

9. These two factors have a significant result in that it only takes a 2.5 centimeter layer of water joining the ground water body to raise the water table approximately 25 centimeters. This is because one cubic centimeter of water on the surface generally occupies approximately 10 times the volume under the soil surface due to the drainable porosity of the soil.

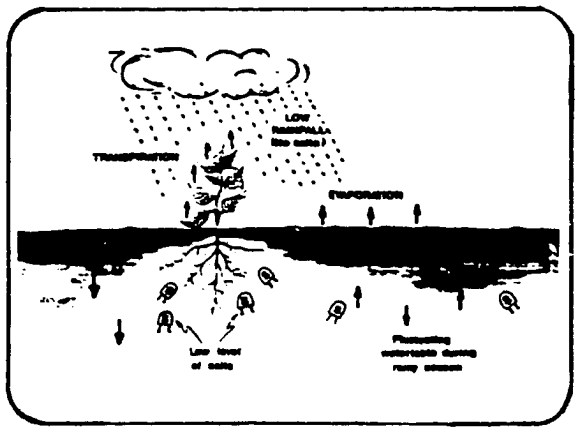


10. Salt affected soils are also formed in unirrigated areas. In basin type situations, water containing salts accumulates, and then leaves the salts behind as residue following evaporation. Two other factors in the formation of salt-affected soils under dry land conditions are :
- a rise in the water table due to outside sources, and,
- weathering processes releasing salts in the absence of leaching.

11. Let's look at how normally productive soils become saline and non-productive. For centuries, much of the land in India farmed under dry land conditions has not developed serious salinity problems. This is because the water table in these areas is far below the surface and only natural salt deposits exist in the soil. No outside salt sources are being introduced, as rainwater contains no harmful salts. And the natural rainfall contributes to leaching existing salts downward.

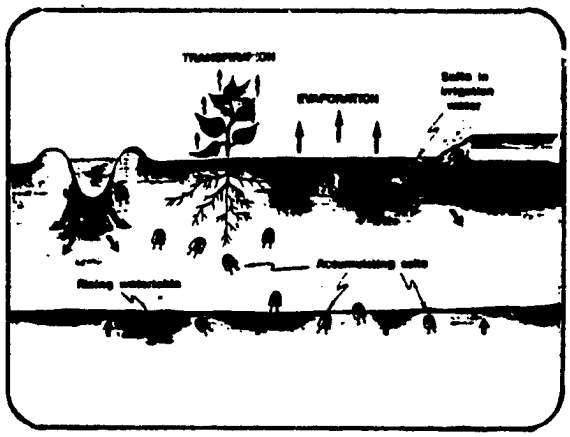


12. Under some dry-land farming conditions, however, salinity problems are becoming serious. This is because the very low rainfall levels are unable to leach salts below the root zone. As salts are slowly added through natural weathering of the soils, this has resulted in a build-up of salts to harmful levels.

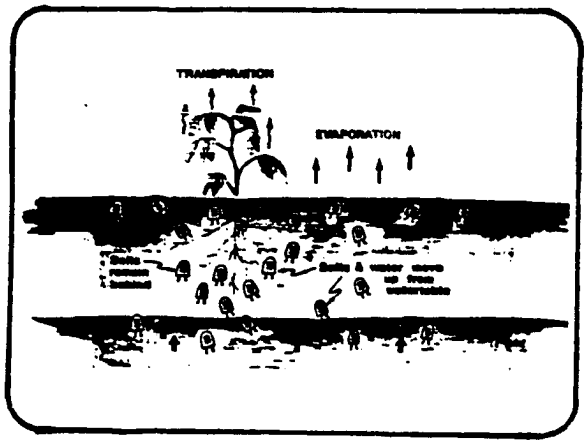


13. With irrigation development, secondary salinization of soils occurs as irrigation water brings along with it soluble salts. The release of salts by weathering during wetting and drying cycles also contributes to the problem. In addition, the moisture in different soil profile layers, and the composition of salts or salt load also contribute to the development of this problem.

In the absence of sufficient rainfall to regularly 'flush' out the salts, or with a high water table preventing this 'flushing' or leaching action, salts begin to accumulate over years to harmful levels in the crop root zone.



14. As the water table reaches within two meters of the surface, this process is accelerated. Water is drawn up due to capillary action carrying dissolved salts with it. As the water evaporates, the salts are left behind on and near the surface of the soil.



The result of this poor internal drainage and a high water table is that salts reach levels of concentration that prevent viable crop production.

15. These water-soluble salts inhibit seed germination and subsequently retard plant growth. Such salts are white or brownish in colour, chemically neutral, and include chlorides, sulfates and sometimes nitrates of calcium, magnesium, sodium and potassium. Sodium chloride is often the dominant salt.

16. Visually, these salts show up as a very thin white film on the soil surface. During hot, dry weather the deposits show up first along edges of salt problem areas. The centers of these areas usually have more salts and will dry out last.

17. The excess salts under saline soil conditions are damaging because they:
   - Limit uptake of water by plants,
   - Limit uptake of essential plant nutrients,
   - Remove water from plant roots,
   - Reduce soil microorganism activity, and,
   - Have direct toxic effects on plant tissues.

SOIL SALTS :

- Limit water uptake
- Limit nutrient uptake
- Remove plant root moisture
- Reduce soil microbial activity
- Have direct toxic effects

18. While sodic (or alkali) soils can be reclaimed using chemical amendments alongwith suitable agronomic and cultural practices, the inland saline soils invariably require lowering of the watertable; leaching, and appropriate agronomic and cultural practices. Leaching is the primary requirement for removing salts from the plant root zone. And only proper drainage and water management can prevent salt build-up from occurring again. The reclamation of highly saline soils under dryland farming conditions, however, is difficult.

ALKALI SOILS	SALINE SOILS
1. Leaching	1. Drainage
2. Amendment	2. Leaching
3. Drainage	3. No amendment

19. Steps to reclaim and cope with saline soils may require a combination of several practices. These include:
   - Surface and Subsurface Drainage,
   - Leaching,
   - Crop Selection,
   - and Cultural Practices.

   Let's look at each of these. The first is surface and subsurface drainage.

COPING WITH INLAND SALINITY:

- Surface & subsurface drainage
- Leaching
- Crop selection
- Cultural practices

20. Reclaiming waterlogged, saline soils, and preventing further soil degradation in inland irrigated areas, requires suitable surface and sub-surface drainage. Researchers at the Central Soil Salinity Research Institute, at Karnal, are studying the use of horizontal sub-surface drains along with surface drainage and appropriate management practices. Results show that these practices can restore the production potential of waterlogged, saline soil areas that have become barren. This bumper crop of wheat was grown on such an area after installation of sub-surface drainage and the adoption of recommended soil and crop management practices.

21. Surface drainage is a first step to get rid of excess monsoon water. This is a preventive measure against waterlogging which will otherwise contribute to a rise in the watertable. If surface drainage is not able to check the rise in the watertable, then a combination of surface and sub-surface drainage will be required. Under such a situation, the surface drainage system will serve as a carrier drain to dispose of surface runoff and sub-surface drainage effluents.

22. In reclaiming severely saline soils, ponding rain water or irrigation water on the surface to dissolve surface salt deposits, and then removing it through surface drains, is a recommended practice where feasible. This practice is called flushing of salts, and removes salts at or close to the surface. Usually, such a practice is adopted in heavy soils when an abundant quantity of irrigation water is available.

However, the most universally adopted practice is leaching by ponding good quality water on the soil surface. In this practice the water passing through the root zone dissolves the salts and carries them downward.

23. The amount of water and the duration of ponding depends on the type and quantity of salts, the soil type, and the depth of soil to be reclaimed.

Ponding areas must, however, be levelled for good results. As shown here, ponding will be ineffective under poorly levelled field conditions.

It should also be noted that both surface and sub-surface drains are successful in removing salts only if they have an outfall. And, there may be objections from people down the stream, because of the rise in salt content in the water.

24. Once heavy clay soils develop the problem of water logging and soil salinity, their reclamation is very difficult and costly. This is because these soils have low permeability. Hence, it is better to resort to preventive measures such as restricting the entry of floodwaters, preventing a rise in the watertable, and eliminating seepage into such areas.

PREVENTIVE MEASURES

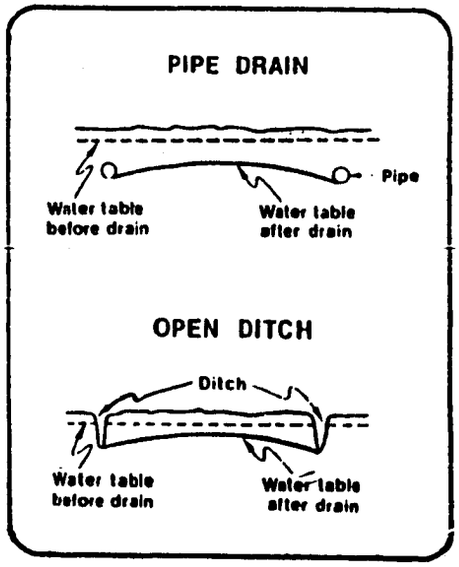
- Restrict entry of flood water
- Prevent rise in the watertable
- Eliminate seepage

25. In most hydrologic and soil conditions, surface drains fail to control the rise in the watertable. This is due to:
- Improper outfall conditions,
- Poor maintenance of drains, and
- Choking of drains due to bank slips and weeds.

OTHER RELATED PROBLEMS

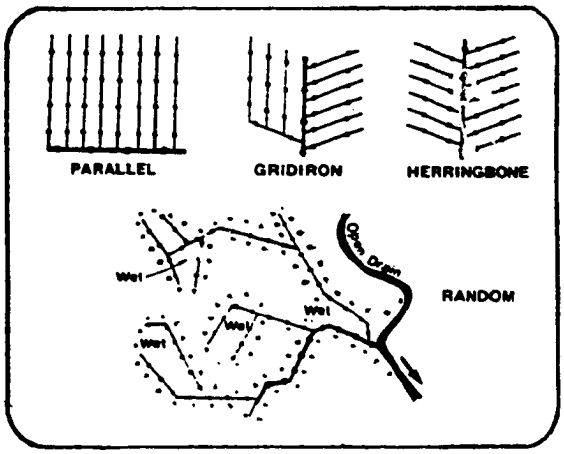
- Improper outfall conditions
- Poor maintenance of drains
- Choking due to bank slips, weeds

26. Sub-surface drain lines are installed with spacings and to a depth to effectively control water table levels. While deep open drains of similar spacing and depth are another alternative to accomplish the same results, much land surface is taken out of production by these open drains, and they are difficult to maintain. In addition, they cause problems related to cattle movement, and in field-to-field transport of farm machinery.



27. Sub-surface drainage systems are designed for each specific site. Designs vary with topography, annual water table fluctuations, hydraulic conductivity of the soil, and the depth of the impermeable layer and hard pan below the soil surface. Other determining factors are the crops to be grown, rainfall, and seepage from adjoining water bodies.

Four common layout patterns for sub-surface drainage systems are the Parallel, Gridiron, Herringbone and Random designs.

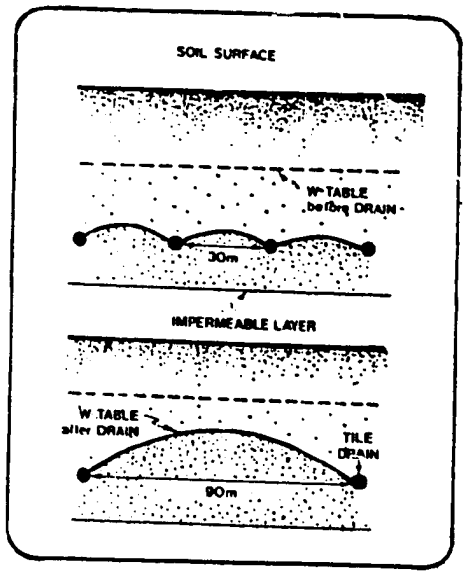


28. Variables that determine the spacing of laterals include rainfall amount and distribution, annual water table fluctuations, the hydraulic conductivity and drainable porosity of the soil, the drainage time desired, the soil depth to be reclaimed, cropping patterns planned, and the risk-bearing and managerial capabilities of the farmers involved. Of course the main consideration is the cost of installation. The closer the spacing, the more costly it is; and the deeper the depth, the more costly it is.

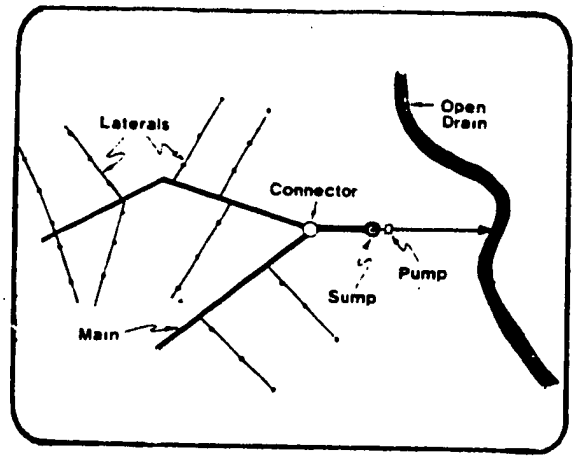
Variables Determining Lateral Spacings

- Rainfall amount and distribution
- Annual watertable fluctuations
- Soil hydraulic conductivity
- Drainable porosity
- Drainage time desired
- Soil depth to be reclaimed
- Cropping patterns
- Managerial capability of farmers

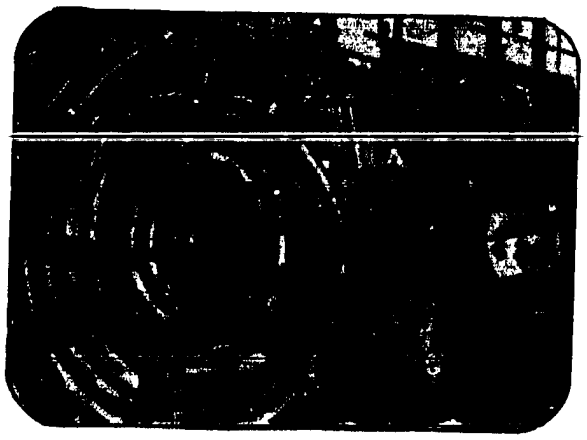
29. Installations in India normally vary from 30 to 100 meter distances between laterals. As distance between laterals increases, more time is required to drain the area, and the water table level between laterals will also remain closer to the surface, for longer periods. Even for the same lateral spacings, watertable levels will be closer to the soil surface for a longer period in heavy as compared to light textured soils. This is due to the drawdown curve characteristics of each particular soil type.



30. Sub-surface drainage components include laterals, mains, connectors, sumps, and a suitable pumping system where gravity outlets are not possible. Drainage problems are often in basin type situations, and therefore a natural outfall is not available. But where open drains with sufficient fall are available, a sump and pump may not be necessary.



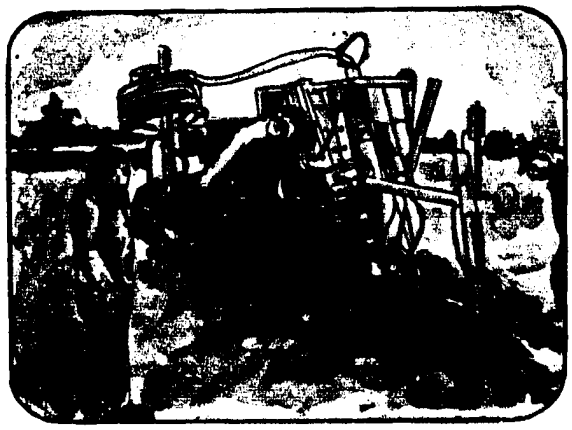
31. For installation of sub-surface drains, clay, cement or plastic pipes are commonly used. However, other indigenous materials are also being tried. In Europe, the United States, and other countries with extensive drainage installations, flexible corrugated perforated plastic tubing is the most commonly used material.



32. This material is now being manufactured in India as well. Note the perforations through which drain water enters the long plastic tubes.

Plastic drain pipes with diameters ranging from 80 to 400 mm are extensively used in Egypt and Pakistan in conditions similar to India. Since 1975, Egypt has installed pipe drains in 1.4 million hectares and Pakistan in 80,000 hectares.

33. In many countries, large machines are used to dig trenches and place pipes and envelope materials in one operation. These machines often use laser controls for exact placement of the pipes. The back-filling of the trenches is then done by tractor mounted blades in a second operation. Projects in progress are introducing drainage trenching machines in Punjab, Rajasthan, Haryana, and elsewhere in India. Manual installations may still be justified where only a small area needs to be drained, where no machines are locally available, or where there is preference for labour intensive work.



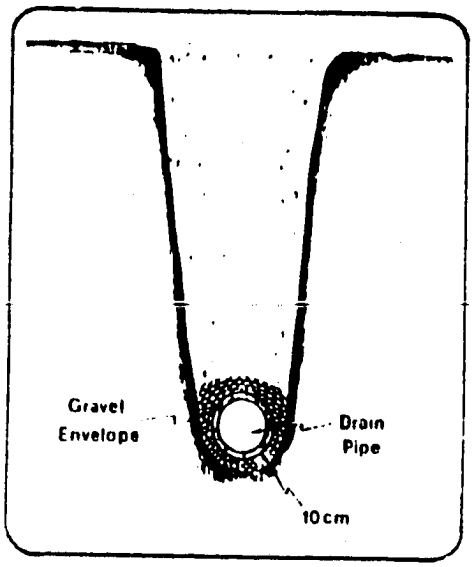
34. Hand labour, skilled and trained, can be substituted to reduce costs and to overcome the present unavailability of these machines in India.

35. When drain trenches are dug, their width must be kept as narrow as possible to minimize deflection of pipes after placement, and to minimize labour costs.

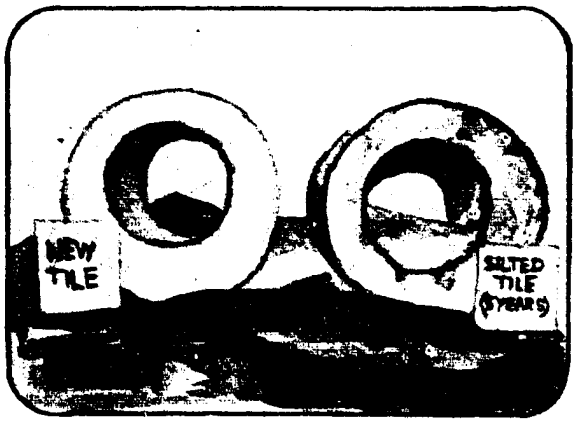
36. The critical stage, however, is the final placement and levelling of the pipelines, regardless of the pipe material used - clay, cement or plastic. Particular care must be taken to achieve alignment as well as proper gradient. Reverse gradient, or dips in any section of the trench bottom must be avoided.

Where the water table is high, de-watering may be necessary for proper installation.

37. Also essential for successful drainage installations are the selection and placement of filter materials, such as sand, gravel, or fabrics. The minimum thickness of a gravel envelope around the drain pipes is kept at 10 centimeters due to the physical difficulty of placing a uniformly smaller thickness of gravel. Satisfactory synthetic filters may be as thin as 2 mm.



38. An improper filter or absence of filter material may result in clogging of subsurface tiles over time. This tile was found half full of silt after only five years.



39. Graded gravel of two to eight milimeter sizes is a common filter used. However due to the distance to the source, this material is often quite expensive to bring to the site. Poor trafficability of waterlogged soils also adds to the problem of transport at the project site.

40. Geosynthetic fabrics made of polyester and polypropylene filaments are now used as sleeves over the pipes to serve as filters. Long-term experiments are being conducted in India to determine the suitability of these and other less expensive and commonly available filtering materials.

41. For example, here coconut coir matting is being used over the joints in this clay tile installation.

42. The cost of sub-surface drainage installations depends on a number of factors. These include:
- drain pipe materials used
- filter materials used
- method and depth of installation
- spacing between laterals
- need for dewatering
- requirements for sumps and pumps
- transportation of drainage materials
- skilled labour costs
- and others.

COST FACTORS

- Drain pipe materials
- Filter materials
- Method & depth of installation
- Laterals spacing
- Need for dewatering
- Sumps & pumps requirements
- Transportation costs
- Skilled labour cost

43. In the 1990s, sub-surface drainage installation costs in India vary from Rs.11000 to Rs.18000 per hectare, depending on the variables listed. The benefit-cost ratio of different crop-rotations following sub-surface tile drainage has been calculated for the CSSRI farm at Sampla in Haryana. The highest benefit-cost ratio was for a cotton-wheat rotation in that area.

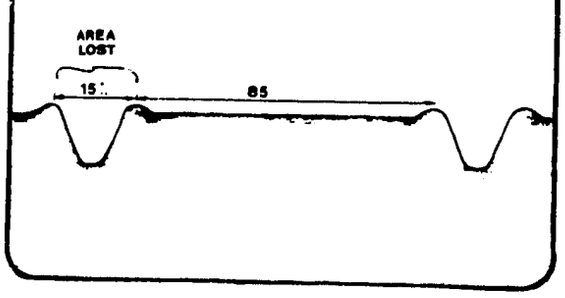
SUB-SURFACE DRAINAGE COST COMPONENTS

	Approx. % cost
Pipe (plastics) & fittings	41
Earthwork & installation	37
Filter materials	14
Sumps, pump, manholes & fittings	8
TOTAL ..... Rs 11,000 -18,000 /ha	

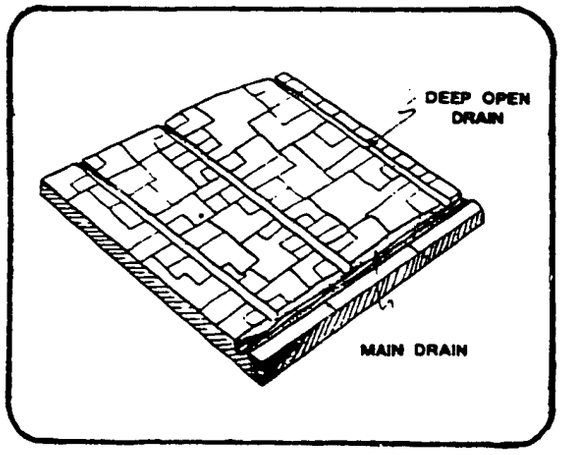
(Pause)

44. There are several advantages of sub-surface drains over the alternative of ~~deep open drains or ditches. The first~~ of these is that little or no land is lost from cultivation, whereas open ditches take up to 15% of cropland out of production in heavy textured soils.

OPEN DRAIN

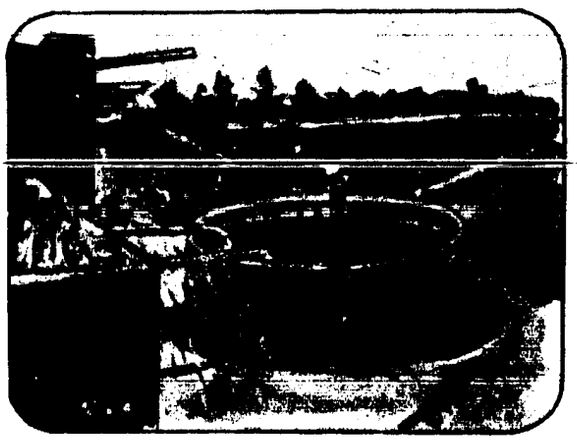


45. Secondly, the bunds of deep open drains impose natural working boundaries on land parcels, often making land consolidation necessary before installing deep open drainage systems. Because of these requirements, farmers have been known to refuse to allow deep open drainage networks on their land.



46. And thirdly, the maintenance of deep open drains is difficult and never-ending. This drain is almost completely filled after only one year of use. Farmers on a 50 ha block in Gujarat are now having their deep open drains replaced with a sub-surface network.

47. When salt content is no longer a problem, some drainage systems can be designed so that a portion of the drainage water can be stored and recycled for crop irrigation, saving both water and plant nutrients. Another alternative is conjunctive use of such waters blended with good quality water. However the associated issues are where and how to store drainage water, space requirements and the salt content of drainage water.



48. Under good management, some systems can also be manipulated during the growing season to provide subsurface irrigation when needed. Here an inflatable rubber dam is used to maintain levels in the main drain, and thus control water table levels in the adjoining cropland. Regular concrete control structures can accomplish the same results.

49. Reclamation as well as the maintenance and operation of drainage systems require community action. For example, farmers are already joining hands to form cooperatives in drainage project areas for maintaining such systems on a long term basis.

50. Such community participation can best begin at the planning stage and continue through the construction, operation and maintenance of the drainage system.

51. A second step in reclaiming saline soils is leaching.

COPING WITH INLAND SALINITY:

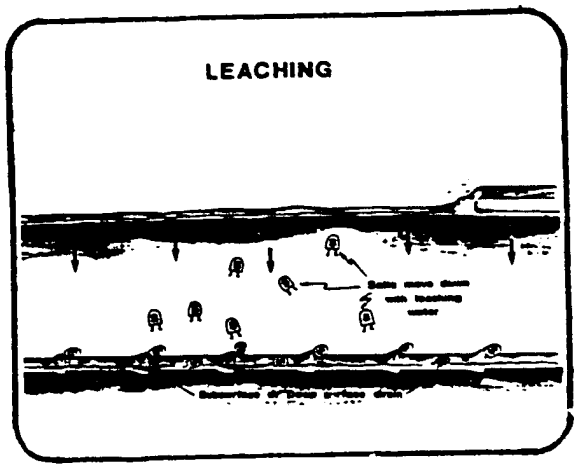
Surface & subsurface drainage

Leaching

Crop selection

Cultural practices

52. The only method to remove high concentrations of salt in the plant root zone in irrigated soil is by leaching, or washing downward with relatively salt-free water. Through leaching coupled with sub-surface drainage, a relatively reduced level of salinity in the root zone of most soils can be maintained.



53. The amount of leaching water required varies according to:
- the initial salt level in the soil,
- the nature of salts present in the soil,
- the final salt level desired,
- the quality of the irrigation or leaching water used,
- the soil texture, and
- the method of leaching.

Leaching Requirement Depends On:

- Salt level of soil
- Nature of salts
- Final salt level needed
- Quality of leaching water
- Soil texture
- Method of leaching

54. One rule of thumb is that the application of 30 centimeters of good quality irrigation water reduces salinity by about 80% in the top 30 centimeters of soil. Experimental evidence in India, however, indicates that in medium and light textured soils, the same results can be obtained ~~even by applying half this amount of~~ water.

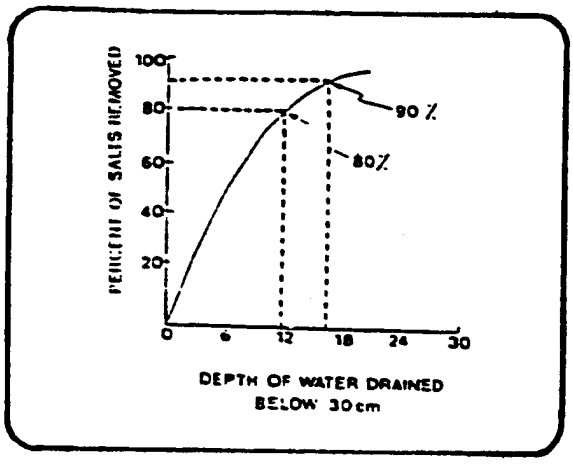
As this chart shows, the lower the salt levels desired, proportionately more water is required to achieve these levels.

The percent of salts to be leached is a management decision related to crops, varieties, and management practices to be adopted.

LEACHING (Thumb Rule)

Depth Water Applied	Approx. Salt Reduction
15 cm	50 %
30 cm	80 %
60 cm	90 %

55. Here is an example of the requirement of irrigation water to be drained below the desired depth, which was 30 centimeters. The soil texture was sandy loam, medium textured. To leach 80% of the salts from the top 30 centimeters of this soil profile, only 11.5 centimeters of water would be required to be drained below the 30 centimeters soil depth. If it is planned to leach 90% of the salts, then the water requirement will be 16.4 centimeters.



To calculate the total water we need to add additional water which will be absorbed by the soil.

56. This field in village Bhana Brahmana of Haryana, having a medium textured soil was put back into production after leaching 80% of the salts by applying 20 centimeters of total water through the 30 centimeters root zone.

57. The third practice in coping with Saline Soils, is selecting crops and varieties which have tolerance for the salt levels present in the soil.

COPING WITH INLAND SALINITY:

Surface & subsurface drainage

Leaching

Crop selection

Cultural practices

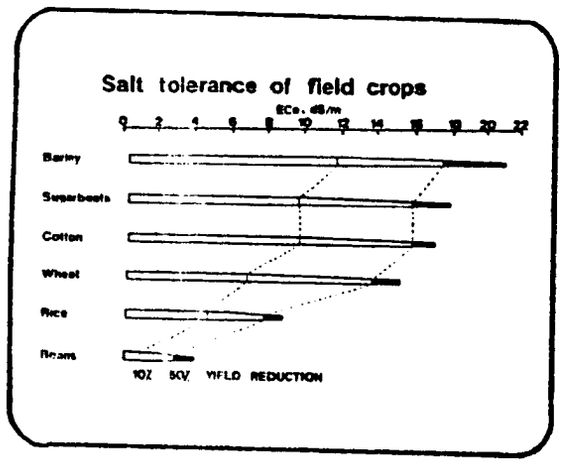
58. To do this, the approximate salt levels must be determined from a soil sample. Soil salt content is measured as electrical conductivity in a soil or sample solution. This test is performed in laboratories equipped for this purpose, and results are expressed in deci siemens per meter. It is important to remember that the same salt content reading is much more serious for crops in coarse textured soils than in fine textured soils. For example, a reading of two to four deci siemens per meter is strongly saline in coarse textured soil but only slightly saline in fine textured soil.

SOIL TEXTURE INFLUENCES SALINITY EFFECTS

Salinity Test (dS/m)	Texture of Soil		
	Coarse	Medium	Fine
2.0 - 4.0	STRONGLY SALINE	MOD. SALINE	SLIGHTLY SALINE
4.0 - 7.0	VERY STRONGLY SALINE	STRONGLY SALINE	MOD. SALINE

59. Crop selection is important for the farmer coping with soil salinity problems because:
- Some crops have much more salt tolerance than others, and
- Some varieties of certain crops are more salt tolerant than others.

60. In general, field and forage crops are more salt tolerant than vegetables and fruits. These chart ratings apply only to tolerance from late seedling stage through maturity - the period of most rapid plant growth.



Among the field crops, note that crops like barley, cotton, and sugarbeet are considerably more salt tolerant than cowpeas or field beans. However, under suitable sub-surface drainage conditions and appropriate crop management practices, good yields are being obtained from Bajra, Cotton, Wheat and Mustard crops on reclaimed saline soils at the CSSRI farm at Sampla, in Haryana.

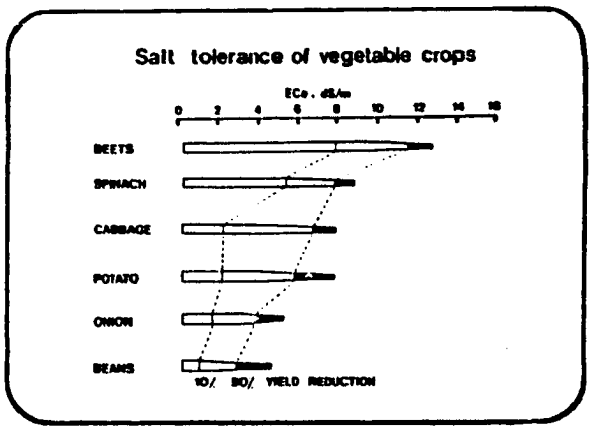
61. Among the forages, grasses are generally more salt tolerant than legumes.

Salt tolerance of forage crops

TOLERANT	SEMI-TOLERANT	SENSITIVE
Karnal grass	Perennial ryegrass	Lucerne (seedling)
Bermuda grass	Sudan grass	Red clover
Blue panic	Lucerne	
	Sorghum	
	Barley (hay)	

For the kharif season, forages such as Sudan Grass, Sorghum and Pearl Millet have been successfully grown on saline soils. Similarly, during the rabi season, Barley when using the first cut for forage, and Lucerne have also been successfully grown in India. Among the grasses, Karnal grass, botanically named Leptochloa fusca, and Blue Panic grass have also shown good promise.

62. Except for asparagus, vegetables have a relatively narrow range of salt tolerance.



63. Most fruit trees are particularly sensitive to high levels of salt, and therefore are not recommended for high saline soil areas.

SALT TOLERANCE OF FRUIT CROPS

Tolerant
Date-Palm

Semi-tolerant
Pomegranate, Figs, Grapes

Sensitive
Citrus, Almond, Plum

64. As just shown, certain crops have more salt tolerance than others. Researchers at the CSSRI in Karnal have also developed <u>varieties</u> which have more salt tolerance than other varieties within the same crop.

65. Some promising Wheat varieties which are tolerant at soil pH 9.6 are Kharchia 65, KRL two-dash-ten, and KRL three-dash-four. Other medium tolerant varieties at soil pH 9.4 are PBW 65, WH 157, Lok 1 & KRL one-dash-four.

SALT TOLERANT VARIETIES

WHEAT

TOLERANT SOIL pH 9.6	MED. TOLERANT SOIL pH 9.4
Kharchia 65	PBW 65
KRL 2-10	WH 157
KRL 3-4	LOK 1
	KRL 1-4

66. Particularly for rice, there are a number of salt tolerant varieties such as CSR 10, CSR 1, CSR 2 & CSR 3 which are suitable for various agro-climatic zones in India.

These are examples recommended for particular saline conditions. More site specific variety recommendations can be obtained from agricultural officers in each state.

SALT TOLERANT VARIETIES

RICE

CSR 10
CSR 1
CSR 2
CSR 3

67. Certain cultural practices can also moderate yield reductions due to soil salinity. The following are a series of facts and recommended practices for farmers coping with saline soils.

COPING WITH INLAND SALINITY:

Surface & subsurface drainage

Leaching

Crop selection

Cultural practices

68. Fact: Even distribution of standing water is required both for flushing off surface salts and for leaching.

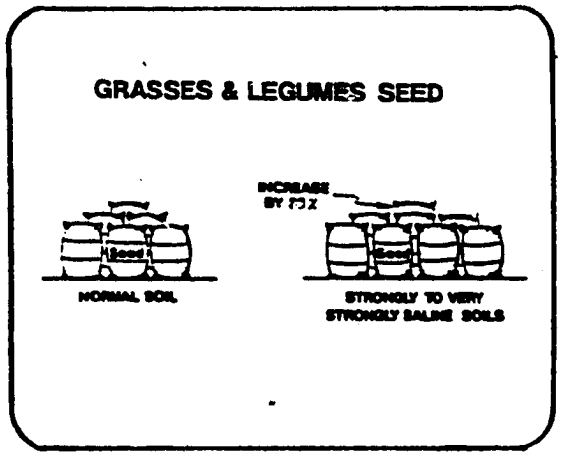
Practice: Level the land and construct bunds around fields for rain water storage and uniform water application.

69. Fact: Generally, as a plant advances in age, it develops more tolerance to salt.

Practice: When revegetating saline soils, transplant seedlings whenever possible. Excess salts cause high mortality in germinating seeds and young seedlings. This recommended practice of transplanting particularly includes rice.

70. Fact: Some crops are not commonly transplanted, such as grasses and legumes. For these crops, as the salinity level of the soil increases, the seed germination rate declines and the time required for germination increases.

Practice: Increase Grass and legume seed rates approximately 33% on soils with strong to very strong saline ratings. And plan more time for the germination stage to be completed.

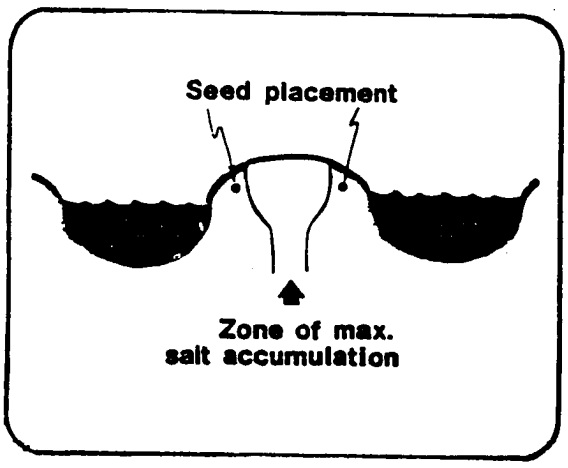


71. Fact: Some soils with high salt levels develop crusts, compact layers, or cemented layers which retard infiltration of water and restrict root penetration.

Practice: Break up the crusts and hard layers with a chisel or moldboard plough to improve the infiltration capacity of the soil and enhance the leaching action. However, do not disturb the subsoil if no such restrictive layers are present.

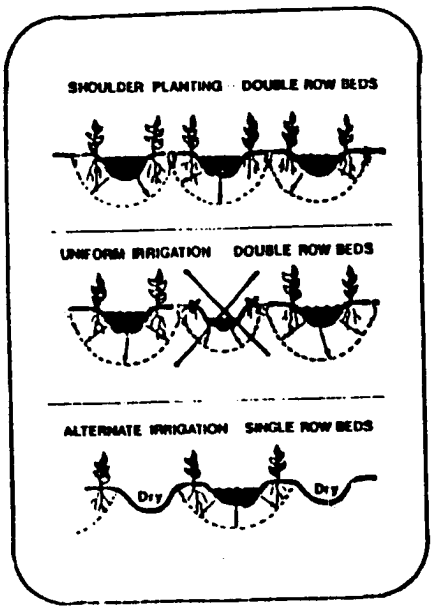
72. Fact : The effects of soil salts are diminished in the soil zone where soil moisture remains high. Salts become more concentrated where soil is allowed to become dry. Therefore placement of seeds and seedlings in row crops can increase or decrease the effects of salinity.

Practice: Plant row crop seeds to avoid a salt build-up in the immediate zone of seed or seedling placement.



73. Other practices relating to seed placement and irrigation include the following:

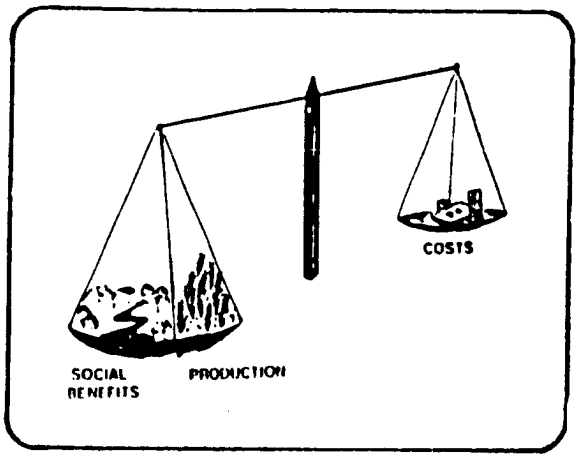
- Plant on the shoulder of double beds with furrow irrigation. This locates the seed away from the zone of salt concentration.
- Maintain uniform irrigation in furrows. Uneven irrigation causes salt concentration around the seed zone.
- And, use alternate furrow irrigation in single row beds. This also moves the area of salt concentration away from the seed row.



74. In summary, lakhs of hectares of productive land in India are affected by waterlogging and salinity. And more area is going out of production each year due to a combination of poor water management and completely neglecting the drainage component in irrigated areas.

75. Farmers can take specific steps to combat increasing salinity build-ups on their fields, such as crop and variety selection and certain cultural practices. However, long-term solutions include a combination of proper sub-surface drainage, sufficient leaching of the top soil with irrigation or rain water, and proper on-farm water management.

76. Rehabilitating water-logged, saline areas after they have become unproductive requires high investment in time and money. The cost of such rehabilitation must be considered against the benefits of putting back to production soils which became degraded due to this menace. The social benefits of putting village communities back on a self-sufficient basis must also be taken into account.



77. Music

For new irrigation schemes in the future, the wisest choice is to complete construction of effective drainage systems at the time of irrigation system development and then manage these systems properly to avoid waterlogging and salinity build-up.

78. Only then can farmers and communities in areas with waterlogging potential, be assured of the life-time benefits of irrigation as planned.

79. Credits

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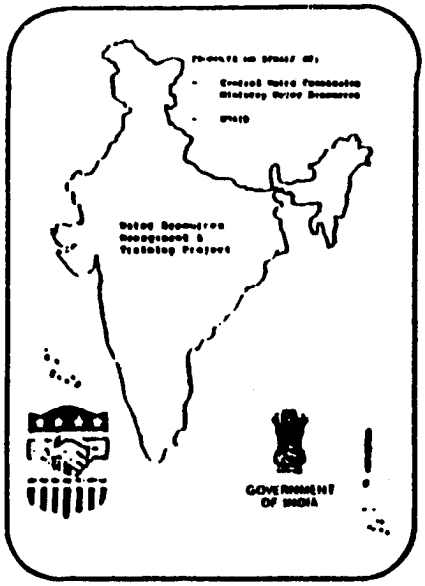
Voice	: Tejeswar Singh

80. Project Logo



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November 12, 1991

Director, ISPAN
Arlington, Virginia
U.S.A.

Dear Sir,

Enclosed for your reference is a copy of the script to the newly completed slide/tape presentation "Coping with Inland Salinity and Waterlogging" with reference to India. This was produced by LBII/WAPCOS with assistance from Central Soil Salinity Research Institute, Karnal, India and others.

Fifty copies of this presentation have been produced and are being distributed to training/educational institutions throughout India as well as several international agencies.

Very truly yours,

THOMAS O KAJER
TRAINING SPECIALIST
WINROCK INTERNATIONAL

Encl : a/a

*bk

NOV 25 1991

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