Technical challenges in Diesel Natural Aspirated Engine to meet TREMV Norms in Agricultural Segment

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Content of Presentation

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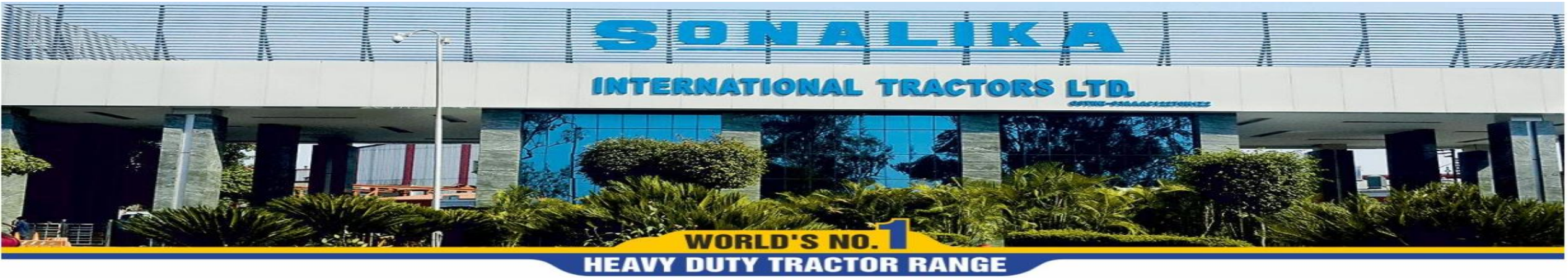
2. Product Portfolio
3. Mechanization status of India
4. Emission Road map in India
5. Tractor Application & Duty Cycle
6. Technical Approach for New Engine development
7. Technical Challenge and Mitigation
8. Summary & Way Forward

Company Profile



Fortune 500 India 2024 Largest Companies

Lead Agri Evolution

No. 1 tractor export brand from India

- State of art Manufacturing Plant
- Capacity of 3 Lacs tractor/year

Sonalika vision is to 'Lead Agri Evolution' by pioneering innovation and technology in the Agri Ecosystem.

One of India's Largest Tractor exporter (Strong presence in over 150 Countries)

Sonalika : International Tractor Limited

- Being associated with **17+ lakh customers across 150 countries around the world.**
- **Manufacturing the customized and widest heavy duty tractor range** in 20-120 HP and 70+ implements for the world.
- Owning the **World's largest tractor manufacturing facility at Hoshiarpur** in Punjab that caters to the varied needs of customers across the globe.
- **Clocking its highest ever annual overall market share of 15.3% in FY'24 and biggest ever 1,53,764 overall annual tractor sales in FY'25.**
- **1000+ channel partner network, 15,000+ retail points and 375+ stockiest,** the company remains as close as possible to customers in addressing their requirements.
- Being the **only tractor brand chosen by Govt. of India to contribute for the inspirational project of Niti-Aayog** to double the farmer's income in the country.

Product Portfolio for Domestic Market

60 HP & Above

50 HP

40 HP

30 HP

20 HP

CRDS ENGINE
55 60 65 70 75
12+12

Sikander 4WD
42 - 49 HP

SONALIKA SIKANDER

DI & RX Sikander
39-49 HP

SONALIKA SIKANDER DLX

DI & RX Sikander DLX
With Multispeed
42-49 HP

47/50/55 III 12+3
55 TP 12+12

Baagban & NT
30 HP + 32 HP

GT Series
20-26 HP

SONALIKA TIGER

TIGER 26 & 30

- Natural Aspiration Engines
- Higher Torque in the segment
- Superior Performance
- Biggest Engine Volume in Segment
- Fuel Economy

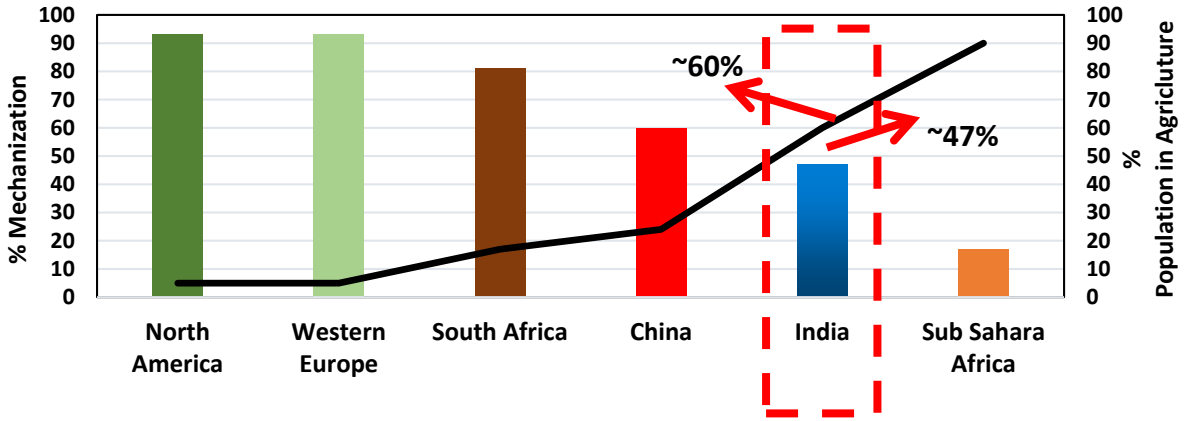
Farm Segment in India

Farming Pattern and Farm Holding Capacity are different from Europe.

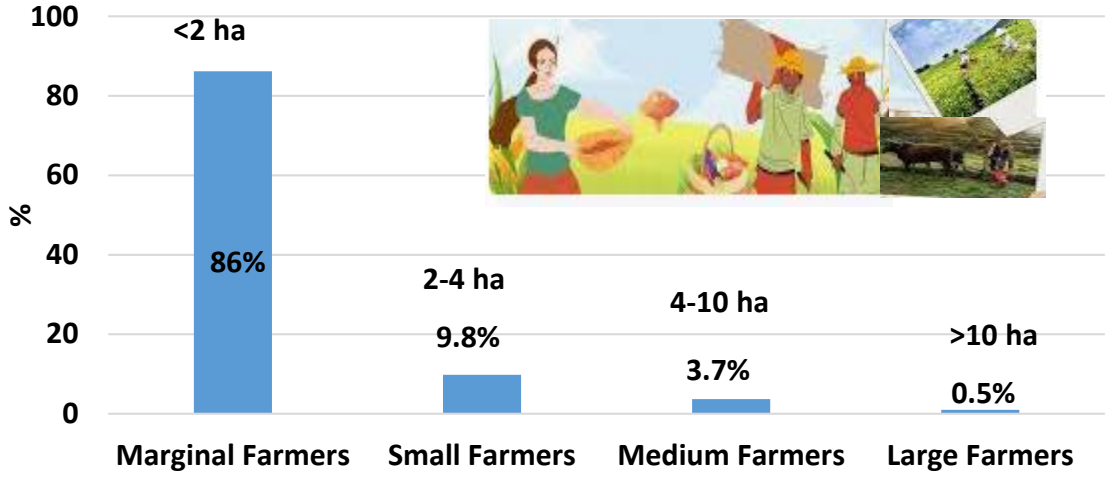
- India is one of the largest agricultural produce country in the world where tractor usage is continuosly increasing.
- Usage pattern of tractors are very unique and distinctive in India.
- In India, majority of tractor segment falls in between power band category of 25- 50 hp based on application and small land holdings- less than one tenth of that in Europe.
- Farming practices & conditions between India and Europe are different like Wet Land Puddling & usage of tractors in threshing in extreme ambient temperatures up to 48° C resulting in dust/straw/mud contamination.
- This transition must be carried out with minimal disruption to sustainable agriculture practices and should leverage indigenously available, field-ready robust technology.

Farm Mechanization in India

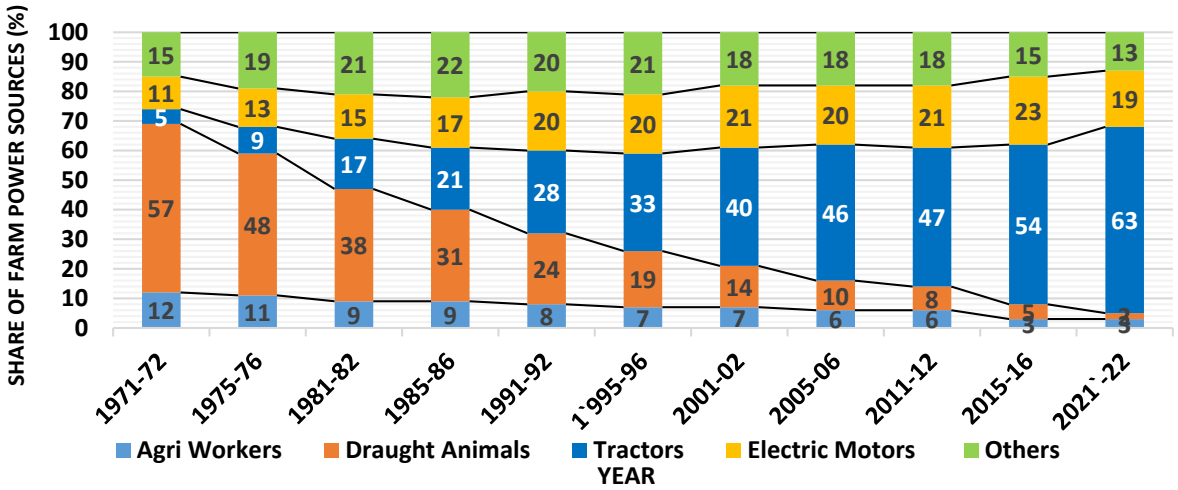
Mechanization Status



Farmers Classification



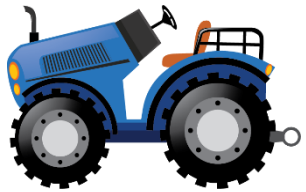
Farm Power Sources



- Even though nearly 60% of population is engaged in agricultural works, mechanization is only 47%.
- With the increasing trend of tractors as farm power sources, there is lot of scope for tractors.

Source: FAOSTAT, CIAET Bhopal, Ministry of Agriculture

Emission Road Map in Agricultural Segment



YEAR

	1999	2003	2005	2011	2020	Implemented In Jan, 2023 (Above 50 hp Category)	2026
Emission Norms	Bharat TREM 1 (Oct, 1999)	Bharat TREM 2 (June, 2003)	Bharat TREM 3 (Oct,2005)	Bharat TREM 3A (Apr 2010 & 2011)	Bharat TREMIV (Apr 2023)		Bharat TREM V (Apr 2026)
Duration (No. of Years since previous Norms Implementation)		+ 4 years	+ 2 years	+ 5 years	+ 12 years		+ 3 years

Bharat TREMIV

Applicable for Tractors above 37 kW (50 hp)

Emission Comparison in different Power Band Category

Engine Power	Date	CO	HC	HC+NOx	NOx	PM
kW		*g/kWh*				
Bharat (Trem) Stage III A						
P < 8	2010.04	5.5	-	8.5	-	0.8
8 ≤ P < 19	2010.04	5.5	-	8.5	-	0.8
19 ≤ P < 37	2010.04	5.5	-	7.5	-	0.6
37 ≤ P < 75	2011.04	5	-	4.7	-	0.4
75 ≤ P < 130	2011.04	5	-	4	-	0.3
130 ≤ P < 560	2011.04	3.5	-	4	-	0.2

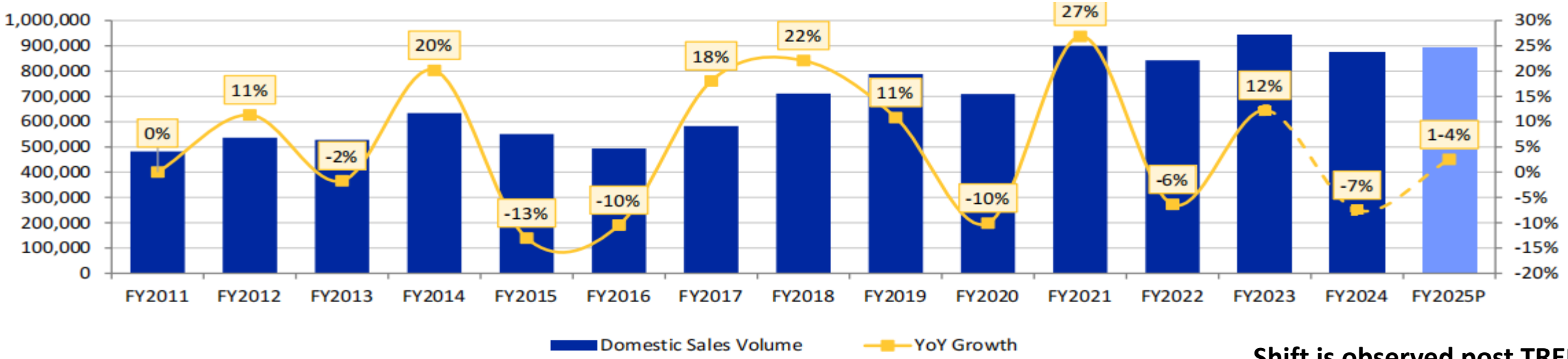
- 40%

- 97%

Engine Power	CO	HC	NOx	PM	PN
kW	*g/kWh*				*1/kWh*
Trem Stage IV					
37 ≤ P < 56	5	4.7*		0.025	-
56 ≤ P < 130	5	0.19	0.4	0.025	-
130 ≤ P < 560	3.5	0.19	0.4	0.025	-
Trem Stage V					
P < 8	8	7.5*		0.4	-
8 ≤ P < 19	6.6	7.5*		0.4	-
19 ≤ P < 37	5	4.7*		0.015	1×1012
37 ≤ P < 56	5	4.7*		0.015	1×1012
56 ≤ P < 130	5	0.19	0.4	0.015	1×1012
130 ≤ P < 560	3.5	0.19	0.4	0.015	1×1012
P ≥ 560	3.5	0.19	3.5	0.045	-
* NOx + HC					

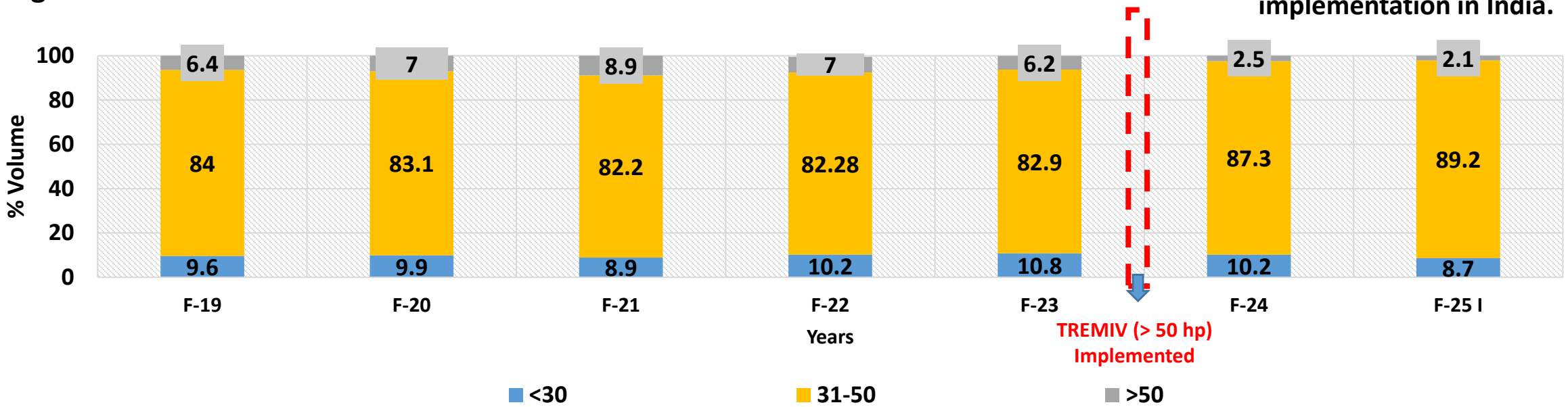
- **If TremV is implemented as per notification, there will be leapfrogging in sub 37 kW Category.**

Tractor Sale based on Power Segment in India



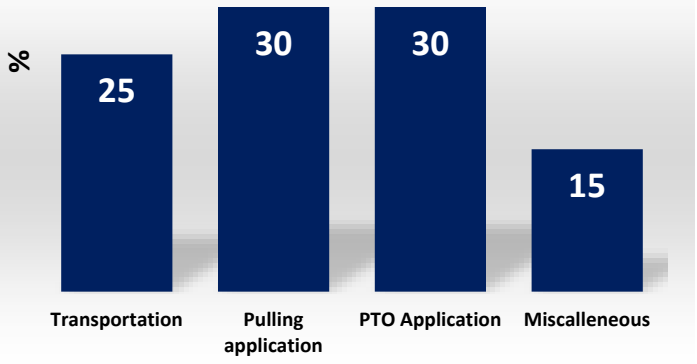
Engine Power wise Tractor Volume

Shift is observed post TREMIV implementation in India.

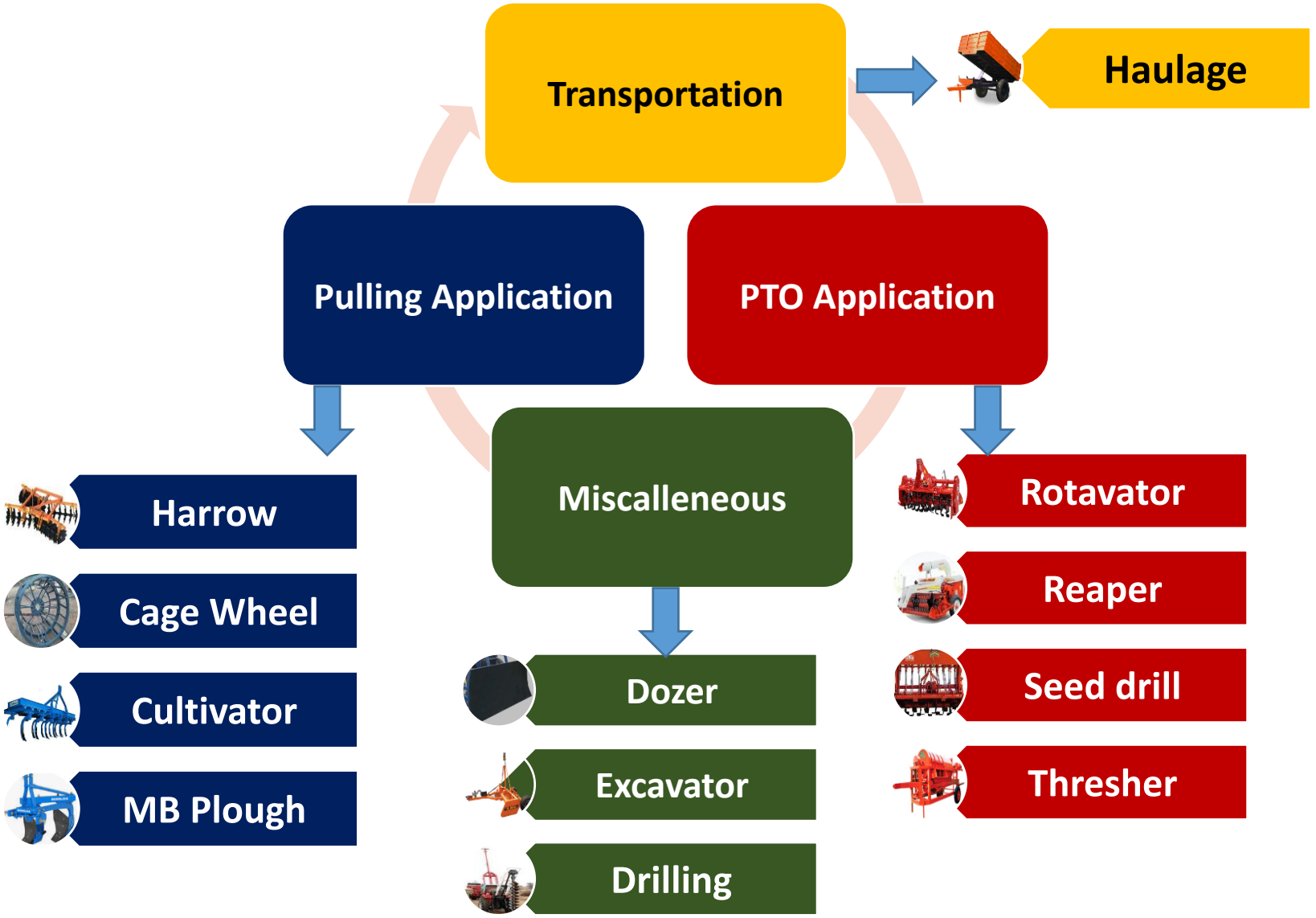


Source: ICRA Research, TMA

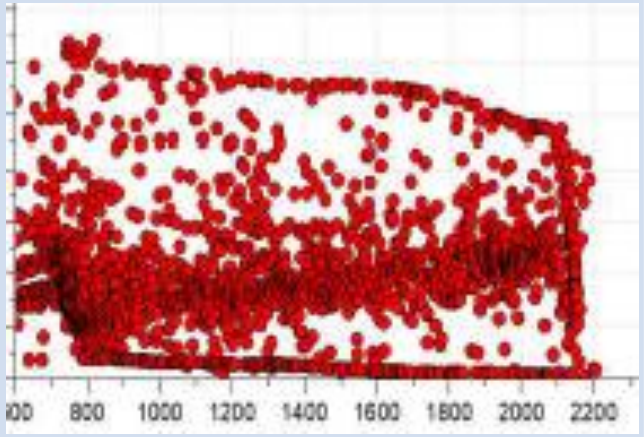
Tractor Application in India Agricultural Industry



Application based Tractor Usage Pattern



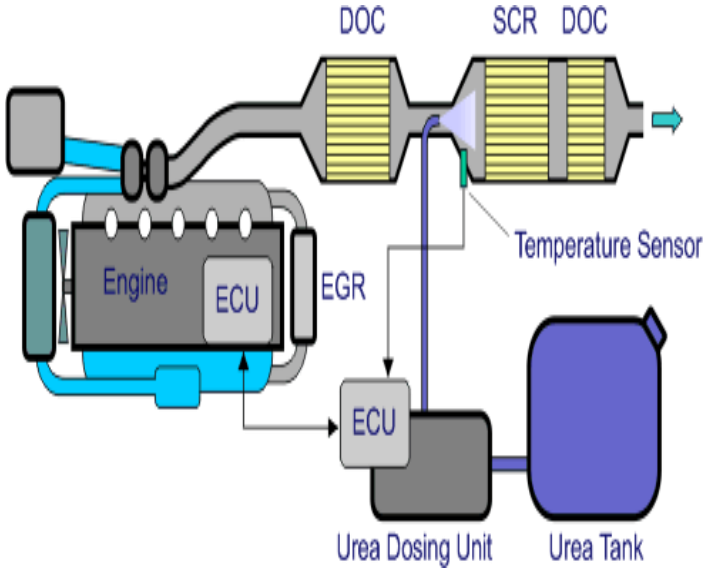
Loading Pattern in Different Tractor Applications

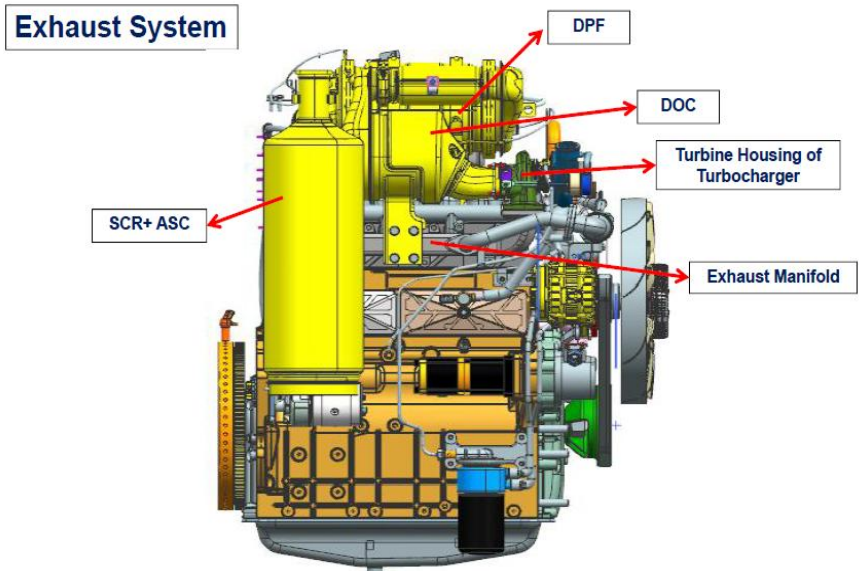
Implement		Implement Size	Loading Condition	Remark
Cultivator		17 /15 Tyne	Partial to Full	**Engine load Depends:** 1. Soil condition 2. Depth of operation 3. Driving pattern **Duty Cycle** 
Harrow		12 X 12	Partial	
M.B Plough		3 Bot Rev	Partial to Full	
Haulage (Loaded)		20 Tonne	Partial	
Rotavator		10 ft	Partial to Full	
Haulage (Empty Trailer)		Empty Trailer	Partial	
Bare Tractor		Bare Tractor	Partial	

New Engine Development

Drivers for New Engine & EAT Development

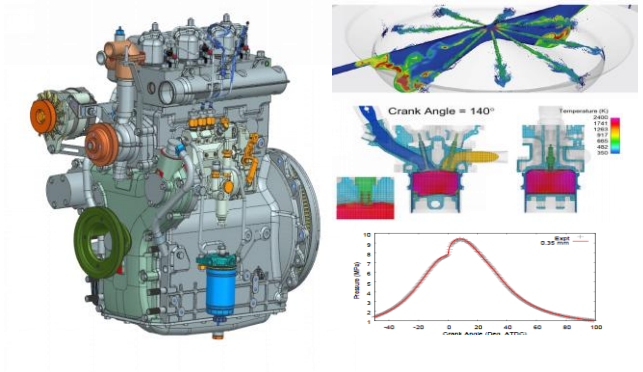
- Emission Regulation
- Efficient performance over wide range of operation
- Limited space
- Real World Emission
- OBD & In Service Monitoring
- Cost Efficiency
- Durability
- NVH

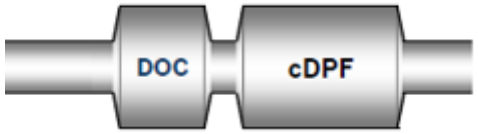


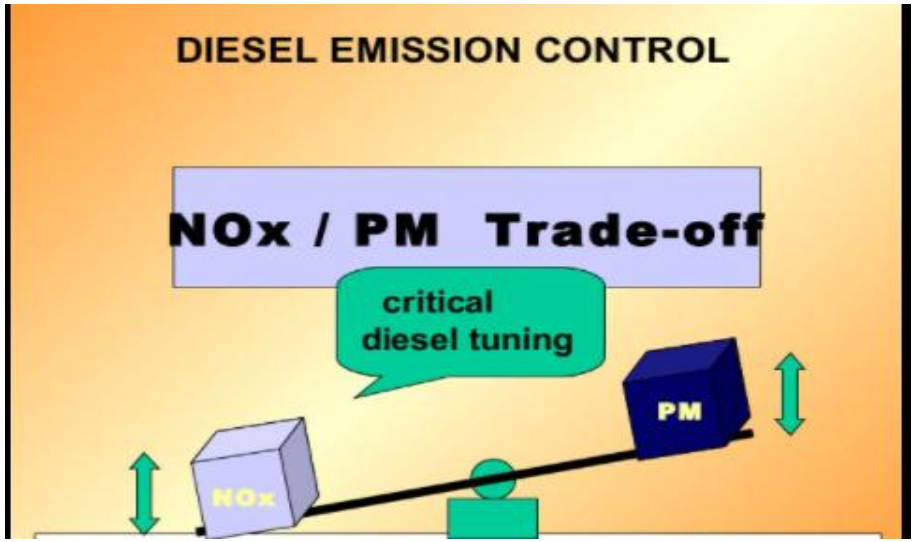


Technical Approach for Engine Development in TREMV

- Base Engine Design Optimization
- Combustion Optimization
- Air Handling system
- Optimized fuel system
- After Treatment selection
- Calibration Optimization
- Testing and Validation



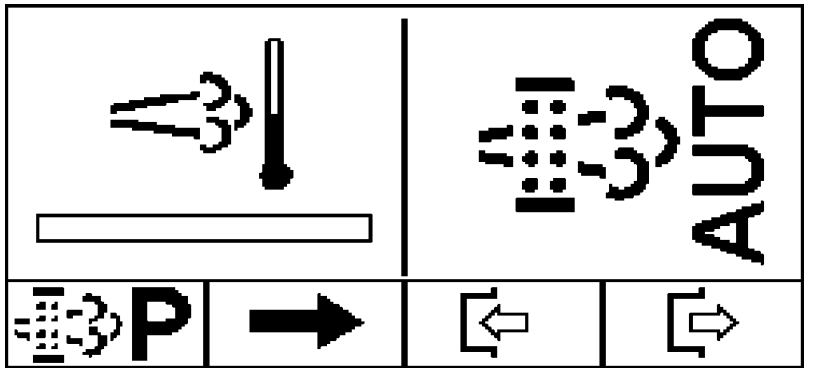


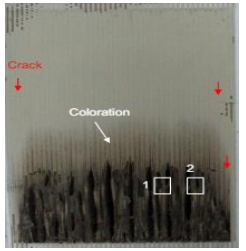


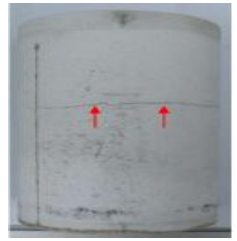
Parameter Change	Effect on Nox	Effect on PM
Cycle Temperature	↑	↓
Excess Air in Bowl	↑	↓
Longer Premixed Phase	↑	↓

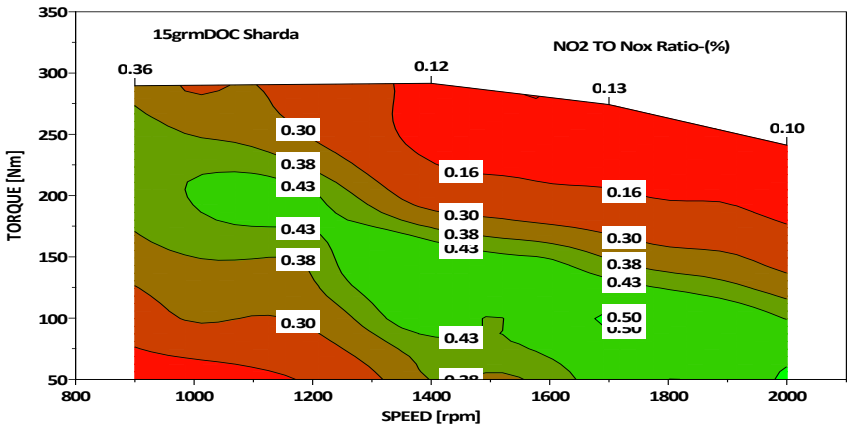
Technical Challenges in DPF

- Packing the DPF under hood on Tractor
- Integration of additional sensor due to DPF : Delta Pressure & T5 Sensor
- Integration of DPF will bring Common Rail Integration in Engine which will bring additional cost and complexity in system
- Regeneration Strategy and its interrelated link from cluster is again new feature for customer
- Regeneration of soot will lead to penalty of Fuel Economy for Farmer
- High Exhaust Temperature and Skin Temperature from Exhaust Manifold & After Treatment
- Limitation of BMEP for Temperature and Soot is challenge with DPF
- Ash accumulation from Engine Lube Oil with DPF





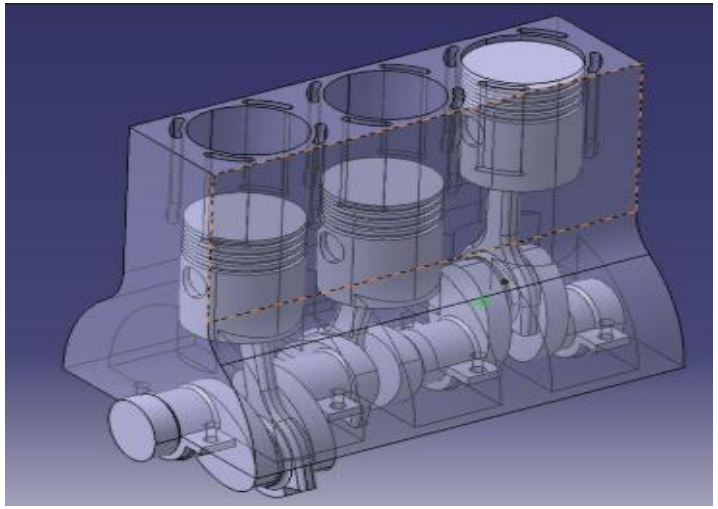




Technical Challenges of NA Engine Development to meet TREMV

High Torque & High BMEP

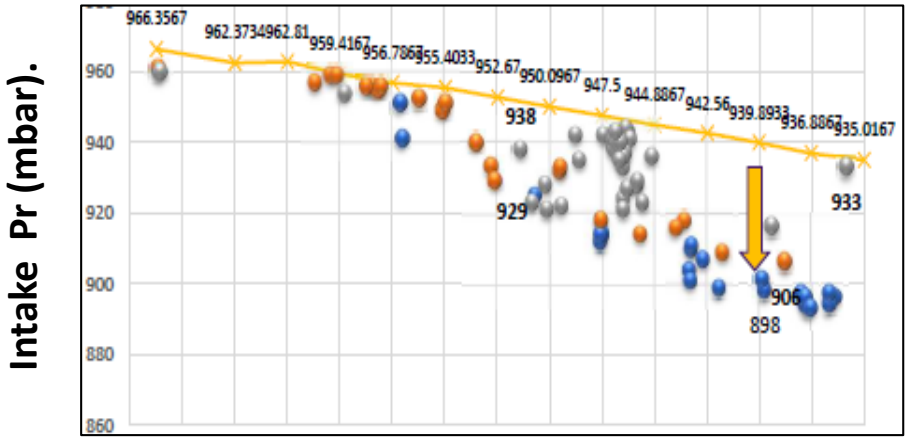
For a Particular Size of Engine



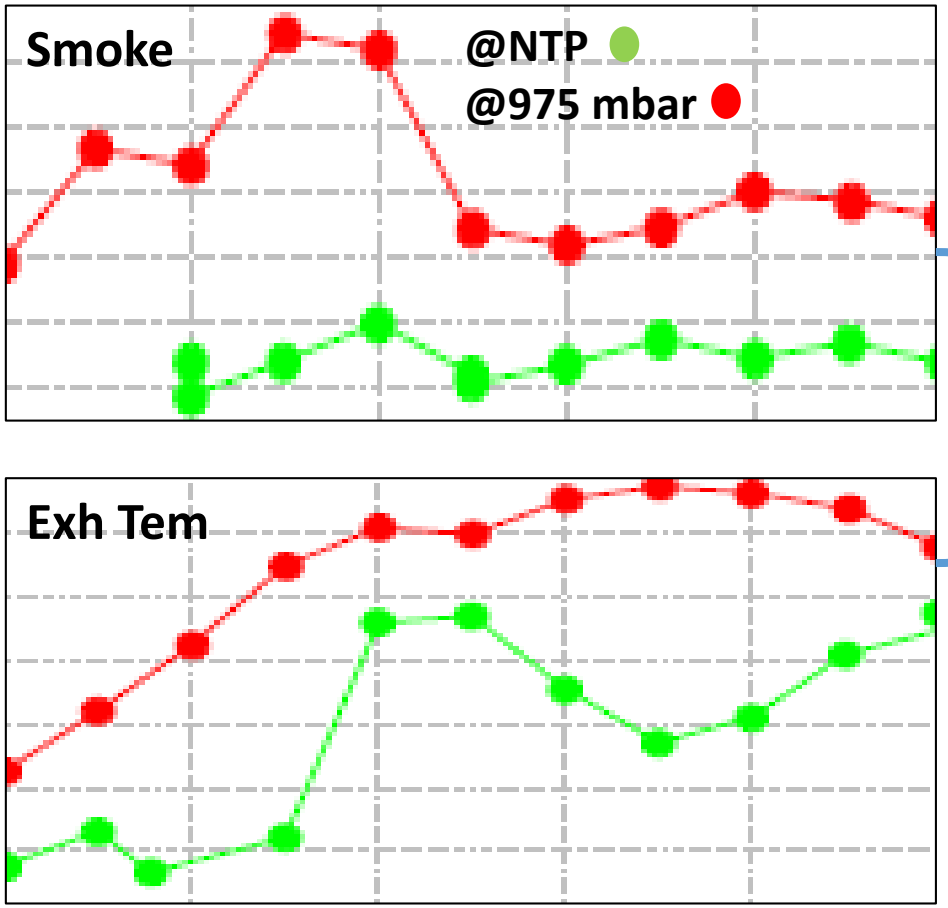
Rich Mixture & Critical Lambda

High Exhaust Temp & High Smoke

Intake Manifold Pressure

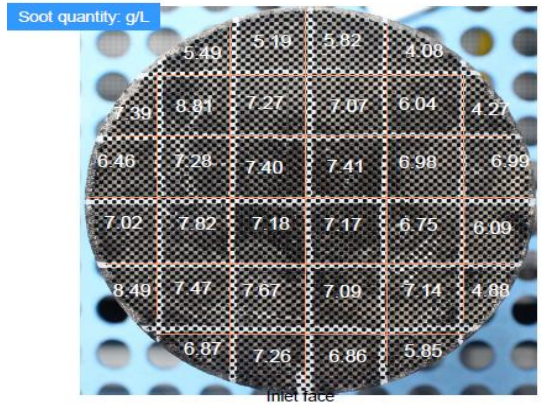


Technical Challenges in NA Engine Development

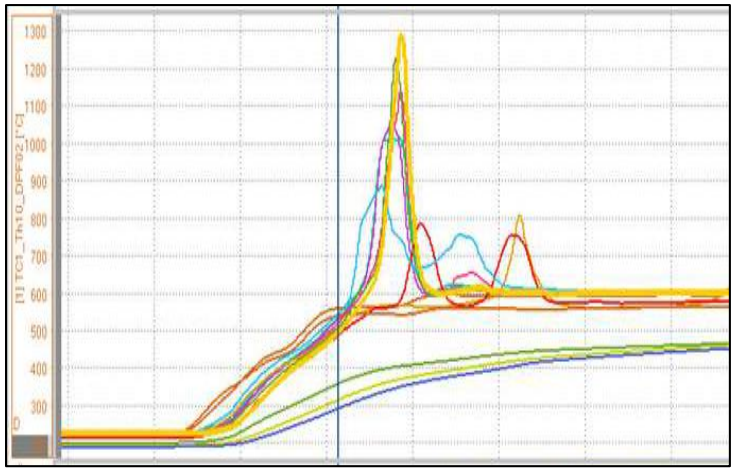


Huge impact on Smoke and Exhaust Temp with slight change in ambient pressure.

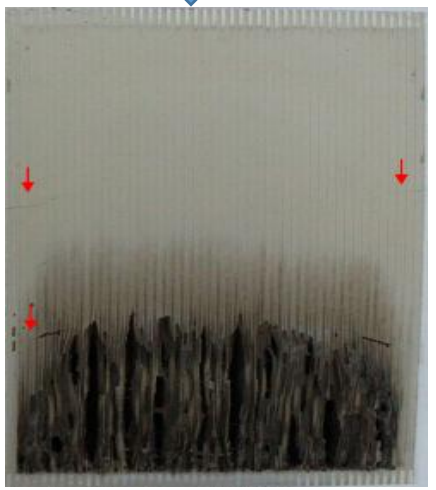
High Soot Accumulation



Soot Distribution

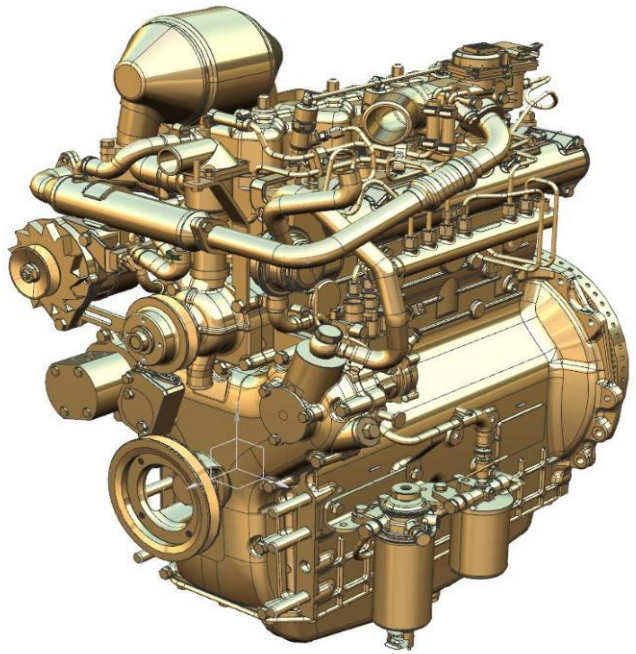


Temperature Shoot up



DPF Failure

Counter Measures



- Air Layout Optimization
- BMEP Adaptation to ensure safe Operation
- Lambda & Smoke Adaptation
- Exhaust Temp Optimization and Altitude Correction
- EGT Optimization for getting improved UI
- SML Readjustment

Summary

- TREMV Emission Norms will bring complexity of the current system.
- Considering the diversity in applications across Indian Agricultural Segment, it will be challenging.
- Even though lot of testing and Validations has been done, unseen failures from the field likely to come which will foster new opportunities and innovation.
- With the implementation, responsibility of OEM and it's technical partners will increase.

What Next : Government Focus in Alternate Fuel Technology

Panchamrit - India's National Statement @ COP26 (Conference of the Parties)

1. Achieving net-zero by 2070
2. Reducing total projected carbon emissions by one billion tonnes starting now till 2030
3. Increasing renewable energy component to 50% of our total energy requirements by 2030
4. Reducing carbon intensity by 45% by 2030
5. Increasing non-fossil energy capacity to reach 500 GW by 2030

सड़क परिवहन एवं राजमार्ग मंत्रालय
MINISTRY OF ROAD TRANSPORT AND HIGHWAYS
सत्यमेव जयते

FLEX FUEL

Flex Fuel : Bio Diesel & Ethanol Blended Fuel
- Blending of Ethanol in Diesel due to surplus amount and production of Ethanol
- Usage of Bio Diesel from B7 to B15 and above blending to reduce the import of Diesel Fuel

DualFuel™ gas solutions

Mono Fuel or Dual Fuel : CNG, Methane Gas and HCNG
- Focus on CNG as Mono Fuel
- Dual Fuel with CNG and Bio CNG or Diesel with CNG
- Gasoline in CNG Engine with turbo

H_2 HYDROGEN FUEL

Hydrogen Fuel, DME and other Alternate Fuel
- Government focus in Zero Neutral Emission gas
- Alternate Fuel : DME, Methanol 100

Electrical Tractor
- Electrical Tractor push on farm segment

Thank a lot for Attention !!