

Logistics and Efficiency of Grain Harvest and Transport Systems with the Use of Silo-Bag

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What is logistic?

- Logistic - Is that part of the supply chain that plans, implements and controls the **efficient** and **effective** flow and storage of **goods**, services and related **information** from the point of origin to point of consumption in order to **meet customer's requirements**. (Ricks et al., 2002)

Important to remember

- What cannot be done by a logistic point of view, it will not be done
 - Even if it is good for quality
 - Even if it is good for economics

Advantages of the Silo-bag

- Easy to load and unload with the current technology
- Improve the logistic of the farmers
- Segregation programs and traceability
- Low cost
- Flexibility in storage capacity
- Grain under control of the farmers!



Factor Promoting Silo-bag Expansion

- Shortage of permanent storage capacity (105million t production and 67-70 million t storage capacity)
- More than 50% of the land is not cultivated by the owner
- Expansion of agriculture to new areas (without infrastructure)
- Shortage of truck fleet during harvest
- Irruption in the market of the new high capacity combines
- This year – large production in the world – silobags wanted!!

Traditional vs. silobag logistics

- Traditional:
 - harvest → in-field transport → road transport → elevator operation
- Silo-bag:
 - harvest → in-field transport → silo-bag loading

Delay, storage

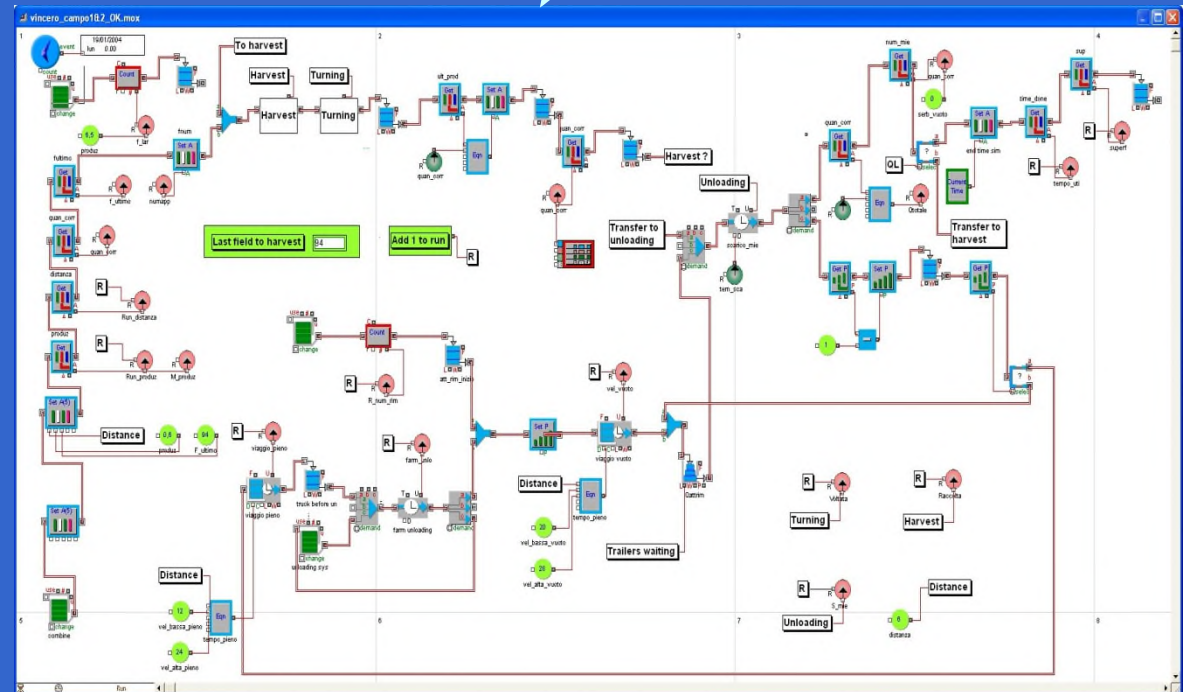
- Silo bag unloading → road transport → elevator operation

Grain harvest operation

- Is a system of machines
- one machine capacity could be limited by others in the system
- working and waiting times are variables, f (distance, transport system, yield, field shape, etc.)
- optimal work organisation and machinery utilization are essential elements in achieving cost reductions
- **We need a tool that is able to analyze the system altogether**

Discrete Event Simulation (ExtendSim®)

- complex
- interactive
- **Dynamic**
- Stochastic
- predict:
 - machine efficiency
 - waiting times
 - resource utilization



Input and output parameters

- **Combine data** (harvest speed and width, grain hopper capacity)
- **Transport data** (transfer speed empty, full, payload capacity...)
- **Field data** (yield, shape, distance)
- **Management rules** (unload on-the go...)
- **Global performance:** harvester efficiency, throughput of the system (t/h), waiting times
- **Field results:** combine capacity, utilization time
- **Specific location data:** queues length, waiting times, resource utilisation

Aim of the study

What is the logistic advantage in using silobags vs. Traditional harvest & transport operation?

This is accomplished with a two-step process:

- 1) Field trials and data collection
- 2) Discrete event simulation model

Field trials

- Argentina, spring 2011 and 2012
- Field performance
- Transport performance
- Elevator performance (assumption) (also elevators use silo-bag as a temporary storage)

Simulation model

- Extendsim 8.0 discrete event simulation software
- 2 models:
 - Traditional operation
 - Silo-bag operation

Experiment data - traditional

- Field 0.8 x 0.8 km(soybeans), yield 4 t/ha, 16 and 64 km from elevator
- Combine: Working speed 7.2 km/h, Working width 9 m
- Grain cart 15 t, unload rate 400 t/hr
- Truck capacity 30 t
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Experiment data –Silo bag

- Silo bag filling machine
 - Loading flow rate 400 t/hr
 - Cost 9,000 \$. lifetime 4000 hr
- Silo bag unloading machine
 - Unloading flow rate 186 t/hr
 - Cost 20,000\$. lifetime 4000 hr

Scenarios

- Traditional:
 - 1 combine, 1 grain cart, 1-3 trucks, one day of harvest, immediate shipment to the elevator
- Silo bag:
 - 1 combine, 1 grain cart, 1 silo bag filling machine, one day of harvest
 - Later shipment to the elevator, 1 silo bag unloading machine, 1 truck (low hauling cost)

harvest capacity – transport 16km (10 mi)

	field capacity		increase with silobags		% increase vs. traditional
	Traditional (ha/h)	Silobags (ha/h)	(ha/day)	(ha/h)	
1 truck	3.28	5.94	21.27	2.66	81%
2 trucks	5.10	5.94	6.70	0.84	16%
3 trucks	5.95	5.94	0.06	- 0.01	0%

Economics – 16 km (10 mi)

	Costs		Savings	
	Traditional (\$/ha)	Silobag (\$/ha)	(\$/ha)	%
1 truck	167.69	149.89	17.80	10.62
2 trucks	161.87	149.89	11.99	7.41
3 trucks	151.07	149.89	1.18	0.78

harvest capacity – transport

64 km (40 mi)

	field capacity		increase with silobags		increase harvest capacity %
	Trucks (ha/h)	Silobags (ha/h)	ha/day	ha/h	%
1 truck	3.17	5.94	22.17	2.77	87%
2 trucks	4.61	5.94	10.62	1.33	29%
3 trucks	5.55	5.94	3.13	0.39	7%

Economics – 64 km (40 mi)

	costs (\$/ha)		savings	
	Traditional	Silobag	(\$/ha)	%
1 truck	327.06	188.28	138.79	42.43
2 trucks	235.72	188.28	47.45	20.13
3 trucks	222.90	188.28	34.62	15.53

Elevator performance

- Silobags could increase performance by 30-50%→ fast unloading, less lane at the elevator (big advantages for farmers next to the plant)
- Implications:
 - For the elevator → more grain collected per day, more grain to trade
 - For the farmer→ more grain harvested per day – less weather risk

ELEVATOR OPERATION

16 km distance

TRAD
(62 min)

SILOBAGS
(22 min)

(60 min)

(60 min)

Transportation
& Harvest

Chain	Truck cycle time	Load per day (12 h)	Increase in transport capacity
traditional	122 min	5.9	
Silo-bag	82 min	8.8	48%

Logistic advantages

- break in the harvest-transport chain – synchronized transport not needed, no longer a bottleneck for the harvest
- Transport, elevator operations are not an issue
- Less uncertainty on farm operation
- Suitable for high performance combines
- Important savings at both short and long distance
- Transport distance and elevator performance are important factors for traditional supply chain – not for silobag chain

Conclusion

- Logistic advantage is one of the most important of the success of silobags
- Discrete event simulation proven to be effective to describe and evaluate the logistic scenarios of silobags
- In-dept, specific results not achievable in other ways (e.g. combine utilisation field by field vs. transport unit availability)
- Suitable to analyse any kind of complex chains (harvest, transport, elevator/port handling, etc.)

Future work

- Make more field trials and simulated experiments, involving elevator plants
- Evaluate other factors (e.g. timeliness of the operation, risk of not finding a truck, traceability advantage. etc.)

Thank you...

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