SUCCESS STORIES

On

1. Tractor Operated Straw Baler
2. Tractor Operated Aero-blast Sprayer
3. Tractor Operated Strip-till Drill
4. TNAU Tractor operated Three Row Plug Type Vegetable Transplanter
5. Custom Hiring of Tractor Operated Straw Combine in Haryana State
6. CIAE Multicrop Thresher
7. Tractor operated Raised Bed Planter
8. Tractor Operated Laser Land Leveler

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7. Tractor operated Raised Bed Planter

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Introduction

Bed planting system is referred to the planting and cultivation of crops on raised beds. Generally wheat and some other crops are planted on raised beds. Researchers from several organizations (DWR, Karnal; PAU, Ludhiana; CIAE, Bhopal; PDCSR, Modipuram; CCS HAU, Hisar, RWC-IGP and CIMMYT etc.) have reported that planting wheat on raised beds has improve yield, increased fertilizer use efficiency, reduced herbicides dependence, facilitated better weed management and mobility in the crop field for other cultural operations, less lodging of crops and saved seed, fertilizer and irrigation water. The total production cost compared to flat sown although found reduced marginally at the first planting on fresh beds but it has reduced by 25-35 per cent when the beds were reused. Bed planting technique is gaining acceptance by farmers because of more benefit-cost ratio compared to the flat sown crop and it is being assessed for its suitability in different parts of the country for different cropping systems.

Traditional practices for sowing of wheat

The traditional method is flat sowing of wheat either broadcasting by hand or sowing behind the animal drawn country plough by dropping seeds manually through a seed tube with funnel. For tractor farmers, the conventional practice is broadcasting the seeds and fertilizer by hand on a ploughed field and then mixing the seed and fertilizer with soil by one operation of a cultivator. With these methods the farmers generally use higher seed rate to compensate for the plant mortality due to non uniform placement of seeds with inadequate soil coverage. Further, due to broadcasting of fertilizer as basal dose during sowing, the weeds take the advantage and compete the crop from the beginning itself affecting thereby the initial stand establishment of the crop.

By use of seed cum fertilizer drill the seed and basal dose of fertilizer are metered uniformly in lines on well prepared seed bed for better stand establishment of the crop and yield. However compared to flat planting the raised bed planting has been found to be advantageous and is gaining acceptance by farmers.

Salient features of the raised bed planter

In view of specific advantages of bed planting system, raised bed planters have been designed and developed (PAU, Ludhiana/DWR, Karnal/CIAE, Bhopal) for planting of wheat on raised beds. The making of beds on well tilled soil, planting of seeds, basal application of fertilizer and covering and dressing of planted beds are done in one operation. For planting of seeds on permanent beds the same machine is also used for single operation and it adds the advantage of conservation tillage to the bed planting thus

reducing the cost of planting compared to the flat sowing of wheat. The general specifications of the machine are given in Annexure-I.

Evolution/Design Process

Raised bed planting of wheat in India gained momentum in the late 1990s. At Punjab Agricultural University, Ludhiana while studying the bed size configuration on wheat yield (Dhillon 1994-95). The bed planter was developed for two bed widths with two/three rows of wheat planted per bed. Simultaneously the bed planting of wheat was assessed at DWR, Karnal with development of raised bed planter in collaboration with a manufacturer. As the farmers started adopting the bed planting technology the initial design of the raised bed planter was progressively refined to the site needs based on the feed-back from different front line demonstration programmes.

The modified version of the machine consists of the following:

- Provision for varying the spacing of furrowers to the main frame for different sizes of beds.
- Provision of leveler ahead of furrow openers for smooth surface of bed prior to planting.
- Provision of shaper after the planting unit to dress the beds to shape.
- Planting on bed was adjustable for 2 or 3 rows.
- Provision with sweep type optional tines for early interculture in furrows.
- The size/section of furrower and other critical components were reduced by 25-30% to make these light weight and easy to handle.

Performance of raised bed planter for bed planting of wheat

The raised bed planter was evaluated for planting of wheat in friable black soils after three tillage operations (Fig. 7.1). The shape of bed was trapezoidal having top width, base width and height of 320, 600 and 125 mm respectively. The shape of furrow was triangular having width and depth in reference to the top of the bed for 340 and 210 mm respectively. However, the size of bed and furrow may vary depending on the soil type and condition of the soil during preparatory tillage. Comparison of raised bed planting and flat sowing of wheat with preparatory tillage is given in Table 7.1.

Table 7.1: Comparison of raised bed planting and flat sowing of wheat with preparatory tillage

Sl. No.	Particulars	Bed planting of wheat using raised bed planter			Flat sowing of wheat using seed cum fertilizer drill		
		Preparat-ory tillage	Bed planting	Total	Preparatory tillage	Flat sowing	Total
1	Time required, h/ha	8.0 -3 tillage	5.0	13.0	6.6 -3 tillage	2.7	9.3
2	Cost of operation, Rs/ha	1278	1000	2278	1188	494	1682
3	Direct (operational) energy used, MJ/ha	1333	995	2328	1239	507	1746
4	Soil condition	Moisture content = 20.58%db Bulk density = 0.98 g/cc MWD of clods = 16.56 mm Depth of tillage = 142 mm			Moisture content = 20.72%db Bulk density = 1.05 g/cc MWD of clods = 22.34 mm Depth of tillage = 114 mm		

The effective field capacity of the machine for fresh beds was 0.2 ha/h and its cost of operation with 45 hp tractor was Rs. 200/- per hour. The time, cost and operational energy use per hectare of bed planting with preparatory tillage were found 28.5, 26.2 and 25.0 percent higher respectively compared to the flat sowings. It was because of the fact that the required deep ploughing and straight ahead operation of the bed planter for fresh bed planting were time consuming compared to the conventional tillage and seeding operations for flat sowings.

By reuse of beds the bed planting operation was found to be energy efficient and cost effective compared to the conventional flat sowing of wheat with preparatory tillage. The reuse of beds for rice after harvest of wheat is being evaluated. Comparison of bed planting on permanent beds, zero till drilling and flat sowing of wheat is given in Table 7.2.

Fig. 7.1: Field operation of raised bed planter for bed planting of wheat.

Table 7.2: Comparison of bed planting on permanent beds, zero till drilling and flat sowing of wheat.

Sl. No.	Particulars	Planting on permanent beds	Zero-till drilling	Flat sowing with conventional tillage	Percent saving over flat sowing with conventional tillage	
					Planting on perma-nent beds	Zero-till drilling
1	Time required, h/ha	3.2	3.5	9.3	65.6	62.4
2	Fuel used, l/ha	11.2	14.0	30.7	63.5	54.4
3	Cost of operation, Rs/ha	645	665	1682	61.7	60.5
4	Direct (operational) energy used, MJ/ha	637	811	1746	63.5	53.5

Compared to zero-till drilling the bed planting operation by reuse of beds was also found advantageous in terms of savings in time, operational energy and cost of operation. However the performance of crops on reused beds is under evaluation to workout the cost-effectiveness of the system.

Three rows of wheat were planted shallow (depth of planting = 40 mm) at inter-row spacing of 150 mm on each bed with 80 kg/ha seed rate and fertilizer dose of N:P:K::90:30:15 kg/ha based on soil test. First irrigation (30 mm) was applied after 3 days of planting for proper germination and emergence of crops. Other cultural operations were similar to that of flat sown crop.

The performance of bed planted wheat (Figs. 7.2, 7.3 and 7.4) was found superior to the flat sown in respect of growth and active tillers. Mechanical weeding was easy in furrows at early stages of the crop. Irrigation was applied for 330 mm of water compared to 500 mm in flat sown. The variety HI-8498 performed well on beds and could compensate for the gaps (furrow) between the beds in terms of required plant population at harvest with higher yield attributes. Production economics and operational energy use in bed planted and flat sown wheat is given in Table 7.3.

Table 7.3: Production economics and operational energy use in bed planted and flat sown wheat.

Parameters	**Bed planted**	**Flat sown**
Grain yield, t/ha	4.80 (385)	4.65 (356)
Cost of production*, Rs/ha	9770	10332
Benefit-cost ratio	3.00	2.75
Operational energy, MJ/ha	6363	6927
Specific operational energy, MJ/kg	1.32	1.49
Specific cost of production*, Rs./kg	2.03	2.22

() Figures in parenthesis show plant population with active tillers per sq.m at harvest.

* Sale price of wheat (HI-8498), Rs/kg = 6.10.

The production economics showed 8.3% higher benefit cost ratio and 8.1% lower operational energy use in bed planting system with savings in seed, fertilizer and irrigation water compared to flat sown wheat. Advantage of bed planting of wheat over flat sowing is given in (Table 7.4.)

Fig. 7.2: Raised bed wheat (HI-8498) after 25 days of planting.

Fig. 7.3: Raised bed wheat (HI-8498) after 45 days of planting.

Fig. 7.4: Raised bed wheat (HI-8498) after 90 days of planting.

Table 7.4: Advantage of bed planting of wheat over flat sowing

Particulars	Bed planting	Flat sowing	Percent savings/benefits
Seed, kg/ha	80	100	20
Fertilizer* , N:P:K, kg/ha	90:30:15	120:40:20	25:25:25
Irrigation water, mm	330	500	34

*Based on soil tests

Planting on permanent beds may however further reduce the operational energy and cost of cultivation for increased benefit cost ratio.

General useful hints for use of raised bed planter

i. Preparatory tillage may be done at friable condition of soil to avoid clod formation and a deeper tillage (150-200 mm depth) is desirable.

ii. Sowing on beds by use of bed planter may be done shallow (depth of sowing : 40-50 mm) and covering of seeds may be ensured for proper seed-soil contact.

iii. Seed rate of 80 kg/ha is sufficient for wheat and it would give average of 30 plants per meter length of row on beds.

iv. Basal dose of fertilizer (P and K full and one third of recommended N) may be applied during sowing and the balance top dressed in two splits.

v. 75 percent of the fertilizers recommended for flat sown wheat is sufficient in bed planting for yield average of 4.8 t/ha.

vi. First irrigation (30-40 mm) may be applied after 3/4 days of planting to ensure proper germination and emergence of crops.

vii. Application of irrigation water may be frequent depending on soil type and weather conditions but the total water requirement for wheat may not exceed 60-70 percent of what is required for flat sown crop.

viii. First weeding may be done by improved weeders in furrows after 20-25 days of sowing and subsequent weedings may be done by moving through the furrow spaces.

Facts at a glance about raised bed planter

Bed planting compared to flat sown cultivation of wheat.

- Improves yield by 05-10%.
- Saves seed and fertilizer by 25-30%.
- Saves irrigation by 30-35%.
- Prevents lodging of crop.
- Facilitates easy mechanical weeding and reduces herbicides dependence.
- Higher benefit-cost ratio.
- More energy efficient and cost effective when planting is done on reused/permanent beds.

Precautions for proper operation of the raised bed planter

< Check the machine components such as furrowers, seed/fertilizer units, leveler and shaper for their proper orientation and alignment with the main frame.
< The machine may be properly hitched to the three point linkage of the tractor by adjusting the top link.
< The sprocket-chain system should be properly tightened and aligned with the drive wheel for positive rotation of seed/fertilizer metering shafts.
< The seed must be clean and graded and fertilizers be free from clods for smooth metering. As far as possible use only granular fertilizers which meter easily and uniformly.
< Calibrate the machine for metering of required quantity of seed and fertilizer.
< The furrow openers for placement of seed/fertilizer should be in between the furrowers ahead. The furrow openers may be adjusted as per crop row spacing's desired. The furrow openers may be a shovel type for loamy soil and shoe edge type for heavy soils. See carefully that the furrow openers do not choke with

moist soil or carry trash underneath. Check the depth of sowing of seed/fertilizer by removing the soil from the sown line.

- To train the operator for straight ahead operation and to place the machine at the headland for subsequent passes the machine may be operated for some time in the field for practice before actual planting is done.
- The depth of operation of the machine should be limited to the depth of the tilled soil to avoid excessive draft load on the tractor.
- For planting on permanent beds the tractor wheels must run on the previously created furrows so that the beds are reshaped by the furrower and shaper simultaneously during planting.

Care and maintenance of the raised bed planter

- Ensure shape of the components/parts against bending and dislocations.
- Repair/replace the broken parts and keep tightening the nut/bolts as and when required.
- Clean throughly the seed and fertilizer boxes and the metering devices after the day's work.
- Lubricate the parts of the machine periodically.
- The machine especially the seed and fertilizer boxes may be painted after the planting season to avoid corrosion and rusting.
- The transmission parts should be regularly cleaned, oiled and protected from dust.
- The machine should be properly stored for protection against rain and dust.

Status of the technology

The raised bed planter was tested for bed planting of wheat after harvest of rice and soybean. The machine has been used for bed planting of wheat in nearly 100 ha (1999-2000 and 2000-2001) on farmer's fields in Punjab, Haryana, Uttar Pradesh, Madhya Pradesh and Bihar under the National Agricultural Technology Project (NATP) - Rice Wheat Mechanization.

Under the Department of Agriculture and Co-operation (DAC) - Indian Council of Agricultural Research (ICAR) central sector scheme Front Line Demonstrations (FLD) of raised bed planter have been implemented in 12 states (Punjab, Haryana, Uttar Pradesh, Uttranchal, Bihar, Madhya Pradesh, Chhattisgarh, West Bengal, Rajasthan, Himachal Pradesh, Assam and Jammu and Kashmir) through 24 locations in which 30 number of raised bed planters are under demonstrations in farmer's fields with target area of 300 hectares.

List of Selected manufacturers of raised bed planter is given in Annexure-II.

Annexure-I

Specification of the Raised bed planter

1.	Type	Tractor operated, 6 rows on 2-beds
2.	Source of power, hp	35-45 (26-34 kW)
3.	Overall dimensions, LxWxH, mm	2080x1870x1350
4.	Shape and size of frame, mm	Rectangular (tubular : cross section :50x50 mm) Size : 2080x685 mm
5.	Furrower for beds Number Size (LengthxWidth),mm Spacing, mm	 03 600x370 730
6.	Furrow openers for seeding Type Size, mm No. of tynes Spacing, mm	 Shoe edge type 40 06 150
7.	Drive wheel Location Size (DiameterxWidth),mm No of lugs, no. Lug spacing, mm Lug height, mm	 front-centre 450x80 12 90 40
8.	Power transmission	Sprocket and chain system
9.	Seed metering Type No. of fluted rollers Size of fluted roller (DiaxLength), mm No. of flutes Size of flutes, (LxW), mm Size of seed box (LxWxH), mm	 Fluted roller type 06 50x45 10 45x10 1250x260x200

10.	Fertilizer metering Type No. of cups, no. Dia. of cup roller, mm Size of fertilizer box, (LxWxH), mm	 Cup feed type 10 140 1250x260x200`
11.	Leveller Shape Size (LengthxDiameter), mm	 round pipe section 62 ɔ
12.	Shaper Shape Size Top width, mm Base width, mm Height, mm Slope, degree	 trapezoidal section for bed and triangular for furrow 340 640 150 45
13	Weight, kg	270
14	Unit price, Rs	17000
15.	Materials of construction Furrower Frame Seed metering unit Box Fluted roller Fertilizer metering unit Box Fertilizer metering roller Seeding tynes	 Mild steel (M.S.) flat and sheet MS flat, square, pipe, channel and sheet MS sheet and angle Aluminium compound MS sheet and angle cast iron MS flat, sheet and pipe

Annexure-II
List of Manufacturers

1. Principal Investigator
   Revolving Fund Scheme
   Department of Farm Power and Machinery,
   College of Agricultural Engineering and Technology,
   Punjab Agricultural University, Ludhiana - 141 004, Punjab.

2. Principal Investigator and Incharge

Prototype Production Centre
Central Institute of Agricultural Engineering,
Nabi Bagh, Berasia Road, Bhopal - 462 038, M.P.

3. M/s ASS Foundary and Agriculture Works,
G.T. Road, Near Anmol Cinema,
Jandiala Guru, Amritsar - 143 115, Pun

4. M/s. Dashmesh Mechanical Works
Amargarh
Distt. Sangrur

5. M/s. National Agro Industries
Link road, Industrial Area A,
Opp. Transport Nagar
Ludhiana - 141003

8. Tractor Operated Laser Land Leveler

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Introduction

Precision land leveling is the foremost step for judicious use of water and laser land leveler is one such device which could promote efficient utilization of water. This will not only conserve water and save electricity and time but will also improve the judicious use of other agricultural inputs like fertilizer, insecticides, pesticides and weedicides etc. This will also result in uniform maturity of the crop, better quality and higher yield. Thus, there is an urgent need to promote the use of laser land leveling technology in a big way through Govt. and Non-Govt. organizations. Department of Farm Power & Machinery, PAU Ludhiana has already taken this initiative and provided services to farmers in different villages of the state particularly in the village Sukhanand (Moga). Enterprising custom hiring agencies are coming up to meet this challenge. State Soil Conservation Department has also taken necessary steps in this regard to promote the use of laser land leveler. This compilation gives information about laser land leveling, major components of the machine, tips/instructions for machine usage in the field and the benefits of laser land leveling.

Why laser leveling?

Declining water table and degrading soil health are the major concerns for the current growth rate and sustainability of Punjab agriculture. Thus proper emphasis should be given on the management of irrigation water usage for adequate growth of agriculture. Keeping in view, the need for judicious use of natural resources, concerted efforts should be made to enlighten the farmers for efficient use of irrigation water at farm level. Generally, in rice-wheat crop rotation farmers believed that their fields are leveled and needed no further leveling. But the digital elevation survey sheet of a field shows that the most of the fields are not adequately leveled and requires further precision land leveling.

The enhancement of water use efficiency and farm productivity at field level is one of the best options to redress the problem of declining water table in the state. The planner and policy maker should be properly informed and motivated to develop strategies and programmes for efficient utilization of available water resources. Laser land leveling is one such important technology for using water efficiently as it reduces irrigation time and enhances productivity not only of water but also of other non-water farm inputs. Results in technologically advanced countries have indicated that it saves water to the tune of 25-30% and time by 30% and also improves production and productivity by 10-15%. It has also been observed that with Laser Land Leveling 2-3% effective cropped area in case of flat fields and even more in ridge sown fields become available for cultivation of crops, as the number of bunds and irrigation channels get reduced considerably. In fact,

the western Punjab (now under Pakistan) is ahead of us in using this new technology for the last few years. More than 2 lacs acres in Punjab province of Pakistan have already been laser leveled and government have been investing substantial money to introduce another 1500 laser leveling machines.

What is laser leveling?

Laser leveling is a laser guided precision leveling technique used for achieving very fine leveling with desired grade on the agricultural field. Laser leveling uses a laser transmitter unit that constantly emits 360° rotating beam parallel to the required field plane. This beam is received by a laser receiver (receiving unit) fitted on a mast on the scraper unit. The signal received is converted into cut and fill level adjustments and the corresponding changes in scraper level are carried out automatically by a two way hydraulic control valve. Laser leveling maintains the grade by automatically performing the cutting and filling operations. Both level grade and slope grade (one way or two way) can be achieved with the help of this precision equipment. The field is cultivated and planked before using the laser land leveler. A grid survey is performed using grade rod to identify highs and lows in the field and mean grade is found. A grid spacing of 10 mx 10 m is maintained for accurate land survey, however this spacing can be varied depending upon the size of the field. For practical purposes and with experience, grid surveys can be done by pacing off the distances (rather than measuring). A map is then drawn to indicate which areas are high, require soil to be cut and the lows which require soil to be added.

Components of laser leveler

The complete laser land leveler equipment includes laser emitter, laser receiver, two way hydraulic valve, laser eye, grade rod, tripod stand, control box on tractor and scraper unit. Working and description of the equipment are given as follows.

Laser Emitter: The laser emitter unit sends continuous self leveled laser beam signal with 360° laser reference up to a command radius of 300-400 m (depending upon it's range) for auto-guidance of the receiving unit. The laser emitter is mounted on a tripod stand placed just out side the field to be laser leveled and high enough to have unobstructed laser beam travel. Different working components & controls on the laser emitter unit includes laser emission indicator, low battery indicator, off/on power button, manual grade buttons, charge jack, battery assembly and manual mode indicator for setting of desired grade. The trouble free usage of these components should be made by following the relevant instructions mentioned in the operator's manual.

Laser Beam Receiver: The laser receiver mounted on the scraper is a unidirectional (360°) receiver that detects the position of the laser reference plane and transmits it to the control box mounted on the tractor. Further this

control box directs the double actuating hydraulic valve for desired upward and downward movement of scraper blade to obtain the leveled field. The grade position LED's indicate the position of the machine's blade relative to the plane of the laser light from the laser emitter. These lamps function in the same way as the grade position lamps on the control box mounted on tractor except they flash rapidly instead of lighting solidly.

Control Box: The control box is to be mounted on the tractor so that the operator can easily access the switches and view the indicator lamps. The control box has the main control unit for actuating the double acting hydraulic valves. The control box receives and processes signals from the b u c k e t . It displays these signals to indicate the drag bucket's position relative to the finished grade. The control box is set to manual for initial adjustments of scraper blade before starting operation. When the control box is set to automatic position, it provides electrical output for driving the hydraulic valve to operate scraper automatically. The three control box switches are On/Off, Auto/Manual, and Manual Raise/Lower (which allows the operator to manually raising or lowering the drag bucket).

Hydraulic Valve Assembly: The valve assembly regulates the flow of tractor hydraulic oil to the hydraulic cylinder to raise and lower the scraper blade. The oil supplied by the tractor's hydraulic pump is normally delivered at 2000-3000 psi pressure. As the hydraulic pump is a positive displacement pump and always pumping more oil than required, a pressure relief valve has also been provided in the system to return the excess oil to the tractor reservoir. The solenoid control valve controls the flow of oil to the hydraulic ram which raises and lowers the bucket. The desired rate at which the bucket could be raised and lowered is dependent on the operating speed. The faster the ground speed, the faster the bucket will need to be actuated. The rate at which the bucket will raise and lower is dependent on the amount of oil supplied to the delivery line.

Laser Eye: Laser eye is to be mounted on the grade survey rod for obtaining the level of the field. It contains a laser receiving panel and when the laser emitted by the laser emitter panel falls in the center of this eye a continuous beep indicates the level of that specific point w.r.t. the laser emitter. The grade of that point is then read from grade rod.

Field operation

The correct methodology is essential to have full advantage of this precision technique for land leveling. The following steps are involved in accurate usage of laser land leveler in field.

- Calibration of equipment
- Setting-Up of equipment for field operation Set-Up for leveling

    - Horizontal level
    - Graded field (one way/both ways)
- Level survey of field

Benching & operating the equipment

It is essential to check the laser for calibration (as per guidelines provided in the operator's manual) upon receipt of equipment and also periodically before using the equipment to ensure that calibration is maintained. If the equipment requires calibration, it should be sent to nearest authorized service centre or to be calibrated as per instructions. While calibrating, the equipment should be placed on a flat/level surface of tripod approximately 100 ft (30 m) from the wall. Once the desired calibration has been set, press the power button at once to store the information and turn the power off. The equipment will be set to the new calibration when power is re-applied.

Caution: The equipment should be calibrated only when required.

Setting-up of equipment for field operation

Following are the guidelines for setting up the laser emitter, laser receiver, laser eye and control box on a tractor.

1. The laser emitter and laser eye should be fully charged or equipped with replicable batteries with sufficient battery back-up before taken to field.
2. The electrical connections of control box on tractor and double actuating valve should be made properly.
3. Choose a location in the field for the laser emitter (to be fixed on tripod) where obstruction, such as trees and buildings, passages etc. do not block the plane of laser light. The laser receiver on the scraper should be able to sense the plane of laser light all times.
4. As far as possible, set up the laser emitter and receiver at a height above the tractor's canopy or any cab or roll over protection attachment to avoid any blocking the plane of laser beam as the machine moves around the field.
5. Fix the laser eye on the graded rod for the field level survey (as mentioned below) which is essential for estimating the quantum of work and find the level of plane to be maintained as per needs.
6. Sufficient number of iron or wooden pegs should be arranged for marking the different points in field during survey.

Set-up for land leveling

The fields can be leveled with this laser levelers to perfectly flat/horizontal fields (level with zero grade) or to any single or dual slope (or grade) depending upon soil & water and agronomic practices.

Setting for Level/zero grade

If the field is to be prepared as perfectly flat field i.e. no slope, the set up of the laser emitter is simple and does not need any alignment. Set the laser emitter for zero level grades (as per instructions in operator's manual) which will provide a level plane of laser beam in all directions.

Setting for Slope Graded field

If the field is to be graded for single or dual slope, laser emitter requires its axes to be aligned accordingly (as per instruction in the operator's manual). The laser emitter will then provide a plane of laser beam at desired slope(s). Remember each field is unique, so consider the instructions as guidelines in particular situation and not as the general method. The laser leveler is used for precision leveling only. Major soil movement should be done (if required) with traditional equipment or specific machine depending upon quantum of soil movement prior to usage of laser land leveler. Following steps are to be followed for the survey:

Fix the laser emitter and laser eye on tripod and graded rod respectively (Fig. 8.1). Adjust/align the emitter for level grading or sloped grading. Establish the level of the field using grade rod at different locations in field. While taking the level on grade rod the laser eye and the laser emitter should be in line and continuous beep should sound from laser eye after adjusting it up and down.

Fig. 8.1: Field adjustment of laser emitter.

Record the field levels at corresponding points selected in the field at every 10-15m (as shown in survey map/sheet, Fig. 8.2) depending upon the size of field. More the points selected for survey more will be the precision.

Mark the points/locations where levels have been recorded with pegs. Calculate the average field level obtained after the field survey. Locate the point similar or nearest to the average level obtained.

Benching & operating the equipment

After locating the average level of the field required for flat level or sloped grade, following steps should be followed for benching the equipment:

- Set the scraper blade and laser beam receiver at the location where average/
  nearest level exists (Fig. 8.3).
- Set the control knob/switch on control box mounted on tractor to manual. Then
  set the scraper blade just above the selected location using raise and lower switch/knob on the control box (Fig. 8.3).
- After setting the scraper blade, adjust the laser beam receiver mounted on scraper mast at such as point where green light blinks on the control box indicating that laser beam emitter and laser receiver are in line. Set the control knob/switch from "Manual to Auto" and start operating the tractor & leveler as per survey map/sheet. The operator must take minimum time and soil to pick, carry and place the soil following the survey map/sheet (Fig. 8.4).

Field evaluation of laser leveler

Punjab Agricultural University, Ludhiana has successfully demonstrated this technology in over 300 acres at different farmers' fields in district. Jalandhar, Ludhiana, Sangrur, Moga, Patiala, and Fatehgarh Sahib (Table 8.1) during 2005-06. It was observed that the average cut/fill and time required for laser leveling at farmer's field was varied from 10 to 16 cm and 1.25 to 1.75 h/acre respectively.
Fig. 8.2: Field levels in survey sheet.

X	X	X	X	X	X
X	X	X	X	X	X
X	X	X	X	X	X
X		X	X	X	X
x ^ ^	X	X	X	X	X
	X	X	X	X	X
X	X	X	X	X	X
X	X	X	X	X	X

Fig. 8.3: Set the scraper blade and laser beam receiver at the location.

Effect of laser leveling on irrigation time:

The farmers felt extremely happy from the results of this intervention. This has not only helped in reducing irrigation time in the laser leveled fields but also resulted in better utilization of available ground water resources (Table 8.2). The average saving in irrigation time in different replicated trials at PAU was 25.57 %, (Table 8.3). The saving in irrigation time at various farmers tube-well irrigated rice fields was ranged from 20 to 27.8% (mean 24%) respectively (Table 8.2). Similar, results were reported by Department of Agronomy, (Table 8.4). Saving in irrigation application time is directly related to saving in electricity/diesel, Labour and most importantly saving in ground water.

Effect of laser leveling on yield: The grain yield of rice on leveled fields was nearly 11 % higher than that on traditional leveled fields (Table 8.3). Similarly, the rice yield on farmer's fields of village Sukhanad, Moga was higher (5.5%) on leveled than unleveled plots (Table 8.5). The yield on laser leveled plots ranged from 7.50 to 8.68 t/ha and for traditionally leveled plots it varied from 7.12 to 8.13 t/ha. The similar grain yield trend was observed at Nurpur bet and Gurusar Kaonke Village (Table 8.6) and it was observed that laser leveled fields yielded 10.6 % more than the conventionally leveled fields.

Thus, the laser-leveled fields are showing 5-10% increase in the rice yields compared to traditional methods. The increase may be due to more even crop stand, better efficacy of weedicides, fertilizer and other farm inputs. This technology is equally beneficial for all other field and vegetable crops.

Benefit of laser leveling

The laser land levelling is an essential farm operation towards precision agriculture along with the following benefit.

- ✓ Enhances water application efficiency.
- ✓ Saving in irrigation water, (20-30%), hence saving in energy (Diesel/electricity)
- ✓ Better crop stand due to even application of fertilizers and other inputs resulting improvement in crop yield by 5 to 10%.
- ✓ Improves weed control efficiency.
- ✓ Less area under bunds/channels increases up to 8 to 10% area under the crop.
- ✓ Reduces labor requirement for irrigation Totally automatic (less load on operator

Table 8.1. Area covered in different districts under various demonstrations.

Name of the farmer	Address	District	Area leveled (acres)
Mr. Avtar Singh	Noo rm ehal	Jalandhar	2.0
Mr. J . B. Singh	Vill. Kadiayaan	Jalandhar	11.0
Mr. Chamkaur Singh	Vill. Pabbian	Ludhiana	2.5
Deptt. of FPM,	PAU	Ludhiana	13.0
Deptt. of Soils			
Dairy Farm			
Master Nishan Singh	Kalyaan	Ludhiana	13.0
S. Hardeep Singh	Am argarh	Sangrur	8.0
Mr. Nahar Singh	Co-operative society,	Moga	148.0
S. Balbir Singh	Mainn	Patiala	13.0
Dr. Harman jeet Singh	KrishiVigaan Kendra	Fatehgarh Sahib	1.5
S. Jagm o han Singh	Gurusar Kaunkae	Ludhiana	50.0
S. Surinder Singh	Nurpur bet	Ludhiana	40.0
TOTAL			302.0

Table 8.2. Percentage time saving in (village Sukhanad, Moga) case of tube well irrigated fields during 2005-06.

Name of the farmers	Area (acers)	Irrigation time (h)	%age Time Saving

		Before Leveling	After Leveling	
Hari Singh	4.25	5.00	4.00	20.0
G urbachan Singh	5.50	4.50	3.25	27.8
Nahar Singh	3.00	5.00	3.75	25.0
Chanjit Singh	7.00	4.25	3.25	23.5
Iqbal Singh	9.00	4.00	3.00	25.0
G urtej Singh	2.75	4.50	3.50	22.2
Harpal singh	8.50	5.00	4.00	20.0
G u rc ha ran Singh	8.00	5.00	3.75	25.0
Jagsir singh	10.00	5.50	4.00	27.3
Bikram Singh	2.50	4.00	3.00	25.0
Average		4.70	3.50	24.1

Table 8.3. Yield and irrigation water saving for Laser leveled and traditionally leveledplots for rice crop under replicated experiments at PAU, Ludhiana.

Sr. No.	**Yield (t/ha)**		**%age increase**	**% Saving in Irrigation**
	Leveled	**Conventional**		
Sitel	8.78 ±0.33	7.73 ±0.21	13.60	26.15
Site 2	8.30 ±0.46	7.53 ±0.39	10.30	...
Site 3	7.60 ±0.21	7.00 ±0.25	8.57	25.00
Mean			**10.82**	**25.57**

Table 8.4. Percentage time saving in case of tube-well irrigated fields for village

Gurusar Kaonke and Nurpur Bet, Ludhiana during 2005-06.

Village, Gurusar Kaonke	Area (acers)	Time taken for one irrigation/ acre (h)		%age Time
		Farmer practice	After leveling	
Jagmohan Singh	14.00	5.50	3.50	36.4
Jai singh	5.00	5.00	3.50	30.0
Nachattar Singh	6.00	5.25	3.25	38.1
Binder Singh	3.50	5.50	3.50	36.4
Pal Singh	5.00	5.25	3.50	33.3
Gurdev Singh	2.00	5.00	3.00	40.0
Mean		5.30	3.40	36.9
Village, Nurpur Bet				

Surinder Singh	15.00	6.00	4.50	25.0
Harminder	8.00	5.50	4.00	27.3
Ajmer Singh	7.50	5.50	4.00	27.3
Amrik Singh	4.50	6.00	4.00	33.3
Mean		5.75	4.10	28.2

The initial cost of the Laser land leveler is quite high so this type of service should be available on custom hiring to the farmers. PAU has already been advocating the use of costly farm machinery through cooperative societies, custom hiring or contracting. This makes these services available to all categories of farmers, reduces its operating cost improves the annual machine usage and thus reduces the cost of farming. Department of Farm Power and Machinery has already loaned one laser leveler to a progressive Co-operative society of village Sukhanand, Distt. Moga, under a US-AID funded farmer's participatory project "Development and Evaluation of second generation drills" through RWC/CIMMYT India in the year 2005. Availability of Laser land leveler on custom hiring basis in Punjab is an outcome of large scale demonstrations carried by Punjab Agricultural University, Ludhiana (Table 8.7). Department of Farm Power & Machinery organizes field days for the farmers and Laser leveler trainings for laser leveler operators of Punjab and other states in India. During 2006-07 more than 100 farmers and operators/secretaries of various cooperative societies were trained. This technology will prove a boon to farmer community and for the state agriculture and will motivate other farmers for adopting proper water management measures to use water more efficiently and judiciously, thus saving the depleting natural resource water.

Table 8.5. Yield for Laser leveled and traditionally leveled plots for rice crop during 2005-06 at Village Sukhanand, Distt. Moga.

S. No.	Name of the farmer	Area leveled (Acres)	Leveled (t/ha)	Unleveled (t/ha)	%age increase
1	Charanjit Singh	4.00	7.50	7.25	3.4
2	Iqbal Singh	9.00	8.50	8.00	6.3
3	Gurcharan Singh	8.00	8.50	7.75	9.7
4	Gurjant Singh	5.50	7.50	7.13	5.2
5	Nahar Singh	3.00	8.25	7.86	5.0
6	Makhan Singh	3.00	8.50	8.13	4.6
7	Darbara Singh	3.00	8.00	7.63	4.8
8	Harpal Singh	8.50	8.63	8.00	7.9
9	Pritem Singh	2.00	7.50	7.12	5.3
10	Santa Singh	1.00	8.38	8.00	4.8
11	Gurtej Singh	3.00	8.25	8.00	3.1
Average			8.14	7.72	5.5

Table 8.6. Yield for Laser leveled and traditionally leveled plots for rice crop during 2005-06 at Farmer's Fields.

Village	Yield (t/ha)		Per cent Increase
	Laser leveled	Traditionally leveled	
Nurpur Bet*	7.77	7.28	6.70
Gurusar Kaonke**	8.43	7.35	14.60
Mean	8.10	7.32	10.65

* Average of 3 farmer fields, ** Average of 5 farmers' fields

Table 8.7. Resource Persons for Laser Land leveling in Punjab.

Type of Service	**Name**	**Address**	**Contact Number**
Demonstrations and trainings	Head	Department of Farm Power & Machinery, PAU, Ludhiana 141004	0161-2401960-Ext.257 0161-2401960-Ext.446 Tele Fax
Demonstrations	Head	Department of Soil & Water Engineering, PAU, Ludhiana 141004	0161-2401960-Ext.284
	Head	Department of Agronomy PAU, Ludhiana 141004	0161-2401960-Ext.308
Custom Hiring	Divisonal Soil Conservation officer	Department of Soil & Water Conservation, Punjab	Required information can be collected from respective districts
	Deputy Registrar Co-operative societies	Department of Cooperative, Punjab	Required information can be collected from respective districts
	Zamindara Farm Solutions Pvt. Ltd.	H.O. Ferozepur Road, Fazilka.	01638-262141, 263155 Fax 01638-261366 99151 84000 98159 79688

Impacts of Laser Land Leveling:

- **550 machines** have been introduced in the Punjab alone in short **span of two years** i.e. 2006-07 & 2007-08 (Fig. 8.5).
- The laser land levelers covered around **10000 ha & 60,000 ha** area in 2006-07 & 2007-08 (Fig. 8.6).
- The laser leveler has generated **business of more than Rs. 13** crores between the farmers and created **job avenues of around 50000 man-days** for rural youth.
- The laser leveling reduced the electricity consumption by tube-wells to the tune of **25 – 30%**, which has the commercial value of **Rs. 25-30 crores** in last two years.
- **1 to 1.5 quinta**l more yield/crop/year
- The state govt. has already provided **25% & 33% subsidy** on the purchase of Laser Land Leveler in last two years.
- **Pay back period** for the custom operator under the current machine demand is **less than two year**

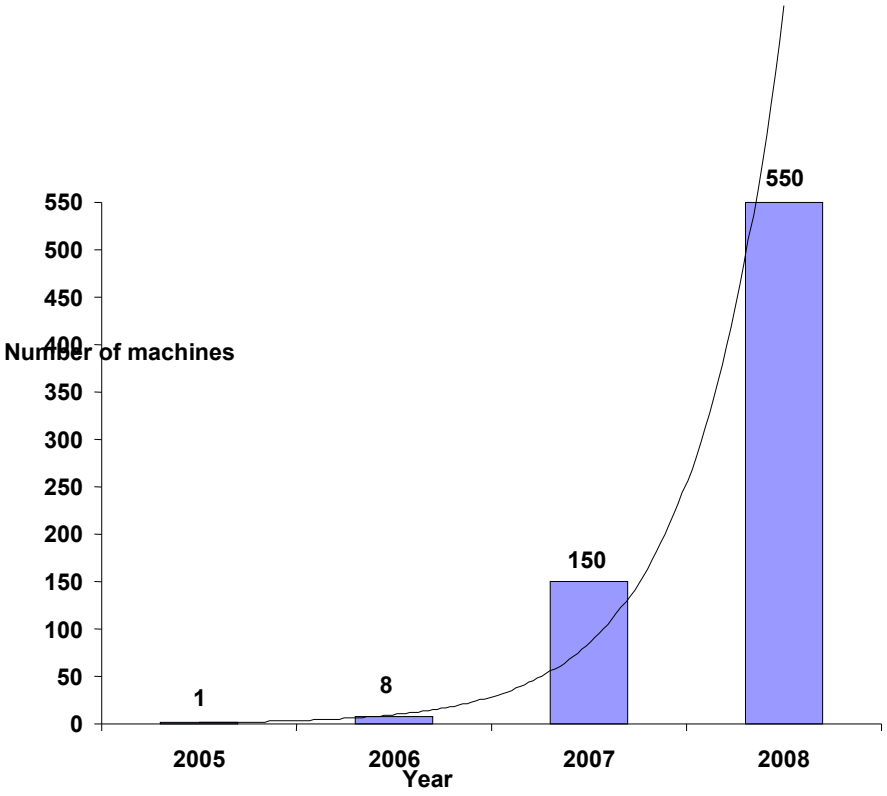

Fig. 8.5: Growth of Laser Land Levelers in Punjab

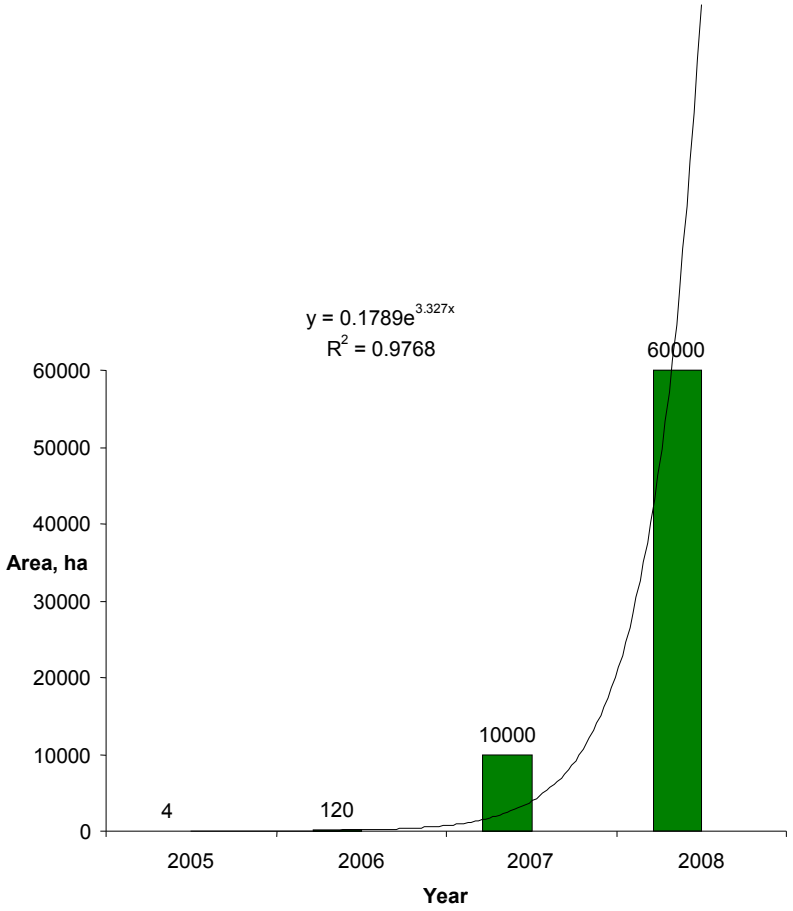

Fig. 8.6: Area under Laser Leveling In Punjab

Acknowledgment

1. Dr. R.K Gupta, Regional Facilitator RWC/CIMMYT India for providing first laser equipment under US-AID funded farmer's participatory research project "Development and Evaluation of Second Generation Drills".
2. Department of Agriculture and State Farmer's Commission, Govt. of Punjab for timely support in terms subsidy to the co-operative societies.
3. The State co-operative department, Govt. of Punjab for playing a pivotal role in taking initiative and making this technology available to the farmers.
4. Department of Soil & Water Conservation, Punjab for promoting this technology.

TRACTOR OPERATED LASER LAND LEVELER

Fig. 8.4: Tractor operated laser land leveller leveling field.