



**'SSCH-3737 (Brand Name - SHAKTIMAN)'  
SELF PROPELLED SUGARCANE HARVESTER**



**भारत सरकार**

**GOVERNMENT OF INDIA**

कृषि मंत्रालय (कृषि एवं सहकारिता विभाग, मशीनीकरण एवं प्रौद्योगिकी प्रभाग)  
Ministry of Agriculture (Deptt. of Agri. & Co-op, Mechanization & Technology Division)

**केन्द्रीय कृषि मशीनरी प्रशिक्षण एवं परीक्षण संस्थान**

**CENTRAL FARM MACHINERY TRAINING & TESTING INSTITUTE**

**(An ISO : 9001-2008 Certified Institute)**

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### 1. SCOPE OF TEST

The Sugarcane Harvester 'SSCH-3737 (Brand Name- SHAKTIMAN)', is a self propelled machine used for harvesting the sugarcane crop with mechanism for cutting cane in billets, extractor to remove trash, leaves and dirt from the cane and the elevator conveyor system to delivers the cane billets to hydraulic assisted tipping trailer i.e. infielder.

The code for testing of sugarcane harvester was not available. The test procedure is evolved with mutual agreement with applicant and existing BIS standard applicable to combine harvester and other agricultural machine are also referred.

Scope of test was to check and assess the followings:

#### Lab Tests

- 1.1 Verification of specification and other data furnished by the applicant
- 1.2 Engine performance Test
- 1.3 Base cutter, topper, crop/line divider, elevator lifting and movement test. (Hydraulic test)
- 1.4 Brake performance test
- 1.5 Mechanical Vibration at various assemblies /sub-assemblies
- 1.6 Noise level measurement at bystander position & at operator's ear level.
- 1.7 Turning ability test
- 1.8 Location of centre of gravity.
- 1.9 Operator's field of vision.
- 1.10 Hardness and chemical composition of a critical component like cutting blades etc.

#### Field tests

- 2.1 Field performance and suitability of the machine for sugarcane crop with regards to:
  - i) Quality of work
  - ii) Rate of work
  - iii) Fuel consumption
- 2.2 Ease of adjustment and handling;
- 2.3 Operator's comfort and safety & safety provisions on machine.
- 3.1 **Investigation after field tests**
- 3.2 Nature of breakdowns and repairs; and  
Wear of various critical components.

### 2. METHOD OF SELECTION

The machine was directly submitted for test by the applicant hence the method of selection not known.

### 3. SPECIFICATIONS

<b>General</b>	
Name & Address of manufacturer	: M/s Tirth Agro Technology Pvt. Ltd. "SHAKTIMAN", Survey No.-108/1, Plot No.B, NH-27, Nr Bharudi Toll Plaza Bhunava (Village), Taluka- Gondal, Dist- Rajkot (Gujarat) Pin code-360 311
Make	: Tirth Agro Technology Privet Limited



	Model	: SSCH-3737	2.1
	Brand name	: Shaktiman	
	Type	: Self propelled, four wheeled, two wheel drive, sugarcane harvester with top drive and chopper mechanism (provided with double crop divider)	
	Year of manufacture	: 2014 (November 2014)	2.2
	Serial Number / Chassis No.	: 14K0000009 / TATSCH373714K0000009	
<b>3.2</b>	<b>Prime mover :</b>		
	Make	: M/s. Tata- Cummins Ltd.	
	Model	: B 5.9173C 31	
	Type	: Four stroke, Direct injection, Turbo charged, intercooled, diesel engine	
	Serial Number	: 41F84169936	2.3
	Compliance with emission norms	: BS-III	
	Maximum speed at no load	: 2550 ± 100	
	Engine max power, kW (hp)	: 128 (174)	
	Rated speed	: 2500 ± 50	
	Rated Engine speed for Field operation	: 2500 ± 50 (No load)	
	Rated Engine speed for Road operation	: 2400 + 50/-150 (On load)	2.4
	Low idle speed	: 2000	
	Engine speed at max torque	: 800 ± 50	
	Maximum torque, Nm (apa)	: Not specified	
<b>3.2.1</b>	<b>Cylinder:</b>	: 650	
	Number	: Six	
	Disposition	: Vertical, inline	2.5
	Bore/Stroke, mm	: 102 / 120	
	Capacity, cm <sup>3</sup>	: 5883	
	Compression ratio	: 18:1	
	Arrangement of valves	: Overhead, inline	
	Type of cylinder liners	: Wet, replaceable	
	Type of head	: Individual	
	Type of combustion chamber	: Direct combustion, Re-entrant on piston crown	2.6
	No. of valve	: 24 (4 per cylinder)	
	Valve clearance in cold / hot, mm	: 0.25/0.25	
	Inlet	: 0.50/0.50	
<b>3.2.2</b>	<b>Fuel System:</b>		
	Type of fuel system	: Force feed	

## 17.4.3

## Material analysis of the chopper blades

## 1) Chemical Analysis

Sr. No.	Elements	Chemical composition (%)
1.	Carbon (C)	0.328
2.	Manganese (Mn)	1.133
3.	Silicon (Si)	0.270
4.	Phosphorous (P)	0.010
5.	Sulphur (S)	0.007
6.	Chromium (Cr)	0.106
7.	Nickel (Ni)	0.142
8.	Molybdenum (Mo)	0.020
9.	Copper (Cu)	0.020
10.	Tin (Sn)	0.05

## 2) Hardness of chopper blades: 78 to 86 HRC

## 17.11

## Final Drive:

Reduction gears were inspected visually and found in normal working condition.

## 17.12

## Brakes

Description	Initial specified thickness of brake disc (mm)	Measured thickness of brake disc after test (mm)	Minimum permissible thickness (mm)
Right	Not specified	2.81 to 2.85	Not specified
Left	Not specified	2.84 to 2.89	Not specified

## 17.12

## Chains, Sprockets and Belts:

All the chains, sprockets and belts were visually inspected and found in normal condition.

## 17.13

## Bearings:

All the bearings of different assemblies of the harvester were inspected and found in normal working conditions.

## 18 SUMMARY OF OBSERVATIONS, COMMENTS AND RECOMMENDATIONS

## 18.1 Engine Performance Test:

Engine Brake power, kW (Ps)	Crankshaft torque, Nm (kgf-m)	Engine speed (rpm)	Hourly fuel consumption l/h (kg/h)	Specific fuel consumption kg/kwh (kg/hph)	Specific energy, kWh/l (hph/l)
1.	2.	3.	4.	5.	6.
i) Maximum power - 2 hours test:					
115.3 (156.8)	524.2 (53.5)	2100	34.99 (29.26)	0.254 (0.187)	3.30 (4.48)
ii) Power at rated engine speed (2400+50/-150 rpm)					



1.	2.	3.	4.	5.	6.
2.1 (152.4)	475.9 (48.5)	2250	35.86 (29.98)	0.262 (0.197)	3.19 (4.25)
4.8 (142.5)	445.0 (45.4)	2250	34.31 (28.68)	0.274 (0.201)	3.05 (4.15)*
<b>Maximum torque:</b>					
3.5 (131.2)	635.8 (64.8)	1450	26.61 (22.24)	0.230 (0.170)	3.42 (4.93)
4.0 (127.8)	544.1 (55.5)	1650	27.37 (22.88)	0.243 (0.291)	3.43 (4.67)*
<b>Five hour rating test:</b>					
<b>Engine loaded to 90% of maximum power:</b>					
3.9 (141.3)	439.0 (44.8)	2261	33.66 (28.14)	0.271 (0.199)	3.09 (4.20)*
<b>maximum power:</b>					
6.8 (145.2)	485.8 (49.5)	2100	33.34 (27.88)	0.261 (0.192)	3.20 (4.36)*

\* Under high ambient condition.  
\*\* At no load speed corresponding to rated speed specified for field work.

### Remarks:

The maximum power output of the engine was observed as **115.3 kW (156.8 Ps)** at **2100 rpm** of engine at full throttle setting, which is 9.9 % less than declared value, which does not meet the requirements of IS: 15806-2008 with regard to tolerance.

This should be looked into for necessary corrective action.  
The specific fuel consumption corresponding to maximum power at full throttle setting measured as **0.254 kg/kwh (0.187 kg/hph)**.

The back-up torque of the engine was measured as **21.3 %** under natural ambient condition at full throttle.

The maximum smoke density was recorded as **1.18 m<sup>-1</sup>**.  
The maximum temperature of engine oil, coolant (water) and exhaust gas were observed as 115, 104 and 693 respectively.

The lubricating oil & coolant consumption during five hours rating test were measured as **0.212 g/kwh & 2.45 %** of total coolant capacity respectively.

**Turning Ability:**  
The radius of turning circle of LHS and RHS was observed satisfactory.

**Visibility:**  
The topper, crop dividers and elevator outlet in field condition are visible from operator's normal sitting position.

**Braking Performance:**  
The braking system function when operator brings traction lever to neutral band that causes machine to brake / stop in the position. Two separate pedals for LHS and RHS braking system also provided to apply brake force at lower travel speed and to take slight turns in the field.

**Mechanical Vibration:**  
The amplitude of mechanical vibration of components is given in the chapter 13 of this report. The amplitude of mechanical vibration on the various assemblies and sub-assemblies is below 100 microns except back light (HD) and other part is considered normal.

**18.6 Noise measurement:**

The ambient noise emitted by the machine at bystander's position and operator's ear level was measured as 94 & 88 / 86 (inside cabin / closed condition) dB (A) respectively. The noise level at bystander's position is on higher side and does not meet the requirement. This may be looked into for necessary corrective action.

**18.7 Field Test:****18.7.1 Summary of field tests:**

The results of the field test are summarized as below:

Sr. No.	Parameter	Range of parameter
1.	Speed of operation, kmph	1.89 to 2.29
2.	Area covered, ha/h	0.161 to 0.290
3.	Fuel consumption	
	l/h	22.03 to 30.51
	l/ha	87.77 to 163.29
4.	Net cane harvested,	
	l/t	1.01 to 1.82
	t/h	14.43 to 24.68
5.	Percentage of lodging	82.98 to 121.75
6.	Percentage of broken billets at outlet of elevator	0.61 to 16.54
7.	Percentage of total non collectable losses	5.52 to 11.90
8.	Percentage of total losses	0.43 to 2.57
9.	Percentage of Extraneous matter	6.46 to 13.62
10.	Cane collection efficiency in comparison with manual harvesting, %	1.94 to 6.27
11.	Percentage of cut cane recovery	80.16 to 94.59
		94.00 to 98.06

**18.7.2 Sugarcane harvesting**

1. During sugarcane harvesting broken billets collected at outlet of elevator inside infielder varied from 5.52 to 11.90 %.
2. Post harvest losses varied from 0.43 to 2.57 %.
3. Percentage of cane missed by crop divider varied from 0.03 to 0.78 %.
4. Percentage of cane billets cut down by topper losses varied from 0.11 to 0.66 %.
5. Percentage of cane billets drop down from elevator varied from 0.07 to 0.51 %.
6. Percentage of total non collectable losses varied from 0.94 to 3.65 %.
7. Percentage of total losses varied from 6.46 to 13.62 %.
8. Percentage of extraneous matter inside the infielder varied from 1.94 to 6.27 %.
9. Cane collection efficiency varied from 80.16 to 94.59 % when compared with manual harvesting.
10. Percentage of cut cane recovery varied from 94.00 to 98.06 %.



### 8.7.3 Ease of Operation and Safety Provision:

- i) The controls provided around the operator are within easy reach but not labelled with symbols as per Indian standard. Therefore it is recommended that the symbols as per the requirement of IS-6283-1998 may be provided.
- ii) The provision for safety and comfort which does not meets the requirements (Refer 3.25) should be looked into.

### 8.7.4 Assessment of Wear:

- i) The transmission gears, Hydraulic motors and components were found in normal working condition.
- ii) The condition of the components of brake, hydraulic system and steering system was observed to be normal.
- iii) The condition of the bearing, chains, sprockets and belts was observed to be normal.
- iv) The components of starter motor and alternator were found in normal working condition.
- v) The percentage wear on mass basis for topper blades, Chopper blades and Base cutter blades are observed as 0.10 to 0.32, 0.20 to 0.64 and 1.96 to 2.55 % respectively for field testing duration of 52.5 hrs. which is normal.
- vi) The percentage wear on dimension basis for Topper blade at top position, 40 mm from top and Height were observed as 0.79 to 1.76, 0.34 to 0.90 and 0.05 to 0.17 percent respectively for field testing of 52.5 hrs. which is normal.
- vii) The percentage wear on dimension basis for Base cutter blade at LHS, Middle and RHS position were observed as 0.05 to 0.74, 0.06 to 0.55 and 6.05 to 9.60 percent respectively for field testing duration of 52.5hrs. which is normal.
- viii) The percentage wear on dimension basis for Chopper blade at LHS, Middle and RHS position were observed as 1.34 to 1.96, 3.17 to 7.83 and 1.89 to 7.94 percent respectively for field testing duration of 30.3 hrs. which is normal.

### 8.7.5 Assessment of Wear:

- i) The wear of engine components i.e. cylinder liners, piston, piston rings, valves, valve guides, springs, big-end bearing were observed normal.
- ii) The transmission gears and components wear found in normal working condition.
- iii) The timing gears, clutch assembly were found in normal working condition.
- iv) The condition of the component of hydraulic system and steering system was observed to be normal.
- v) The component of starter motor and alternator were found in normal working condition.

### 8.8 Hardness and Chemical composition:

- 8.8.1 Hardness of Topper blades is observed 78 to 80 and 136 to 140 HRC at hardened zone and remaining zone respectively. Hardness of Chopper blade and base cutter blade are observed 78 to 86 and 80 to 90 HRC respectively. The hardness of topper blade, chopper blade and base cutter blade does not comply with the IS: 6025-1999.
- 8.8.2 The manganese of topper blade is not within the prescribed limit of IS:6025-1999



**18.9 Labelling of Combine Harvester:**

The labelling plate provided on the harvester on LH side of chassis, below air cleaner on pumps cabin.

**18.10 Literature supplied with the Machine:**

The following literature supplied in English were supplied with the machine for reference during testing and these were found adequate, however, it needs to be modified in Hindi and other regional language for the guidance of the users in accordance with IS :8132-1999.

- i) Operator's Manual Shaktiman 3737 model.
- ii) Parts Catalogue Shaktiman 3737 model

**19. SELECTED PERFORMANCE AND OTHER CHARACTERISTICS AS PER IS: 15806-2008.**

S. No.	Characteristics	Requirement	Declared	Observed	Remarks
1.	2.	3.	4.	5.	6.
<b>19.1</b>	<b>Prime mover performance</b>				
	i) Max. Power (absolute) Average max. power observed during 2 hrs. max. power test in natural ambient condition kW(Ps)	It should not be less than 5% of the declared value.	128 (174.0)	115.3 (156.8)	Does not Conform
	ii) Max. power observed during test after adjusting the no load engine speed as per recommendation of the manufacturer for field work, kW(Ps)	Max. Power observed must not be less than 5% of declared value.	128 (174.0)	112.1 (152.4)	Does not Conform
	iii) Power at rated engine speed, kW(Ps)	The observed value must not be less than 5% of the declared value by the applicant.	128 (174.0)	112.1 (152.4)	Does not Conform
	iv) Specific fuel consumption g/kWh.	The average value during 2 hr. max. Power test must be within $\pm 5\%$ of the declared value by applicant/manufacturer.	242.9	254	Conforms





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**SSCH-3737 (Brand Name- SHAKTIMAN), SELF PROPELLED SUGARCANE HARVESTER – Commercial (Initial)**

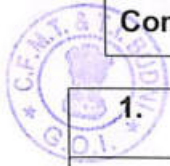
1.	2.	3.	4.	5.	6.
v)	Max. smoke density (bosch no.) at 80% load between the speed at max. power & 55% of speed at max. or 1000 rpm which ever is higher, should be observed as per CMVR rule	For tractor:- 5.2 bosh no. or 75 hartridge For engine:- Free deceleration or natural aspirated or turbo charges 65 hartridge	3.25 m <sup>-1</sup>	1.18	Conforms
vi)	Max. crank shaft torque, (N-m) observed during the test after no load engine speed is adjusted as per manufacture's recommendation for field work	It must not be less than 8% of declare value of manufacturer.	650	635.8	Conforms
vii)	Back up torque, %	7% min.	0.33	21.3	Conforms
viii)	Max. operating temp. To be declared by manufacturer	i) engine oil	127	115	Conforms
		ii) coolant	107	104	Conforms
ix)	Lubrication oil consumption, g/kWh	1% of SFC at 5 hr. max. Power during high ambient condition.	N.A (D)	0.212	Conforms
			2.67(R)		
<b>19.2 Brake performance</b>					
i)	Max. stopping distance at a force equal to or less than 600 N on brake pedal, m	10 m or $s \leq 0.15v + v^2/130$ v= speed corresponding to 80% of design max. Speed, kmph.	--	2.54	Conforms
ii)	Max. force exerted on brake pedal to achieve a deceleration of 2.5 m/sec <sup>2</sup> .	≤ 600N.	--	47	Conforms
iii)	Whether parking brake is effective at a force of 600 N at foot pedal or 400 N at Hand and lever	Yes or No.	--	Yes	Conforms
<b>19.3 Mechanical vibration</b>					
i)	Operator's platform	120µm max.	--	30	Conforms
ii)	Steering wheel	150µm max.	--	70	Conforms
iii)	Seat with driver seated	120µm max.	--	40	Conforms

1.	2.	3.	4.	5.	6.
<b>19.4.</b>	<b>Air cleaner oil pull over</b>				
i)	Max. oil pull over in % age when tested in accordance with IS: P8122 pt. (II)-2000	0.25% max.	Not applicable (Dry type of air cleaner)	N.A.	--
<b>19.5</b>	<b>Noise measurement</b>				
i)	Max. ambient noise emitted by combine at bystander position dB (A)	88 dB (A) as per CMVR	--	94	Does not Conform
ii)	Max. noise at operator's ear level dB (A)	98 dB (A) as per CMVR.	--	88.0	Conforms
<b>19.6</b>	<b>Discard Limit</b>				
i)	Cylinder bore diameter	Should not exceed the values declared by the manufacture	102.21	102.02 to 102.04	Conforms
ii)	Piston diameter	-do-	101.640	101.874 to 101.877	Conforms
iii)	Clearance between piston and cylinder liner at skirt	-do-	Not specified	0.153 to 0.166	Conforms
iv)	Ring End gap				
	- Top comp. ring.	-do-	1.50	0.25 to 0.35	Conforms
	- 2nd comp. ring.		2.50	0.65 to 0.75	
	- Oil ring.		1.50	0.30 to 0.40	
v)	Ring groove clearance				
	- Top comp. ring.	-do-	Not specified	-Taper Ring-	--
	- 2nd comp. ring.			0.049 to 0.071	
	- Oil ring			0.058 to 0.069	
vi)	Diametrical clearance of main bearing	-do-	3.464	0.089 to 0.1.00	Conform
Vii)	Crank shaft end float	-do-	Not specified	0.27	--
viii)	Diametrical clearance of big end bearings	-do-	2.468	0.104 to 0.118	--
ix)	Axial clearance of big end bearings	-do-	Not specified	0.150	--
x)	Thickness of brake lining	-do-	0.50	2.81 to 2.89	Conform
xi)	Thickness of clutch plate	-do-	30.20	--	--

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**SSCH-3737 (Brand Name- SHAKTIMAN), SELF PROPELLED  
SUGARCANE HARVESTER – Commercial (Initial)**


1.	2.	3.	4.	5.	6.
19.7	<b>Field performance</b>				
i)	Percentage of total non collectable losses	-	-	0.94 to 3.65	-
ii)	Percentage of broken billets at outlet of elevator	-	-	5.52 to 11.90	-
iii)	Percentage of total losses	-	-	6.46 to 13.62	-
iv)	Percentage of Extraneous matter	-	-	1.94 to 6.27	-
v)	Percentage of cane collection efficiency when compared with manual harvesting	-	-	80.16 to 94.59	-
vi)	Percentage of cut cane recovery	-	-	94.00 to 98.06	-
19.8	<b>Safety requirement</b>				
i)	Guards against all moving per	Essential	-	Provided	Conforms
ii)	Lighting arrangement a) Head light b) Parking light c) Indication d) Reverse gear e) Brake f) Chassis number	Essential as per CMVR	-	Provided	Conforms
iii)	Working clearance around the controls	Essential 70 mm, min.	-	Not provided	Does not conform
iv)	Labelling of control gauge	Essential	-	Not provided	Does not conform
v)	Operator seat requirement	Essential	-	Provided	Conforms
vi)	Safety slip clutch arrangement for Chopper assembly	-	-	Provided	Conforms
vii)	Safety guard for operator cabin, sideways and backside of elevator	-	-	Provided	Conforms
19.9	<b>Material of construction :</b>				
i)	Topper blade as per IS: 6025-1999	It must have chemical composition as C= 0.70 to 0.95% Mn= 0.30 to 0.50%	-	C-0.771 Mn-0.625 Si-0.201 S-0.005 P-0.022	Does not conform



1.	2.	3.	4.	5.	
ii)	Chopper blade	No any respective code is available	-	C-0.328 Mn-1.133 Si-0.270 S-0.007 P-0.010	--
iii)	Base cutter blade	No any respective code is available	-	C-0.386 Mn-1.157 Si-0.285 S-0.009 P-0.012	--
19.10	<b>Labelling of harvester</b>				
	It should conforms to IS:10273-1987	Essential	-	Provided	Conform
19.11	<b>Break down (critical, major &amp; minor)</b>				
	Critical Major Minor	As per IS 15806-2008	-	Nil Nil 01	Conform

### 20. CITIZEN CHARTER

Time frame for Testing & Evaluation as per Citizen Charter	Duration of Test	Whether the Test Report is released within the time frame given in Citizen Charter	Remarks
10 Months	03 Months (January, 2015 to March, 2015)	Yes	--

TEST CARRIED OUT AT C.F.M.T. & T.I., BUDNI (M.P.), INDIA

**TESTING AUTHORITY :**

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*H.L. Yadav*  
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 SENIOR AGRICULTURAL ENGINEER

*C.R. Lohi*  
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 DIRECTOR

Test Report compiled by **Sh. Pramod Yadav**, Senior Technical Assistant.