

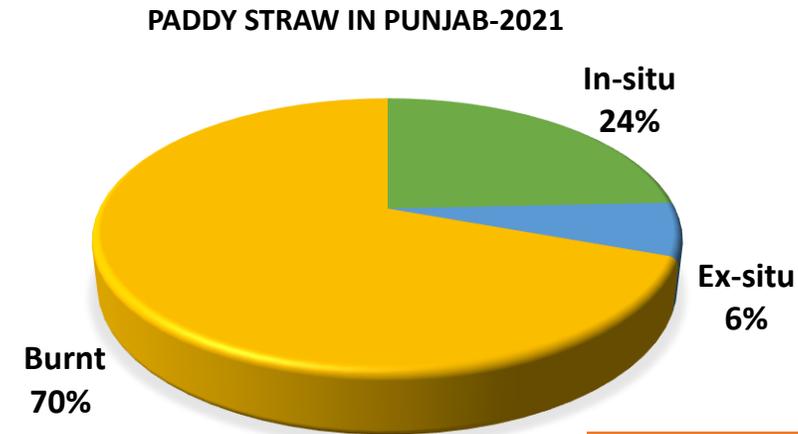
Ex-situ Management of Crop Residue in Punjab: Some Insights

Kamal Vatta

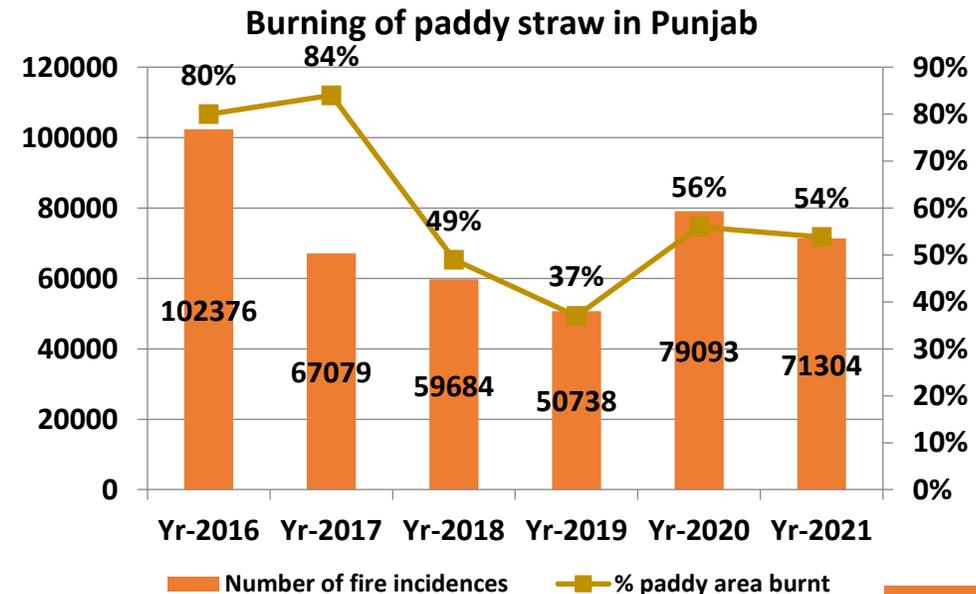
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The Status of Paddy Straw and its Management in Punjab

- In Punjab, 70-80% of paddy straw is burnt
- Serious environmental issue
- GOI provided >1050 cr INR for in-situ management
- >76000 subsidized machines to the CHCs and farmers
- Established 19,000 CHCs
- Still the residue burning incidences remain unchecked

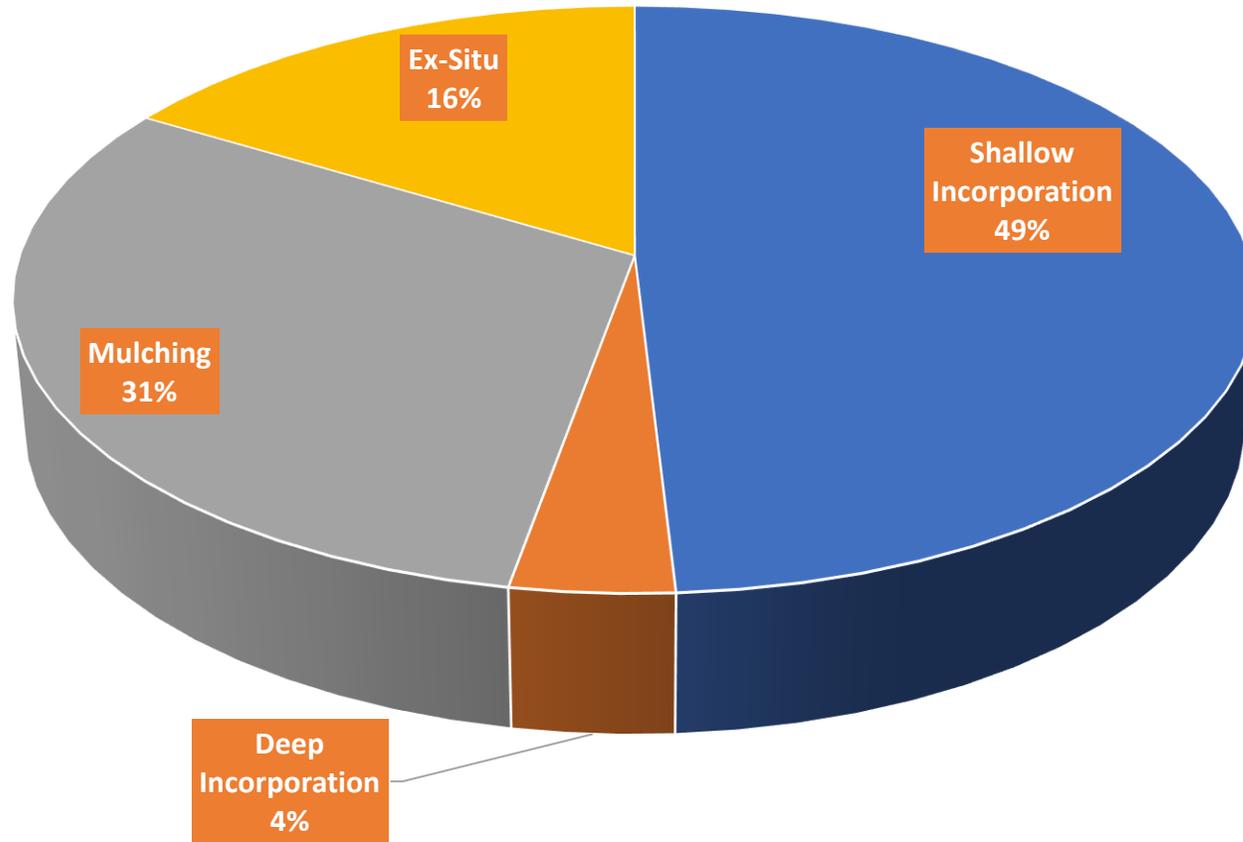


Source: NTPC India

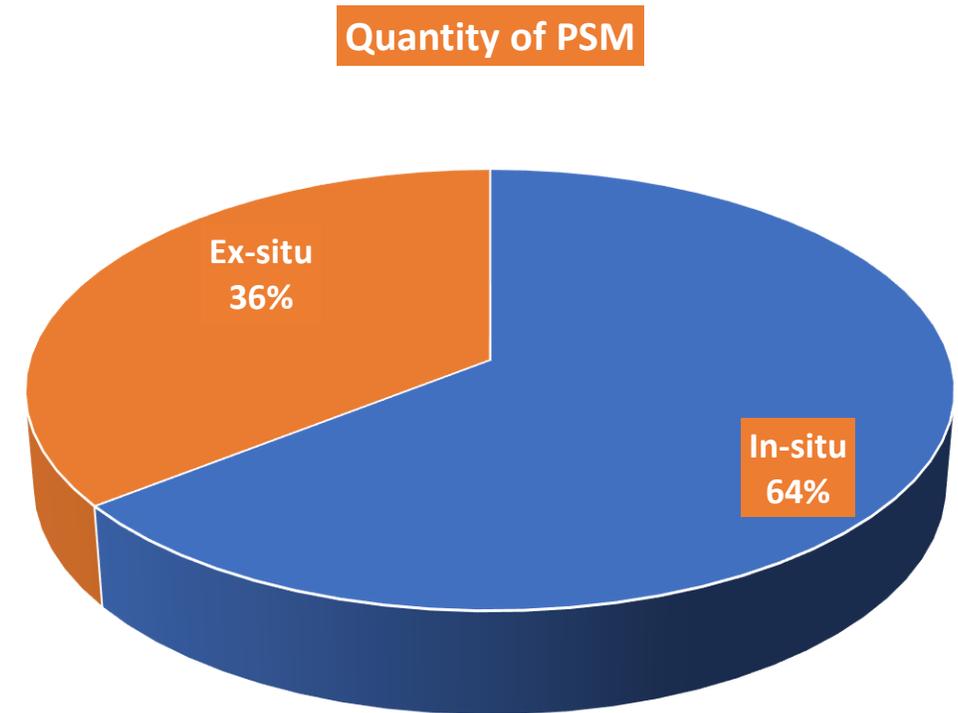


Source: Govt. of Punjab

What adopters choose? Insights from a Field Survey

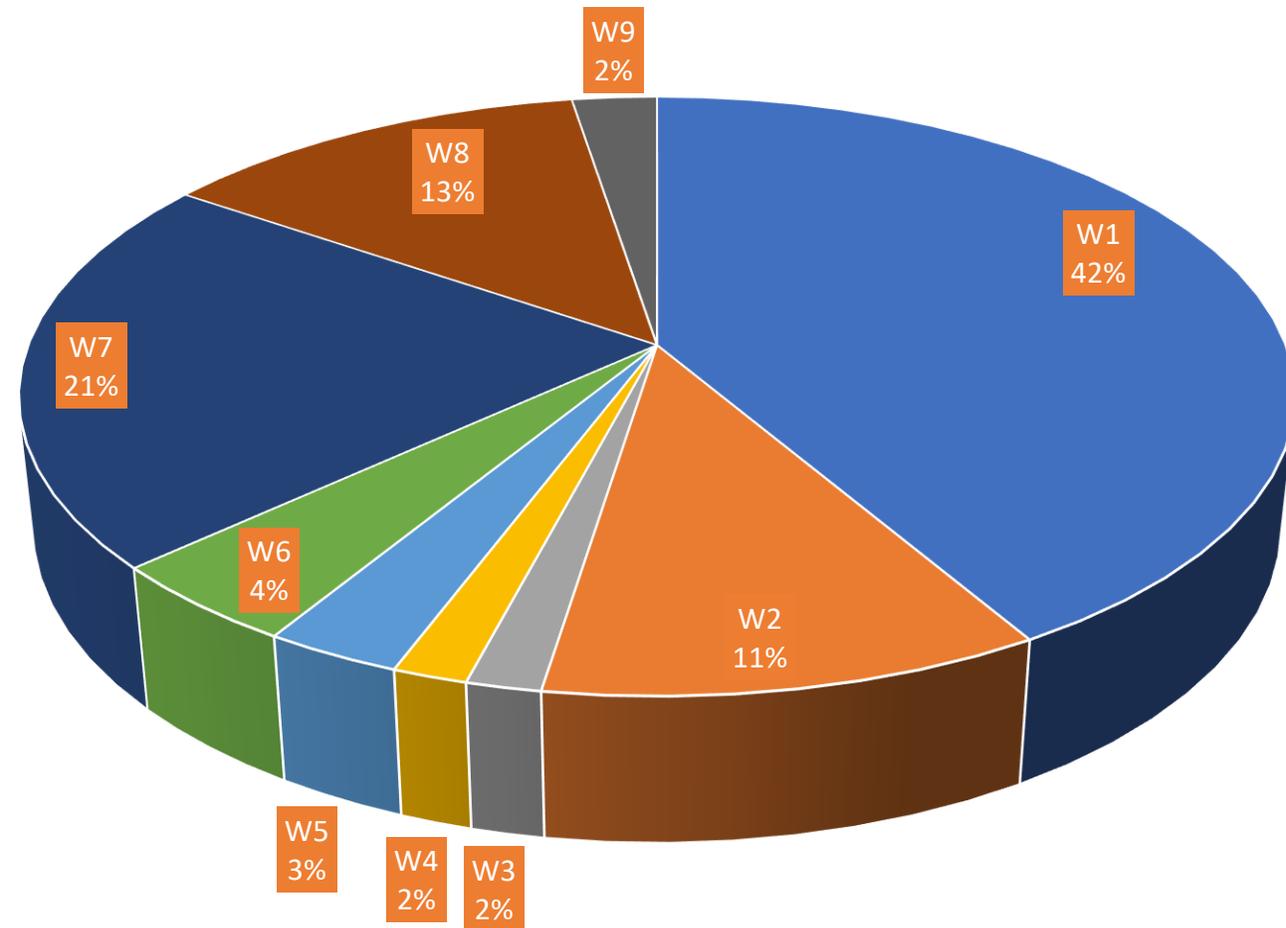


Adopter percentages



Source: PAU Survey, 2021

What adopters choose? Insights from Field Survey

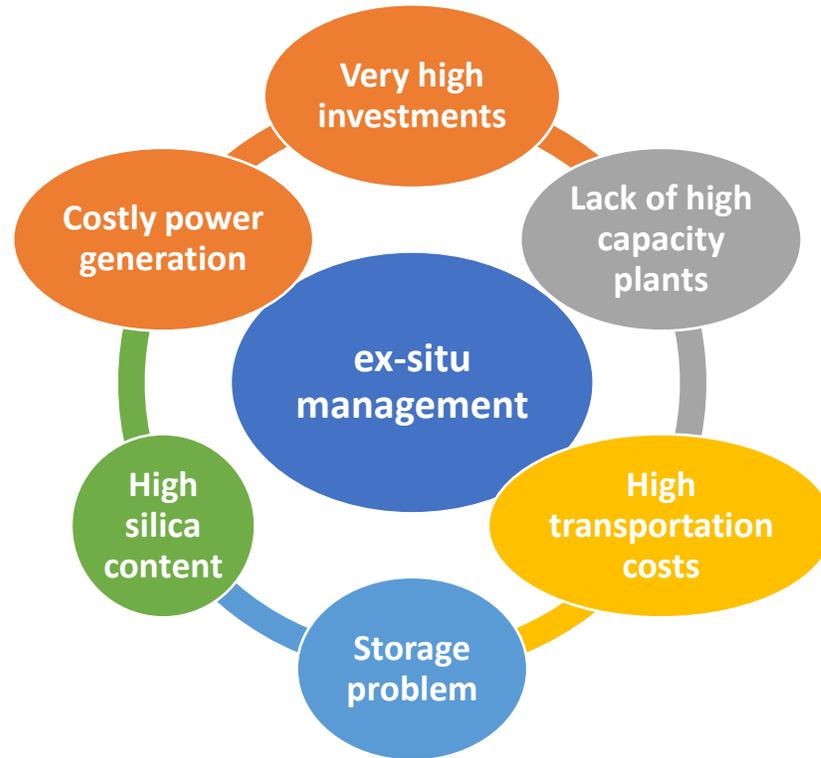
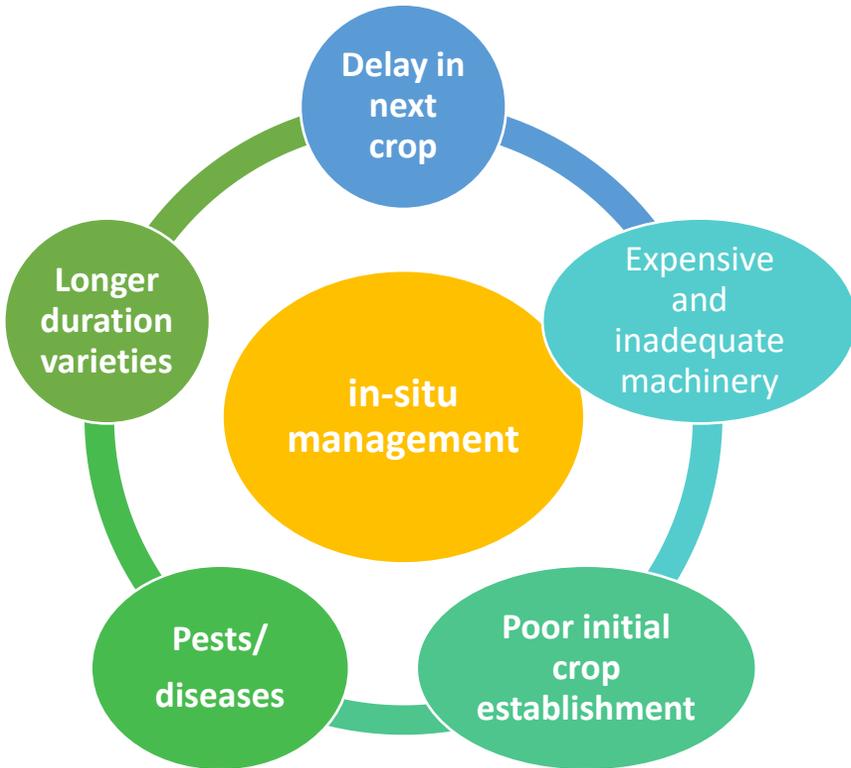


In-Situ Choices

PSM technique	Code	Combinations
Incorporation + Shallow	W1	SMS + Super Seeder
	W2	Stubble Shaver + Rotavator + Zero Drill
	W3	Stubble Shaver + Disc Harrow + Cultivator + Planker + Seed drill
	W4	Disc Harrow + Cultivator + Planker + Seed drill
	W5	SMS + Chopper/Mulcher + Rotavator + Cultivator + Planker + Seed drill
Incorporation + Deep	W6	SMS + Disc Harrow + MB Plough + Cultivator + Planker + Seed drill
Mulching	W7	SMS + Happy Seeder
	W8	Conventional machines Approach
	W9	SMS + other machines

Source: PAU Survey, 2021

The Challenges of in-situ and ex-situ PSM

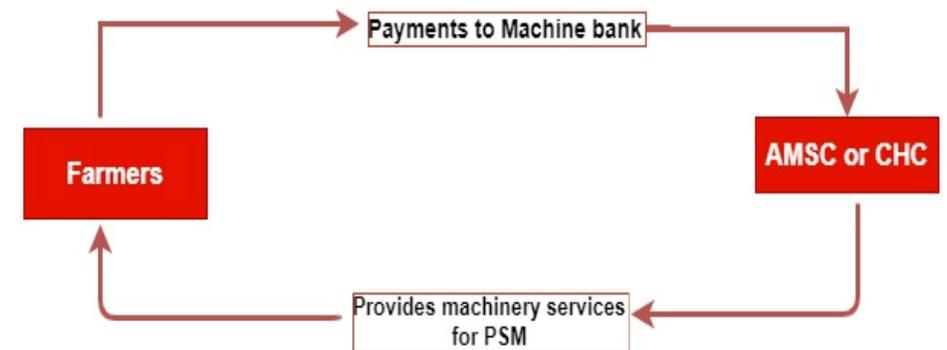
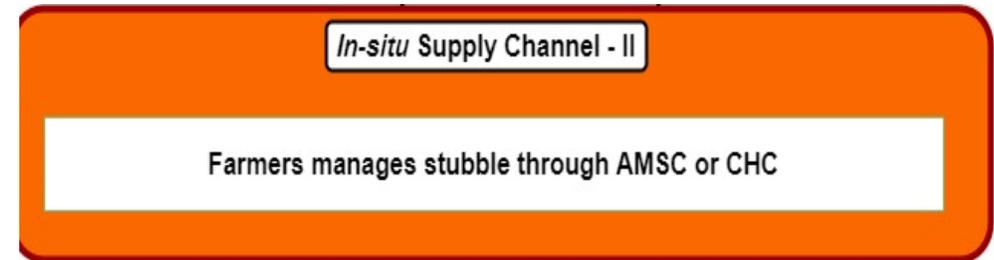
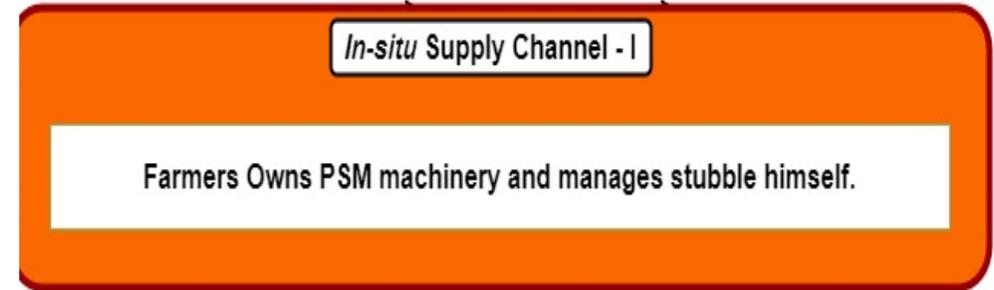


Reason	Response (%)
High Powered machinery	95-99%
Machinery not available on rent	80-85%
Increase in cost of production	97-99%
Non-availability of skilled labour	80-85%
Delay in operations	90-99%
Area under long-duration varieties	2/3 rd
Machine availability (ha/machine)	53
Happy Seeder	683 (7.8%)
Super Seeder	952 (5.6%)

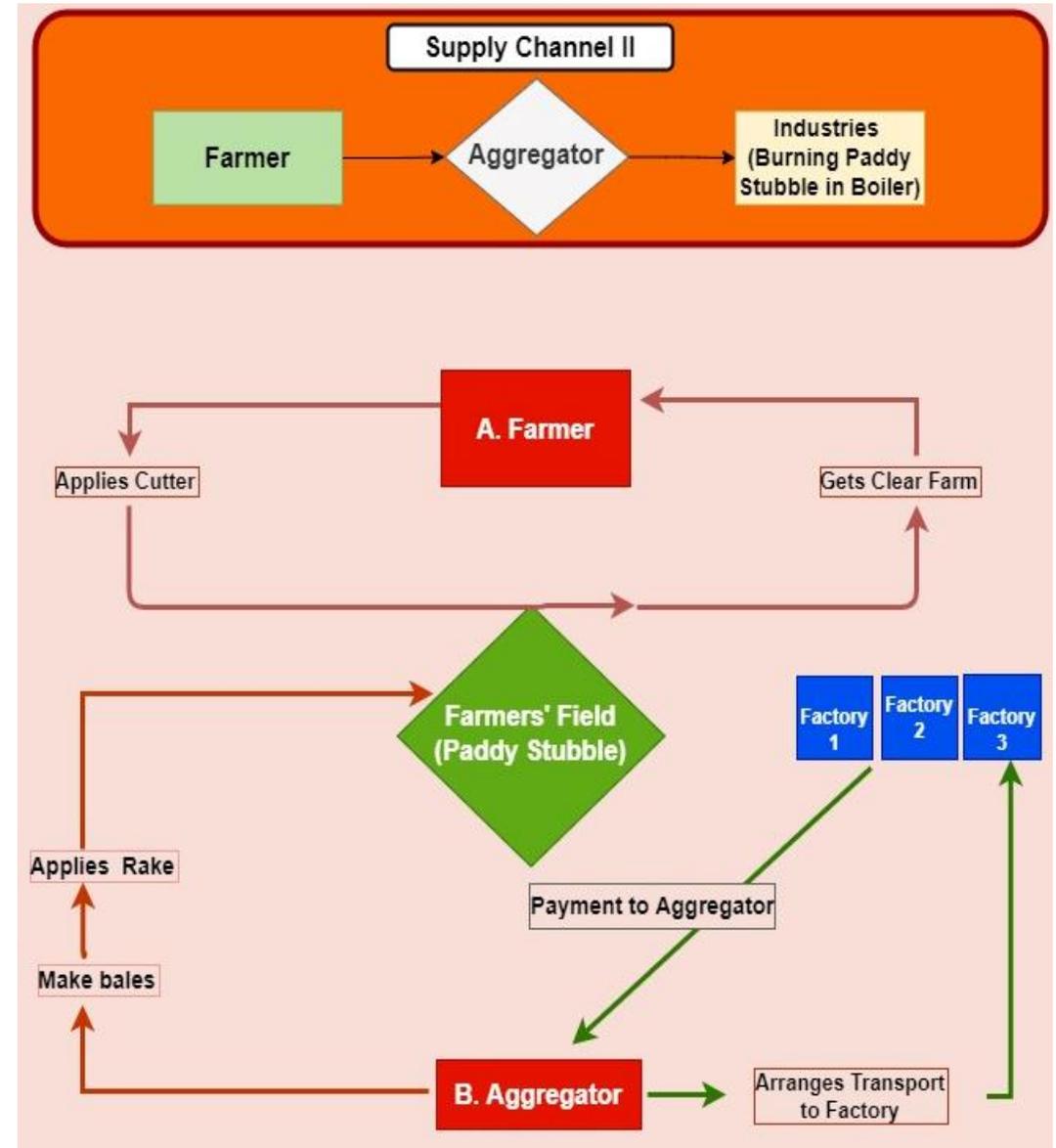
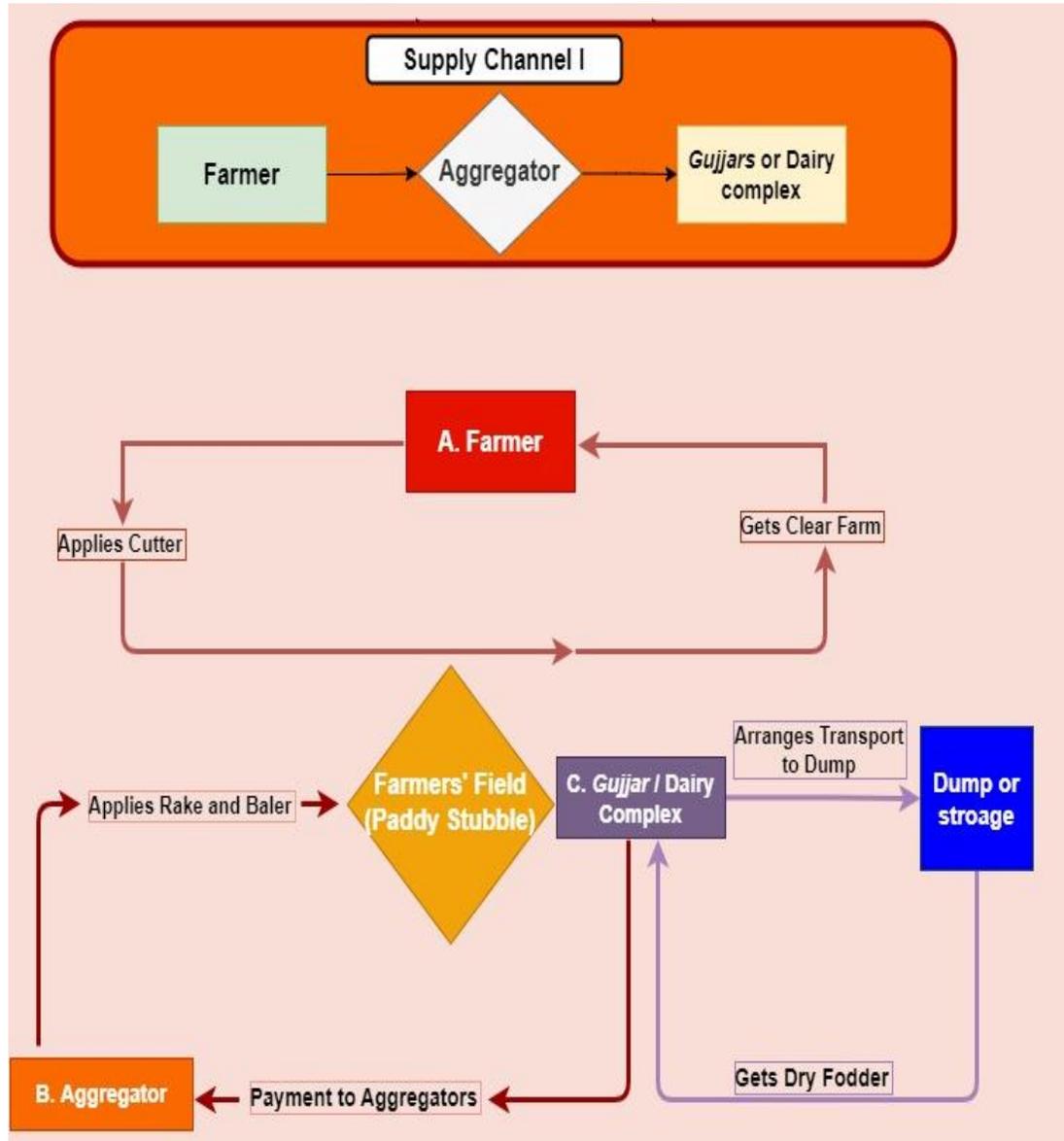
Source: PAU Survey, 2021

PSM Cost is a Deterrent: Understanding the Mechanism

- No-burning options entail costs
- For in-situ, costs are incurred on machinery like Happy Seeder, Super Seeder, Rotavator, etc.
- For ex-situ, costs are incurred for baling of the straw and its transportation
- Comparison renders ex-situ less preferred
- But there are differences in who pays for what.
- It needs to be understood properly



Channels for ex-situ PSM



Rising Demand for Paddy Straw in 2022: Reasons

- The current prices of paddy straw: Rs 9000-12000/ton
- Demand Push
 - NTPC demand 2.5 million tons
 - MSMEs have started using paddy straw in their boilers
 - GOI target of carbon neutrality (COP26) and co-firing target of 5-10%
- Supply Pull
 - Reduction in wheat straw due to decline in wheat yields
 - Farmers holding back paddy straw due to reduction in wheat straw
 - Gujjars also competing for paddy straw for animals
 - Delay in subsidies for balers and poor repair services
 - Increased burning incidences than before

Understanding the Costs and Returns

An field example of 1000 ha capacity

Particulars	Number	Own Investment (Rs Lakh)	Subsidy (Rs Lakh)	Total Investment (Rs Lakh)
Cutter	1.38	0.20	-	0.20
Raker	2.9	7.49	1.62	9.11
Baler	2.9	30.12	5.07	35.19
Tractor Trailer	3.25	8.63	-	8.63
Total	-	46.44 (87.41)	6.69 (12.59)	53.13 (100.00)

Particulars	Value (Rs Lakh)
Thread cost	15.14
Fuel (Baling + raking + cutter)	9.75
Wages for labour	7.72
Transportation	5.79
Drivers' salary	1.21
Repair and maintenance	0.87
Storage costs	0.18
Total variable costs	40.66
Fixed costs (depreciation (10%), interest on investment) (7%)	9.03
Total Costs	49.69
Total returns	113.63
Net returns	63.94 (129%)

Source: Vatta et al., 2022

Comparing Different Types of Aggregators in PSM

Particulars	Co-operatives	Farmer groups	Agri-entrepreneur
No. of balers	1 (square baler)	5 (square balers)	20 (round balers)
Operations	Raking and baling	Raking, baling and transportation	Raking, baling, transportation and processing straw to Bio-coal.
Investment	14 Lakh	1 Crore	Machinery – 6.8 Crore Bio-coal plant: 20 crores per 10000 TPD
Potential area of Op* (acres)	900	4500	45000
Potential Quantity [§] (tonnes)	2700	13500	135000
Actual area of Op (2021-22) (acres)	250	2760	
Actual Quantity [§] (2021-22) (tonnes)	750	8280	
Payments to/from farmers	Charges farmers Rs 2500/acre from farmer for raking and baling. Preferably farmer applies cutter (stubble shaver).	Don't charge farmers for raking and baling. Charge Rs 500/acre for cutting.	No payments charged from farmers.
Purchasers	Gujjars only (farmers contact gujjars themself, society engages in baling only)	Gujjars, Industry (for combustion in boilers), Biomass power projects (electricity)	Self-consumption to produce bio-coal for sale to NTPC (capacity of 10 tonne per day)
Sale price	Gujjars pay Rs. 2500/acre and lift bales from the field. Source: Vatta et al., 2022	<ul style="list-style-type: none"> To industry at Rs. 160/quintal. To gujjars at Rs. 2000-2500 and gujjars themselves arrange lifting. 	To NTPC at pre-contracted rate.
Future plans	No scope and plans of expansion due to other engagements of society limited resources and limited staff.	Significantly large expansion	<ul style="list-style-type: none"> Procure 5 times for new plant of 100 tonnes per day capacity.

Ex-Situ Opportunities for Paddy Straw Management

- Mission SAMARTH
 - Co-firing of thermal plants (5%-10%)
 - India needs 76 m tons of pellets for co-firing (5%) and 152 m tons (10%)
 - Co-firing in small industrial units
- Ethanol Blending
 - 10% blending target by 2024 (achieved 2022)
 - 20% target (2025-26)
- Electricity Generation (13 plants in Punjab)
- Biogas Plants (demand is rising)
- Packaging Materials
- Dairy Farming

Carbon Credit Pricing by Type

Project Type:	Volume Sold (MtCO ₂ e):	Average Price:	Price Range:
Wind	12.8	\$1.9	\$0.3 - \$18
REDD+	11	\$3.3	\$0.8 - \$20+
Landfill methane	7.9	\$2	\$0.2 - \$19
Tree planting	3	\$7.5	\$2.2 - \$20+
Clean cookstoves	3	\$4.9	\$2 - \$20+
Run-of-river hydro	1.5	\$1.4	\$0.2 - \$8
Water/purification	1.2	\$3.8	\$1.7 - \$9
Improved forest management	0.8	\$9.6	\$2 - \$17.5
Biomass/biochar	0.7	\$3	\$0.9 - \$20+
Energy efficiency - industrial-focused	0.7	\$4.1	\$0.1 - \$20
Biogas	0.6	\$5.9	\$1 - \$20+
Energy efficiency - community-focused	0.6	\$9.4	\$3.3 - \$20+
Transportation	0.5	\$2.9	\$2.2 - \$6.8
Fuel switching	0.5	\$11.4	\$3.5 - \$20+
Solar	0.3	\$4.1	\$1 - \$9.8
Livestock methane	0.2	\$7	\$4 - \$20+
Geothermal	0.1	\$4	\$2.5 - \$8
Agro-forestry	0.1	\$9.9	\$9 - \$11

Ex-Situ Options and Value Generation

Ex-Situ Option	Output per ton of paddy straw (kg)	Prices of product (Rs/kg)	Total value generated per ton (Rs)
Bio-ethanol production	183	59.5	10860
Bio-gas generation	107	56.7	6090
Bio-coal manufacturing	500	9.0	4500
Use in paper industry and packaging	900	1.6	1480
Use as animal fodder	1000	1.0	1000
Bio-thermal energy (direct burning)	111kWh	8.2	910

Source: Vatta et al., 2022

The Scenario of Value Generation through Ex-Situ PSM

Ex-Situ Option	Immediate Scenario		Long-term Scenario	
	Potential (m tons)	Value Generation (Rs Crore)	Potential (m tons)	Value Generation (Rs Crore)
Bio-ethanol production	1.0	1086	2.0	2172
Bio-gas generation	1.5	913	3.5	2130
Bio-coal manufacturing	2.5	1125	8.0	3600
Use in paper industry and packaging	0.5	74	1.5	222
Use as animal fodder	2.0	200	3.0	300
Bio-thermal energy (direct burning)	1.0	91	2.0	182
Total	8.5	3489 (858)	20.0	8606 (1991)

Own estimates, Vatta et al., 2022



The screenshot shows the Hindustan Times website with a news article titled "To curb stubble burning: Punjab has sent a proposal to give cash incentive to farmers, says Kejriwal". The article mentions that the proposal suggests ₹2,500 per acre for farmers in Punjab to reduce stubble burning. An image shows a person standing in a field with a large fire burning in the background.

Delhi chief minister and Aam Aadmi Party (AAP) national convener Arvind Kejriwal on Wednesday said the Punjab government had submitted a proposal to the Commission for

Conclusions

- Ex-situ management may emerge as potential and sustainable solution
- Ex-situ has in-built incentive system for all the stakeholders
- Carbon credit mechanism may strengthen incentives to induce behavior change
- The climate change may be another factor affecting PSM