Lecture
On Form Water Management

Pic courtesy: Technical Brief 3, Directorate Gen.Agric. (Water Management), Punjab

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- History
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  - OFWM Project I,II and III
- Components of OFWM
  - Precision Land Leveling (PLL)
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On Farm Water Management

- Management of Water Downstream Outlet
- WHY OFWM
  - Demand Management Technique
  - Supplies are limited

History

- USAID Study through CSU (1968)
  - 40-65% losses due to:
    - Poorly maintained/designed Water Courses
    - Uneven Fields
    - Inefficient Irrigation Practices
  - First Water course selected for improvement MN-78 Water Course (Bhalwal)
  - MN-56 (Unofficial WUA)

OFWM Pilot project

- 5 Year Pilot Project (1976-80)
- All provinces
- US$ 7.5 Million (USAID)
- Scope:
  - Renovation of Watercourses with 10% lining
  - Promotion of Precision Land Leveling with 50% subsidy
  - Establishment of Water Management Training Institutes
  - Establishment of WUA
- Actual Work Done
  - Establishment of Federal Water Management Cell in Min of Food and Agriculture.
  - OFWM Directorate creation
  - 1330 Water Courses Improved (in all provinces)
  - Only 22% of target (13687 ha) of precision land leveling achieved

OFWM project I, II, and III

- OFWM-I in 1981-84
  - Technical assistance from World Bank, ADB, and USAID
  - Water course improvement reduced the losses from 25-40%
  - 95% of targeted accelerated water course improvement and PLL was achieved
  - WUA given legal status in 1981
  - OFWM Ordinance Amended 2001
- OFWM-II (1984-88) with extension upto 1990
- OFWM-III (1991-93)

Evaluation of OFWM I, II and III

- Spread over quarter of a century
- OFWM becomes a well established technology

- Water Course Improvement Benefits
  - Delivery Efficiency increase --- 23-30%
  - Saving in Water Losses ---24-25%
  - Increase in cropped area ----4.5-7%
  - Increase in cropping intensity ---5.8-14%
  - Increase in crop yield --- 14-17%
  - Saving in Irrigation time --- 25-30%
  - Reduction in salinity affected area --- 4.9%

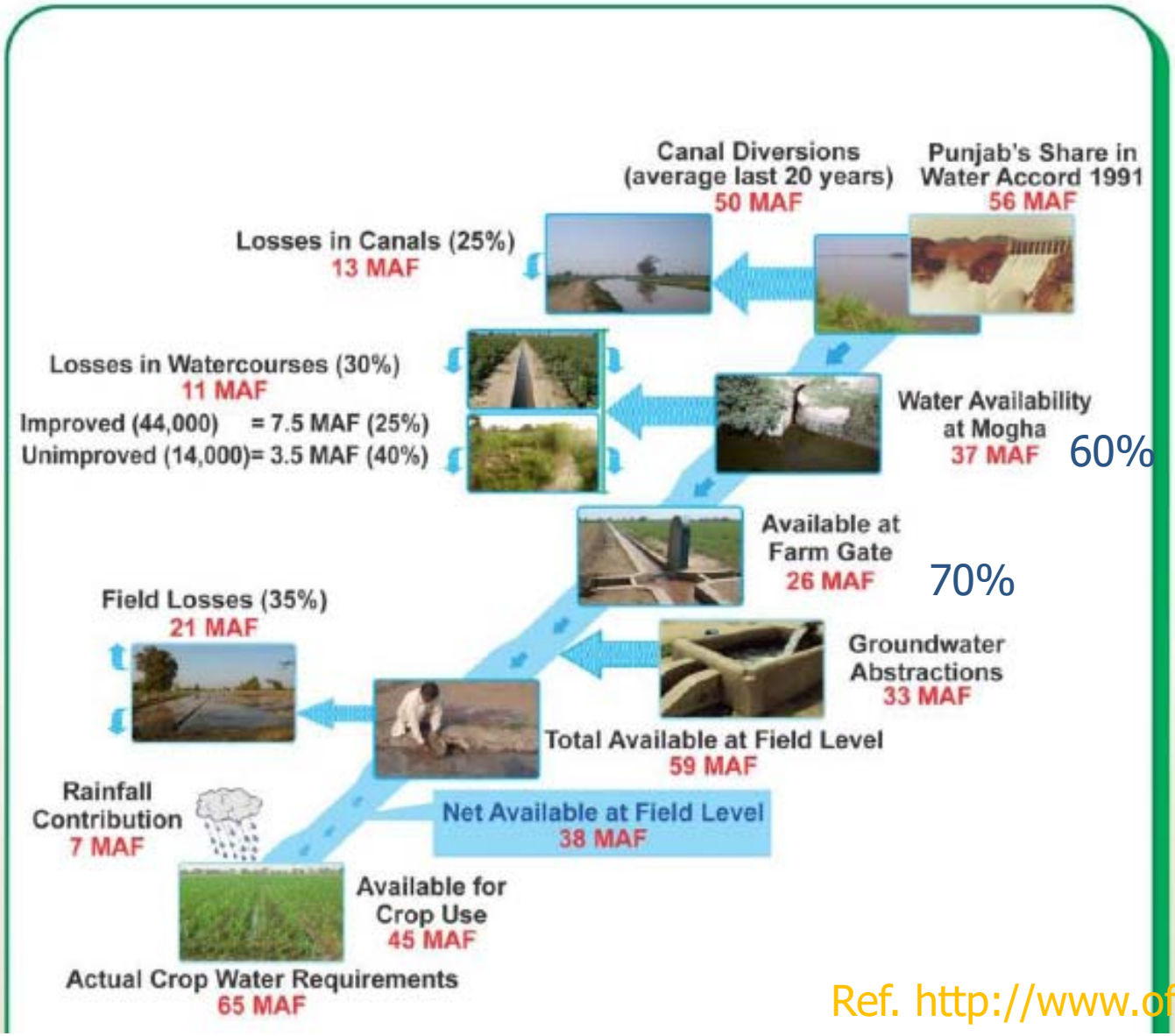
Evaluation of OFWM I, II and III

- Precision Land Leveling Benefits
  - Saving in Water Losses ---25%
  - Increase in cropping intensity ---20-40%
  - Increase in crop yield --- 18.5-35%
  - Saving in Irrigation time and labour --- 23-25%
  - Reduction in salinity affected area --- 42%
  - Increase in cultivable land --- 2-5%
- Shifting from low to high value crops

Component of OFWM

- Water Course Improvement
- Precision Land Leveling
- Irrigation Agronomy
- Training of manpower
- Organizing Water Users Association (WUA)

PUNJAB WATER BUDGET



Ref. http://www.ofwm.gop.pk/

Components:
Water Course Improvement

- Most Important Component of OFWM
- Improvements
  - Redesign based on:
    - Outlet (Mogha) Discharge
    - Topography and profile survey of Command Area
  - Demolishing of existing water course
    - Construction of a pad for new WC at designed slope
    - Embankments
    - Installation of concrete structures
      - Nakka
      - Buffalo wallows
    - 15% of the improved length to be brick lined in Fresh Groundwater zone
    - 30% of the improved length to be brick lined in Saline Groundwater zone

Components:
Water Course Improvement

- All works through WUA
  - Decision to improve the Water Course
  - Provision of unskilled and semi-skilled labour
  - Sharing 25% of the cost of material through easy installments (10 installments over 5 years)

Components: Precision Land Leveling

- Significant component
- Moving soil between low and high points for improved leveling
- Eliminates unwanted ditches, field water courses, and dikes/bunds
- Benefits:
  - Even spreading of irrigation water
  - Reduction of scouring and siltation
  - Uniformity in seed germination
  - Controlling loss of nutrients through leaching
  - Reduction in Salinity Sprouts (growth)
  - THUS increase Yield per unit area (MORE CROP PER DROP)

Components: Precision Land Leveling

- Modality:
  - Field is surveyed
  - Stacked
  - Designed for appropriate elevation
  - Earthwork is calculated (Cut and fill)
  - Equipment is made available by OFWM Project on rent
    - Bucket scraper, wheel type scraper, land leveler, chisel plough, border disk ditcher, laser transmitter and receivers

Components: Irrigation Agronomy

- Agronomy: Science of soil and crop management
- Irrigation Agronomy: Branch of agronomy which deals with scientific management of irrigation water, soil and crop to attain high water use efficiency, soil fertility and crop yield
- Major initiatives:
  - Soil~Water~Plant relation is studied
  - Loss of water is minimized
  - Conservation of moisture in soil is increased
  - Schedules are given so that the moisture in the root zone is replenished before damage to crop
  - Farmers Education regarding Modern Irrigation agronomy practices through:
    - Demonstration plots, demonstration farms, to show:
      - How, When, and How much to apply irrigation water
      - How, When, and How much to apply Agronomic Inputs (Fertilizers)
    - With the same amount of water 30% more land can be irrigated by better agronomic techniques

Components: Training of manpower

- To impart training of OFWM techniques to farmers, for continuous use of the techniques
- Farmers Training Centers established
- Training through demonstrations and case studies
- Training courses for the filed staff (Training of Trainers)
- Still there is need to enhance this component through well trained instructors

Components: WUA

- Association of farmers sharing same water course
- Association is registered if 51% farmers agree
- Informal Associations (for warabandi) were already present
- Problems with Associations (Collective effort)
  - Social differences (Cast, ethnic, regional, status)
  - Head to Tail differences (farmers at tail-end are more inclined towards improvements)
  - Feudalism is challenged if status of farmers is improved
- Informal Association tried in 1976-80
- Legal cover provided in 1981 and the WUA became formal associations

WUA Ordinance 1981

- Promulgated in 1981
- Obligatory for the field staff to have and association registered prior to starting renoavtion of WC
- Association will be registered only if 51% farmers agree to renovate
- After formation of association, all the irrigators are bound to cooperate in renovation and pay their respective share of labour and cost
- Leadership role will be played by the office bearer elected by the irrigators

WUA Functions

- Major duty is to properly clean and maintain the renovated Water Course
- Arrange and provide physical and financial resources
- Fix the responsibility of individual irrigators according to their land holdings
- Setting all disputes at the WC level
- Making alternate arrangement of water during renovation
- Arranging Safe guarding water course material provided to them and keeping a proper record of it
- Recovery of 25% cost in 10 easy installments over 5 years
- Receiving and disseminating the information from OFWM regarding demonstration plots
- Replicating improved practices of OFWM on farmers private ditches and branches

WUA proved good beginning for involving the farmers in resolving their issues through PUBLIC PRIVATE Partnership (PPP)

Precision Land Leveling (PLL)

- Benefits:
  - Uniform application of water
  - Uniform growth and stand of crops
  - Improved crop yields
  - Water saving
  - Increased efficiency of physical inputs
  - Soil and water conservation

Precision Land Leveling (PLL): Steps

- Planning and surveys
- Land leveling calculations
- Equipment for land leveling
  - Laser Technology for Land Leveling
- Leveling operation

Planning and surveys

- Information about
  - Soil type,
  - Fields boundaries,
  - Location of water courses and branches
  - Path/road in the fields
  - Residence/Dera
- Draw Plan of the area on graph sheet
- Select suitable grid size
- Mark the grid lines on Plan and on the field
- Mark center line of grid on ground with pegs
- Using surveying/leveling techniques measure existing level of each grid

Farm Layouts:
Khal Kiyari System

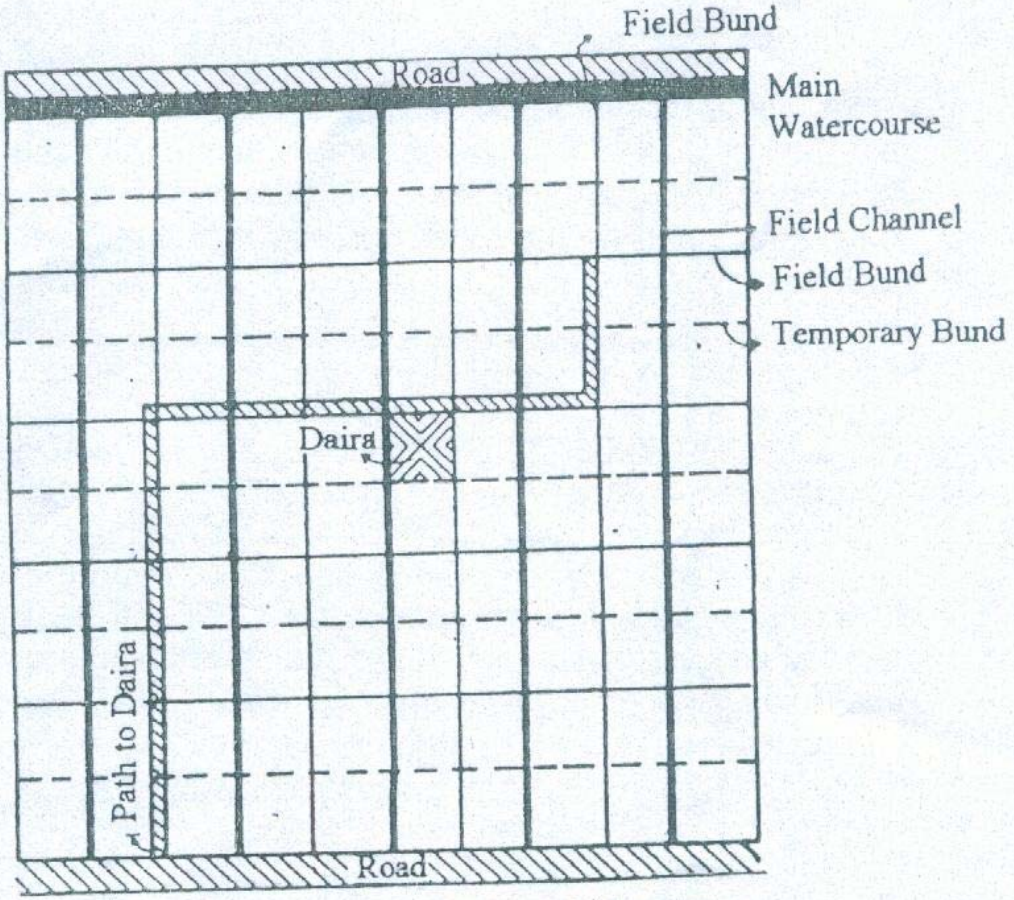
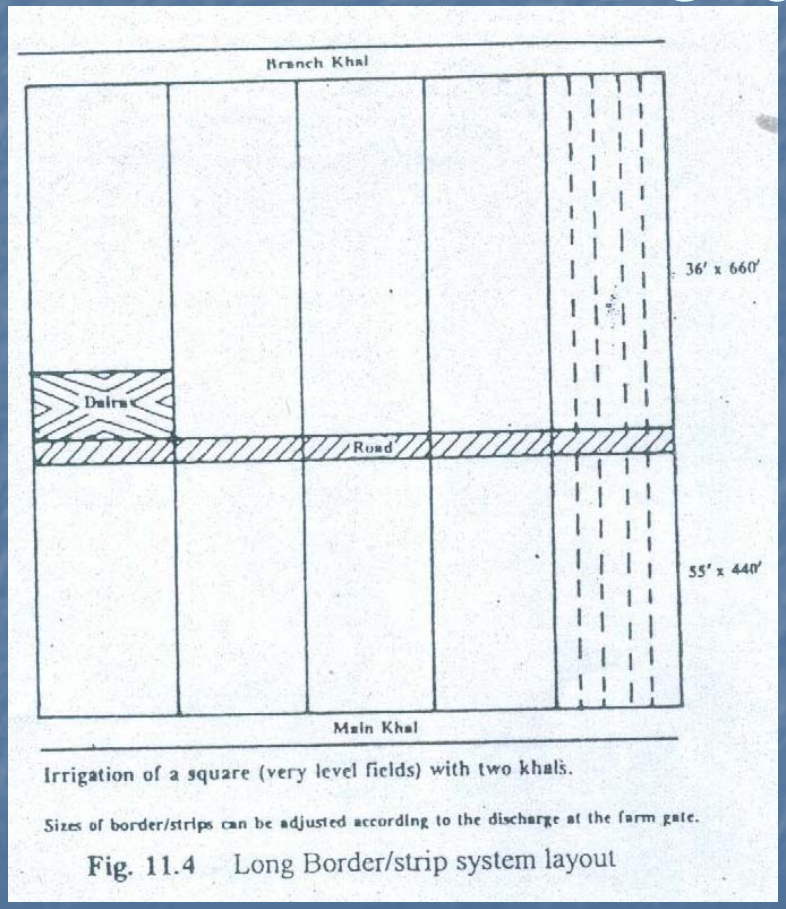


Fig. 11.3 Layout of square for khal kiari system.

Farm Layouts: Border Strips

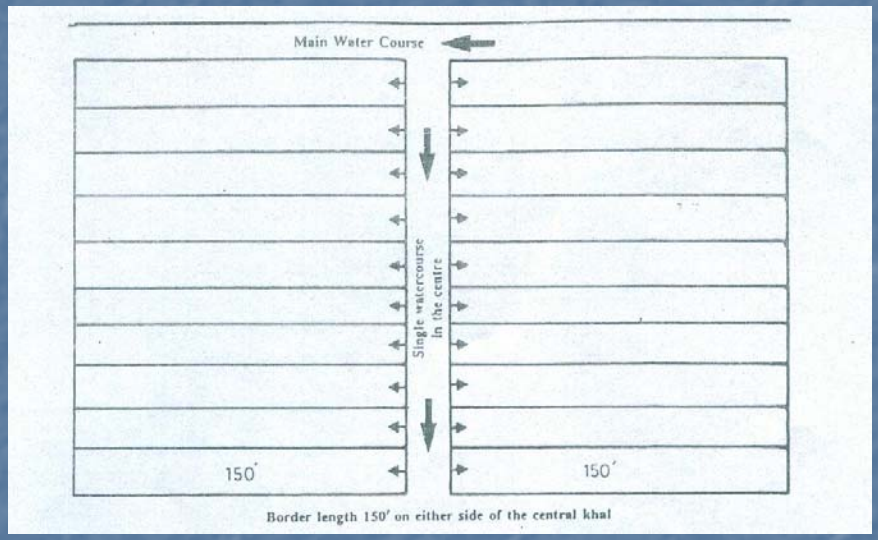


Irrigation of a square (very level fields) with two khals.

Sizes of border/strips can be adjusted according to the discharge at the farm gate.

Fig. 11.4 Long Border/strip system layout

With TWO Khals



Border length 150' on either side of the central khal

With Single Khal in Center

Farm Layouts: Border Strips

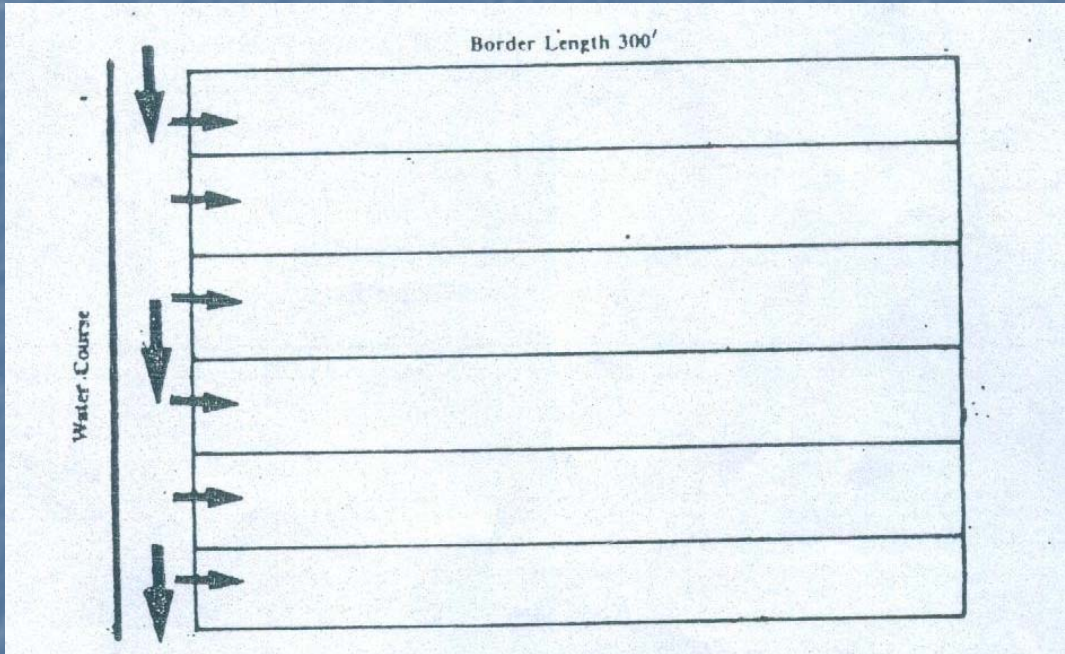


Fig. 11.5 Layout plan for irrigating a very level square with a single watercourse on one side of the square.

With Single Khal on a Side

Recommended Border widths

Table 11.5 Selection of border width according to nature of soil And discharge of water.

Nature of soil	Border width (meters) Discharge in cusecs		
	1-2	2-3	Over 3
Clay or clay	6	9-10	12
Loam	x	6	9-10
Sandy loam	x	x	6
Sandy	x	x	x

With Single Khals on side

Table 11.6 Selection of border width according to the nature of soil and discharge of water.

Nature of soil	Border width in meters Discharge of water in cusecs			
	<1	1-2	2-3	>3
Clay or clay loam	6	12	15	20-21
Loam	x	9-10	12	15
Sandy loam	x	6	9-10	12
Sandy	x	x	x	6

With TWO Khals Or single khal in center

Land leveling calculations

- Determine slope required based on type of soil. For Surface Irrigation, recommended slopes are:
  - Heavy (Clay) --- 0.1% to 0.4%
  - Medium (Loam or silt) --- 0.2% to 0.4%
  - Light (sandy) --- 0.25% to 0.65%
- Determine the cutting and filling required to maintain the required slope

Land Leveling calculation methods

- Plane method
- Profile method
- Plan inspection method
- Contour adjustment method

Ref: SCS USDA Handbook: Section 15 Irrigation: Chap 12, Land Leveling

Plane method

- Surface elevations are calculated so that the land surface has uniform downward and cross slopes
- Centroid of the area is found.
- Level of centroid is selected based on average level.
- Cross Lines through centroid are drawn
- Levels at the cross lines are calculated to achieve the slopes required
- Levels at the parallel lines are determined
- Centroid is lowered a bit to have more cutting than filling

See MS Excel Sheet

Equipment for land leveling

- Bulldozer for hauling the earth
- Scraper for hauling the earth
  - Self propelled
  - Tractor drawn: Turkish scraper (Small wheels)
- Chisel plough for hard surface
- Land Planes: for final touching to leveling jobs
  - 2 or 4 wheels
  - Adjustable blade at center of frame
  - 10 – 15 m long

Equipment

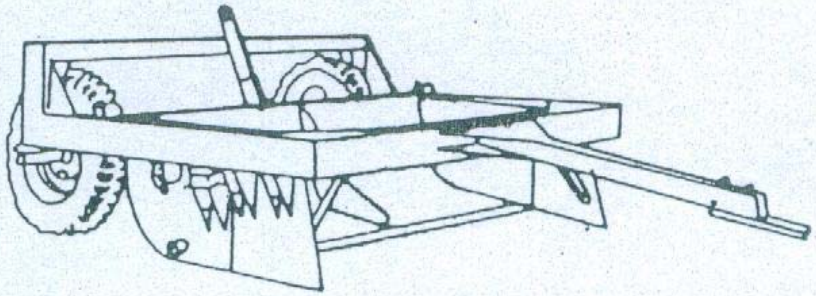
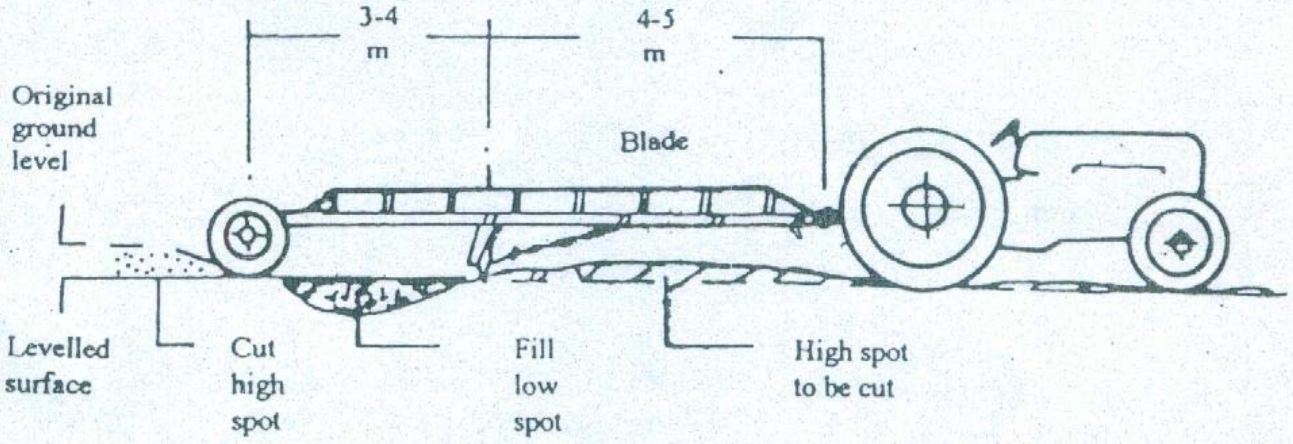


Fig. 11.1 Turkish type scraper.



Principle of operation

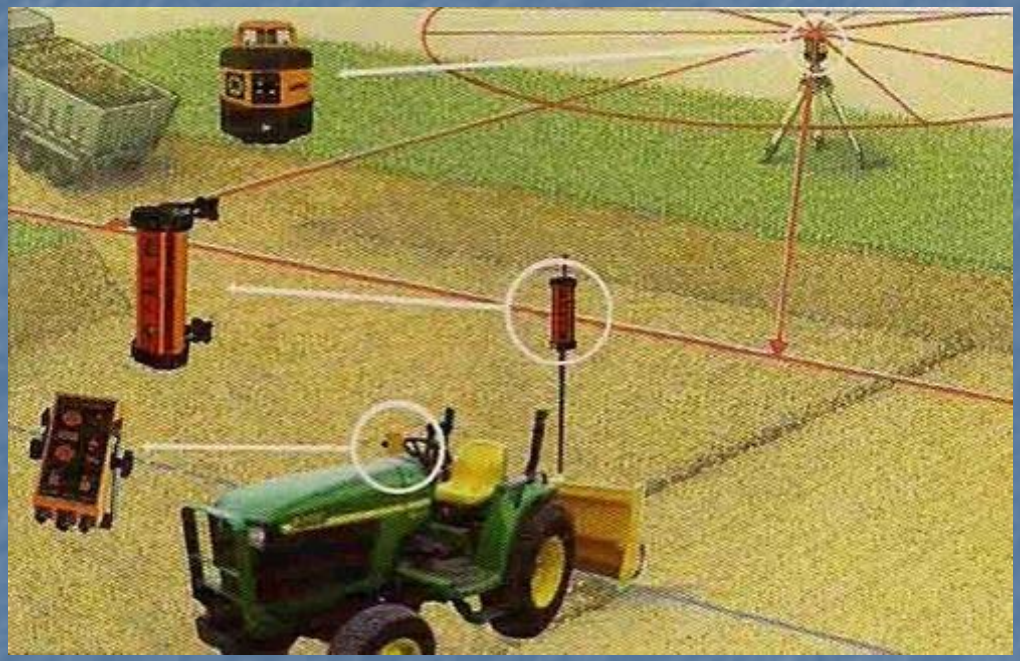
Fig. 11.2 Two wheel type land plane.

PLL in action

a. Laser land leveling

Ref: IWMI Research Report 108, 2007

Source: Photographs a and c: Mr. M. A. Gill, OFWM, Punjab, Pakistan
Photographs b and d: Dr. Riaz Ahmad Mann, PARC, Islamabad, Pakistan



http://www.tradeindia.com/fp1118759/Laser-Land-Leveler.html

http://www.facebook.com/photo.php?fbid=442769715815721&set=a.442768169149209.1073741836.318537724905588&type=1&theater

Laser Technology for Land Leveling

- PLL can be done with Laser Technology
- Quick and less labourious
- Give more accuracy than conventional leveling
  - Automatic (with hydraulic controlled blade)
  - Semi Automatic (Blade controlled by driver)
- Components:
  - Transmitter (at fixed location)
  - Receiver (At scraper)
  - Control Panel (in front of operator)
  - Interface Unit

Land Leveling

- Transmitter Set according to the average elevation
- Range is about 360 m, 2-3 m above ground
- Receiver is mounted on the scraper
- Elevation at which laser rays intersect are conveyed to dial mounted on control panel
- Blade is lowered or raised according to difference of level w.r.t. the required level
- After a perennial crop, leveling operation may be repeated for further improvement

Home Assignment

- Carryout the cut and fill calculations for land with spot levels as shown. The soil is sandy loam. Provide suitable slopes.