UNDERSTANDING BIOWASTE COMPOSTING IN DEVELOPING COUNTRIES: LESSONS FROM COLOMBIA

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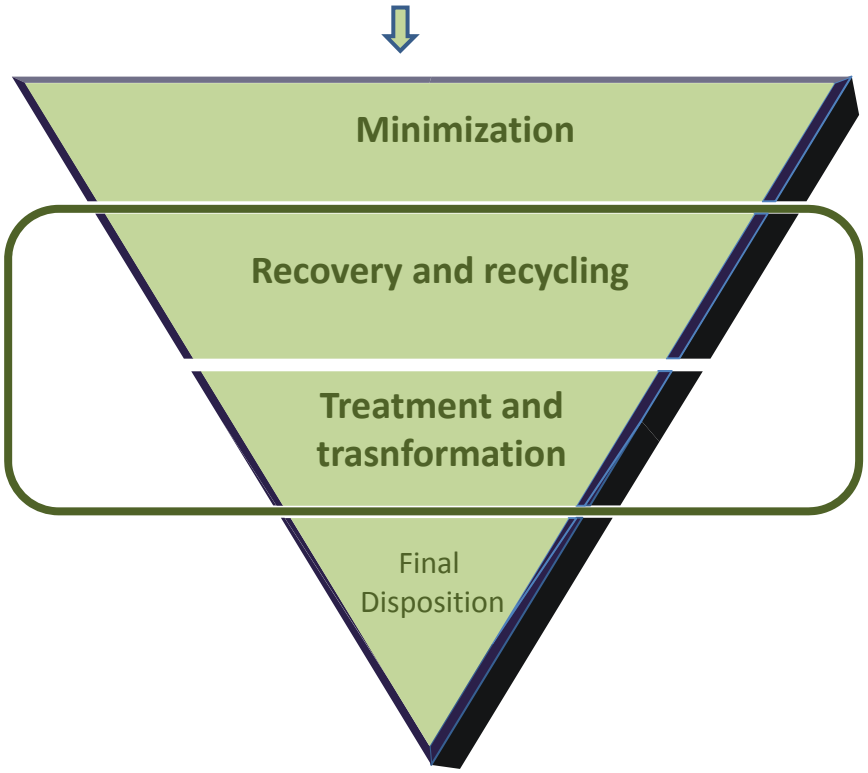
Outline

1. Research framework and objetive
2. System analysis of biowaste (BW) composting
3. Evaluation of the substrate quality entering BW composting facilities
4. Effect of adding selected bulking materials on the composting process.
5. Conclusions

Research framework

Hierarchy solid waste management



Social

Environmental

Economic

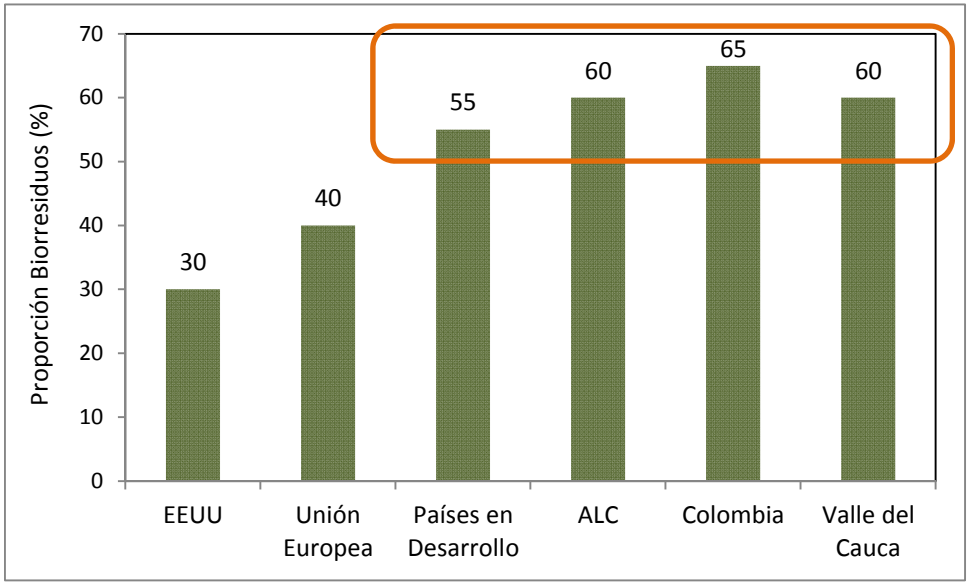
Ordinance 2981 de 2013
Ordinance 754 de 2014

Research framework

Among 50 y 70% of the MSW

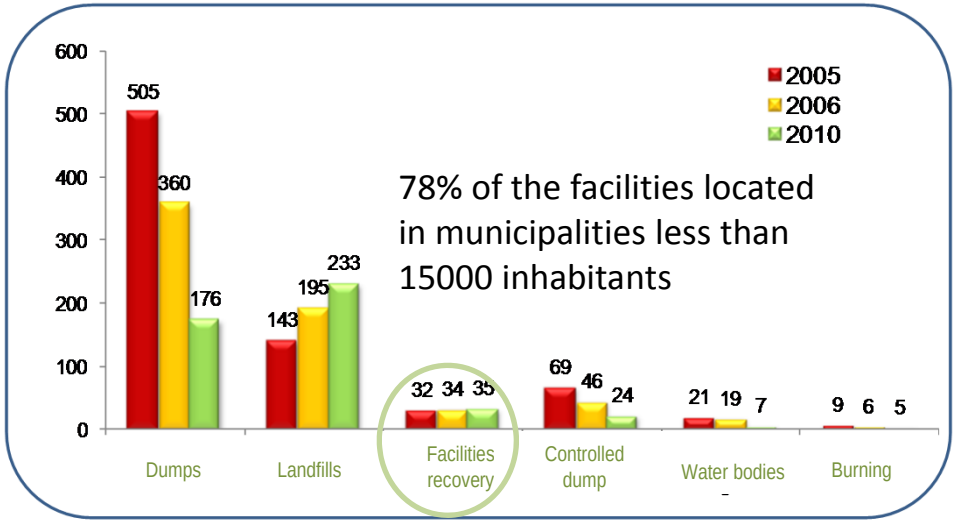



Biowaste in MSW in different countries



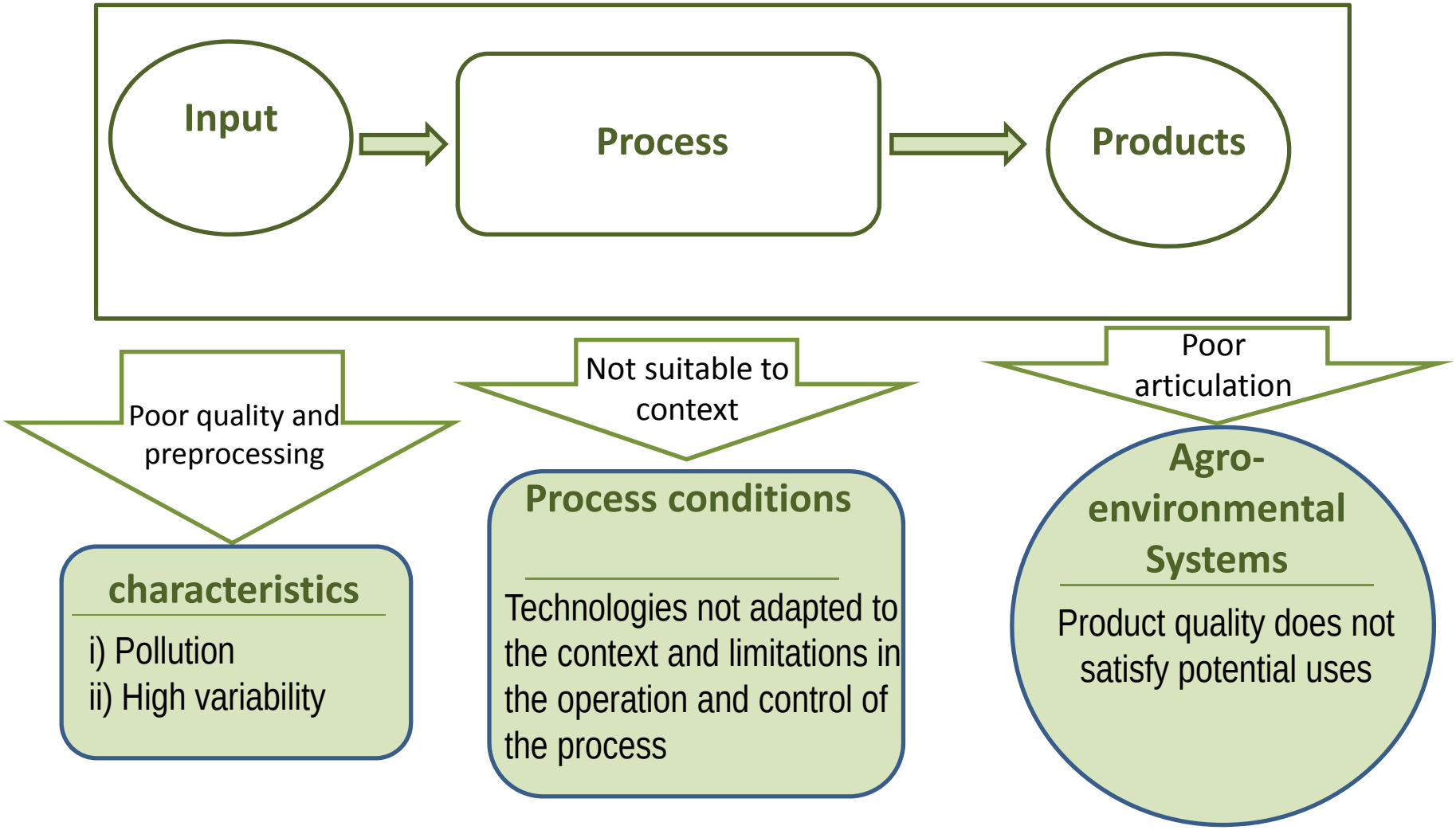
Source: EPA (2012). Eurostat (2009). OPS (2005). MAVDT (2007).Marmolejo et al. (2010)

Research framework



SSPD (2010)

Research framework



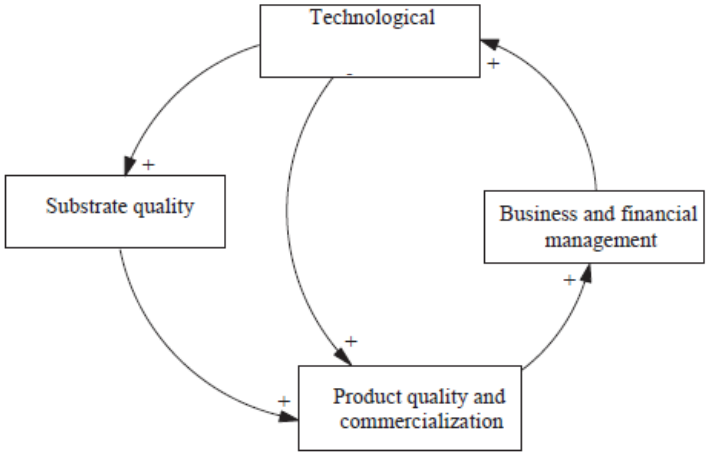
Objective

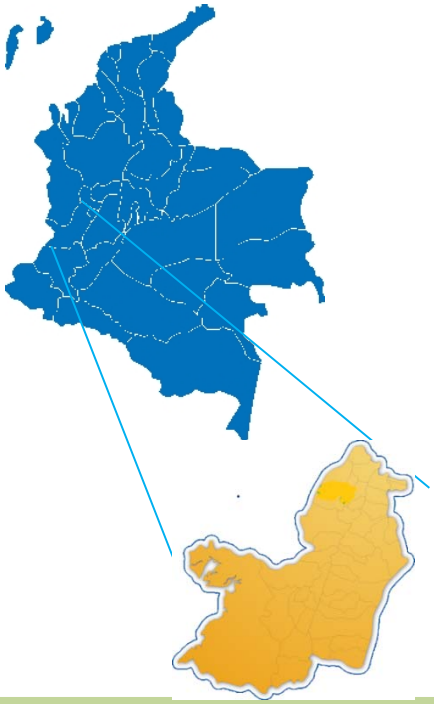
Understand the performance of bio-waste composting systems and evaluate strategies to improve their implementation.

System analysis of biowaste composting

Literature review about experiences of BW composting implementation in developing countries.

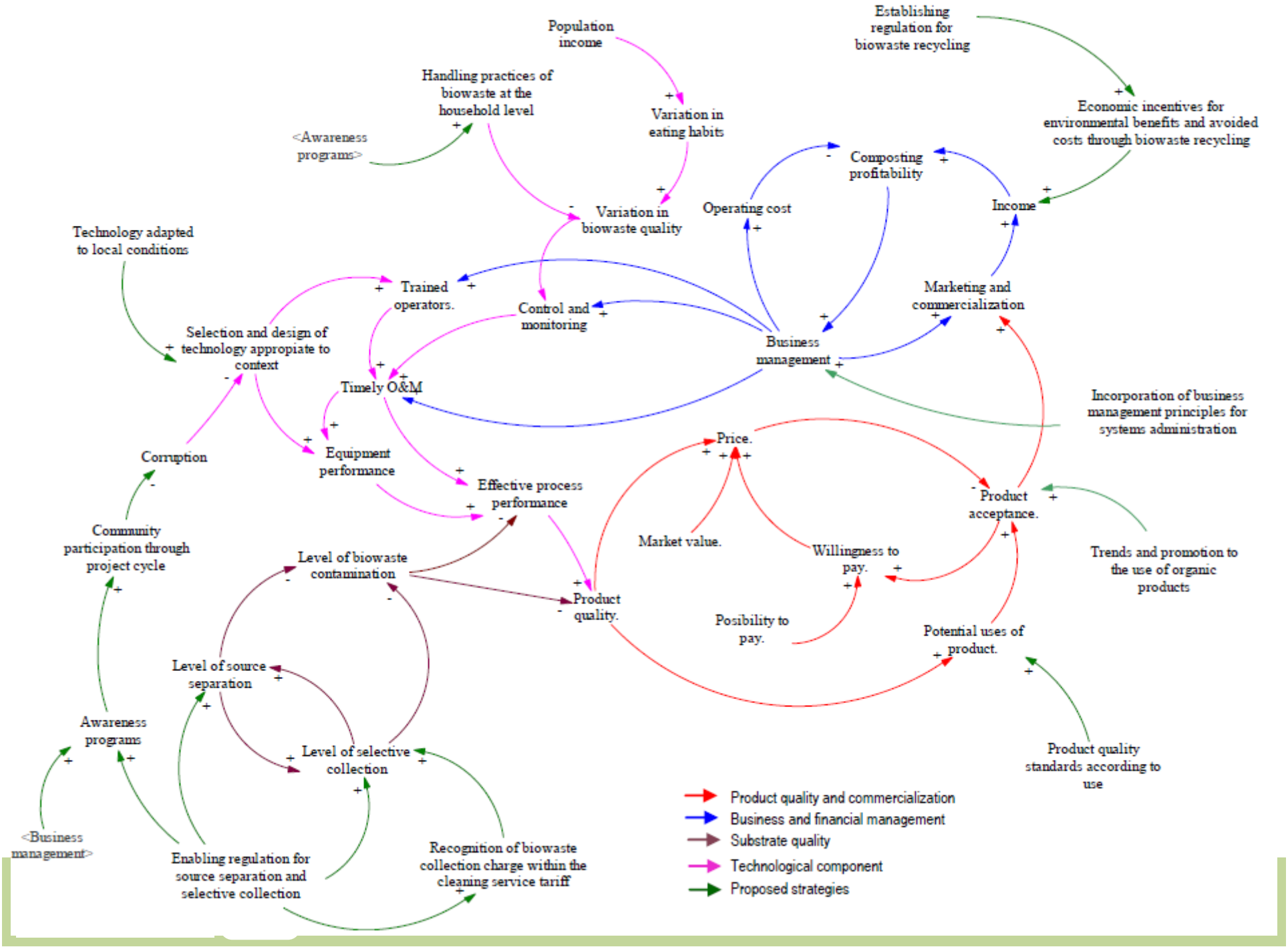
Follow up to operation and monitoring of five composting facilities in Colombia





Location	Urban Population	Waste Processed (t month^{-1})	Type of Substrate
Alcalá	9106	60.0	SSBW
Bolívar	3621	17.3	MBW
El Dovio	5175	39.1	SSBW
La Victoria	9265	84.1	MBW
Versalles	3831	18.9	SSBW

SSBW: source separated biowaste
MBW: mixed biowaste


Population income
Establishing regulation for biowaste recycling
Handling practices of biowaste at the household level
Variation in eating habits
Economic incentives for environmental benefits and avoided costs through biowaste recycling
<Awareness programs>
Composting profitability
Variation in biowaste quality
Operating cost
Income
Technology adapted to local conditions
Trained operators.
Marketing and commercialization
Control and monitoring
Selection and design of technology appropiate to context
Business management
Timely O&M
Incorporation of business management principles for systems administration
Price.
Corruption
Equipment performance
Effective process performance
Product acceptance.
Community participation through project cycle
Market value.
Willingness to pay.
Trends and promotion to the use of organic products
Level of biowaste contamination
Product quality.
Posibility to pay.
Potential uses of product.
Level of source separation
Awareness programs
Level of selective collection
Product quality standards according to use
<Business management>
Enabling regulation for source separation and selective collection
Recognition of biowaste collection charge within the cleaning service tariff
Product quality and commercialization
Business and financial management
Substrate quality
Technological component
Proposed strategies

System analysis of biowaste composting

key strategies to improve biowaste composting sustainability

Internal	✓promoting administration within a business perspective. ✓promoting marketing and commercialization initiatives. ✓implementing local technological development.
More distant along the causal chain	✓Developing standards and public policies to promote source separation. ✓Recognizing the economic and environmental benefits of Composting. ✓Encouraging the use of products, such as compost. ✓Setting product quality standards in accordance with the potential uses of products ✓Supporting technological development.

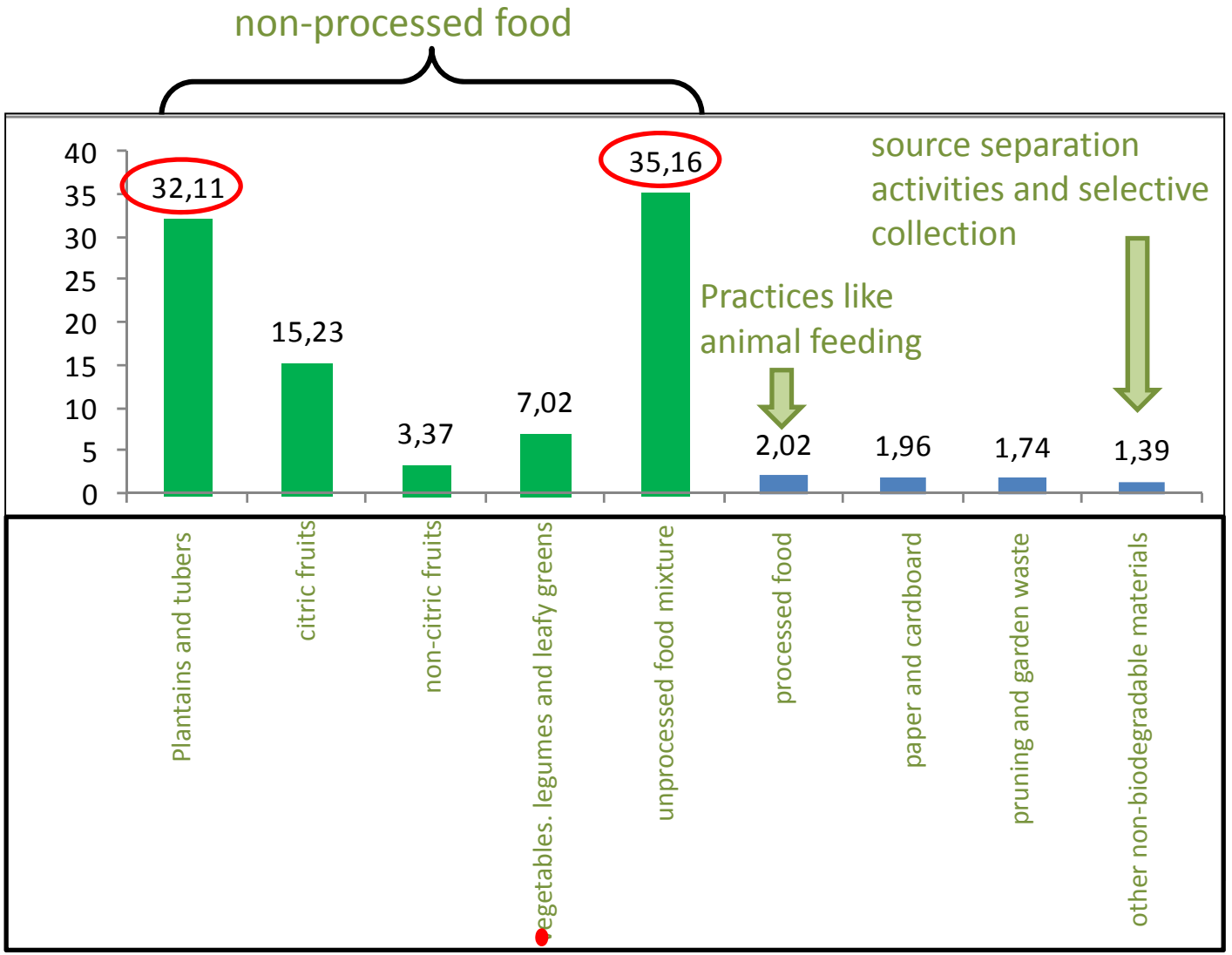
Evaluation of the substrate quality entering BW composting facilities

- ✓ Height: 1860 m.a.s.l.
- ✓ Average temperature : 18°C
- ✓ Economic activity: agriculture and livestock
- ✓ Population: 3523 inhabitants
- ✓ MSW Production: 10.2 t/week
- ✓ Biowaste: 63% MSW
- ✓ Collection : 2 times for week
- ✓ Type collection: Selective
- ✓ Collection days: Monday and Thursday
- ✓ Piles forming was developed 24 hours after the entry of waste

39 samples were taken from piles

Evaluation of the substrate quality entering BW composting facilities

Physical composition



Evaluation of the substrate quality entering BW composting facilities

Physicochemical characteristics

Variable	Unit	CV	$\overline{X}$ + s
pH	--	9.09	5.5 ± 0.5
Moisture	%	4.17	76.7 ± 3.2
TOC	% (b.s.)	14.55	33.0 ± 4.8
N_{TOTAL}	% (b.s.)	31.25	1.6 ± 0.5
C/N	--	24.42	21.7 ± 5.3
K_{TOTAL}	% (b.s.)	31.25	1.6 ± 0.5
P_{TOTAL}	% (b.s.)	33.33	0.3 ± 0.1
Ash	% (b.s.)	22.52	25.1 ± 5.6
Ethereal extract	% (b.s.)	27.01	4.3 ± 1.2
Raw fiber	% (b.s.)	42.98	12.1 ± 5.2
Protein	% (b.s.)	30.32	10.1 ± 3.1
Carbohydrates	% (b.s.)	13.75	48.4 ± 6.7

fast degradation of organic matter

high variability

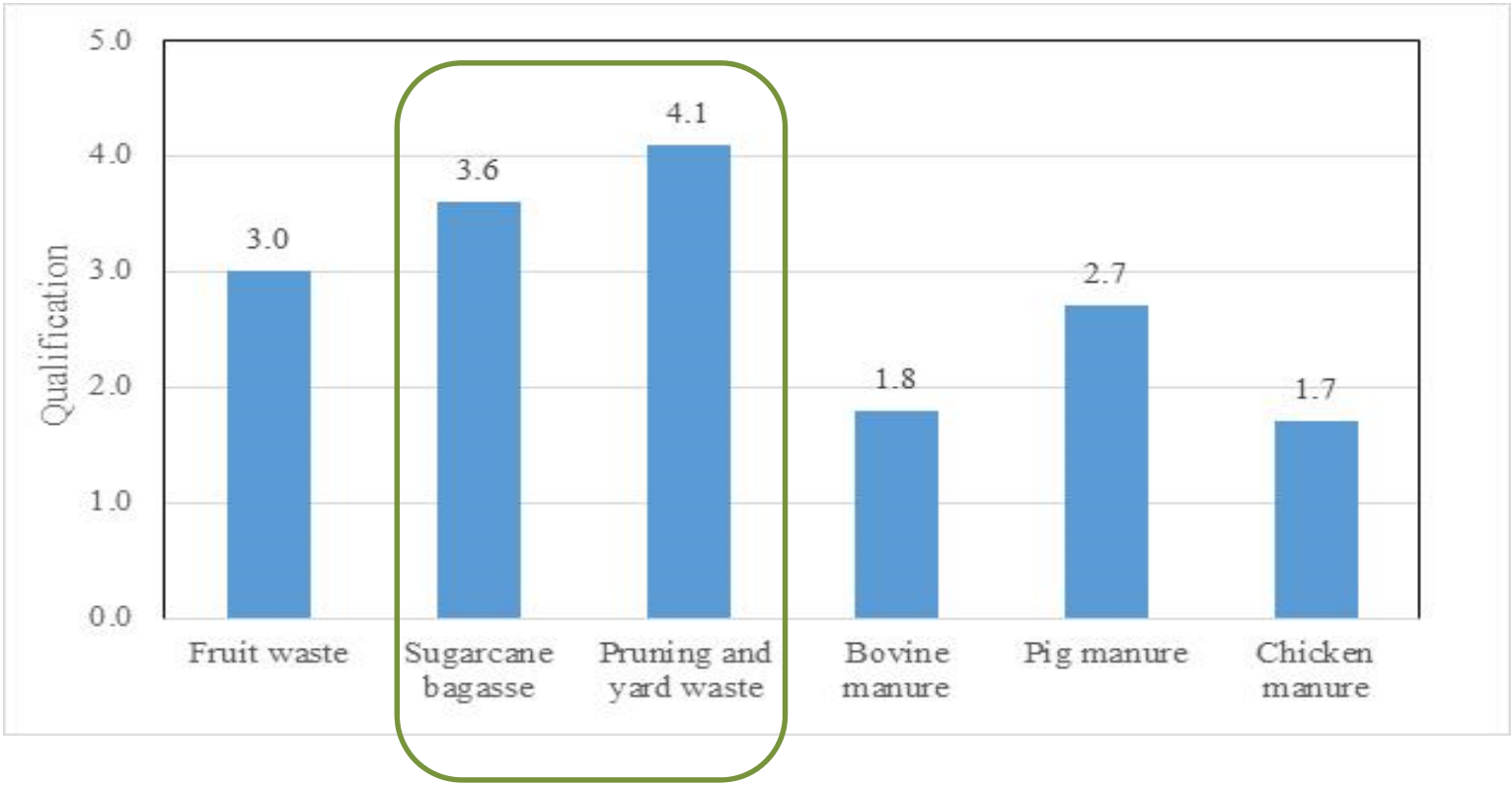
Effect of adding selected amendment or bulking materials

Selection of amendments and bulking materials for BW composting

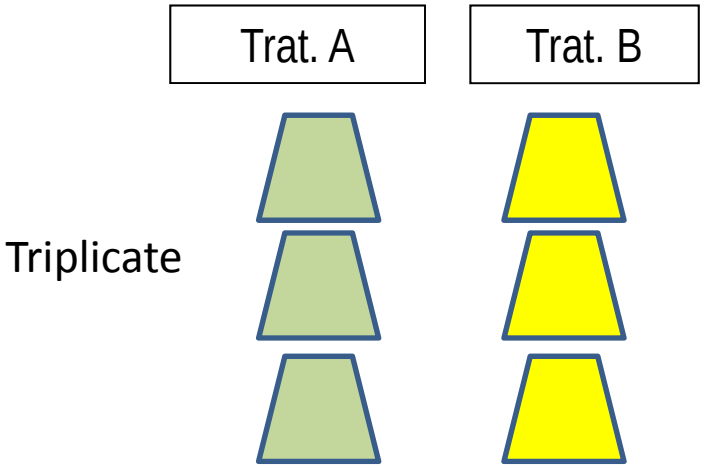
%[1]	Indicators	%[2]	Measurement	Potential values	Desired values	Score (points)
25	Required quality[3]	28	C/N criterion	Yes/No	Yes	Yes: 5
		24	Moisture criterion	Yes/No		
		24	pH criterion	Yes/No		No: 1
		12	Other nutrients criterion	Yes/No		
		12	Porosity increase	Yes/No		
20	Required quantity	100	Required Quantity of material (RQM) to complement substrate in terms of weight	-99% <RQM<99	Quantity between 0 and 15%	<0%: 0
						> 30%: 1
						>15% and < 30%: 3
						>0% and < 15%: 5
15	Lower acquisition cost (Ind_{cost})	100	Cost of material / higher cost of all materials	$Ind_{cost} \geq 0$	$Ind_{cost} \leq 0,5$	$Ind_{cost} < 0,5$: 5
						$Ind_{cost} \geq 0,5$: 1
10	Access to obtain the material	100	Type of access road	Very good	Paved	Very good: 5
				Good		Good: 4
				Acceptable		Acceptable: 3
				Bad		Bad: 2
				Non-existent		Non-existent: 0
10	Distance to the agrosystem (AS)	100	Distance to AS (D)	$D \geq 0$	D = 0	D = 0 km:5
						1 < D< 3 km : 4
						3 ≤ D < 5 : 3
						D≥5 :1
10	Availability for delivery of the material	100	It has restrictions for continuous supply	Yes	No	Yes: 1
				No		No: 5
10	Simplicity for material handling	100	Operational requirements	Sorting and shredding	Does not require	Clasif. and shredding.: 1
				Shredding		Shredding: 3
				Does not require		Does not require: 5

Effect of adding selected amendment or bulking materials

Selection of amendments and bulking materials for BW composting



Effect of adding selected amendment or bulking materials



Experiment 1

Treatment A: 22% sugarcane bagasse and 78% biowaste

Treatment B: 100% biowaste

Experiment 2

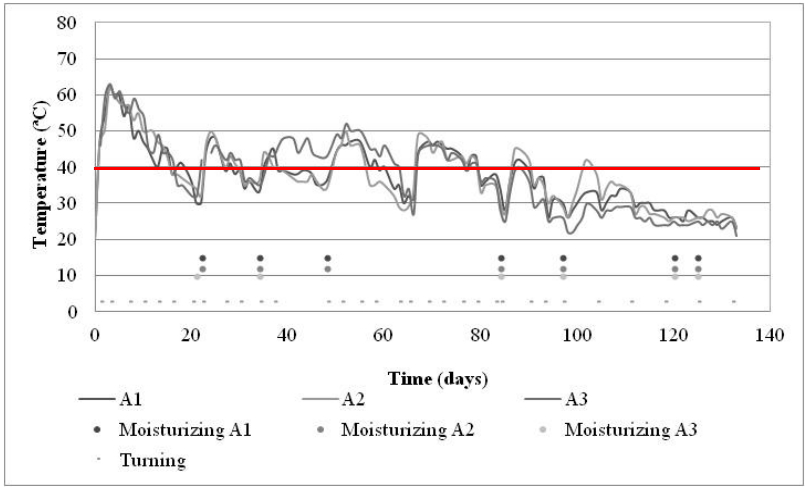
Treatment C: 34% star grass and 66% biowaste

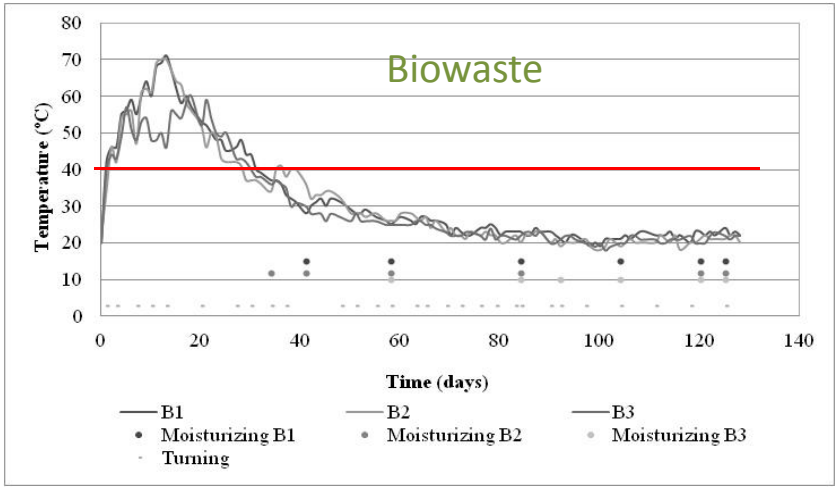
Treatment D: 100% biowaste

- Substrate quality
- Monitoring of process
- Product quality

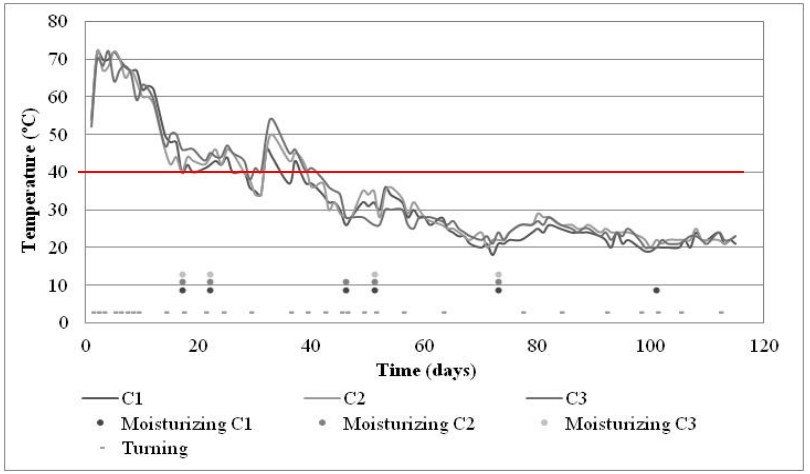
Effect of adding selected amendment or bulking materials

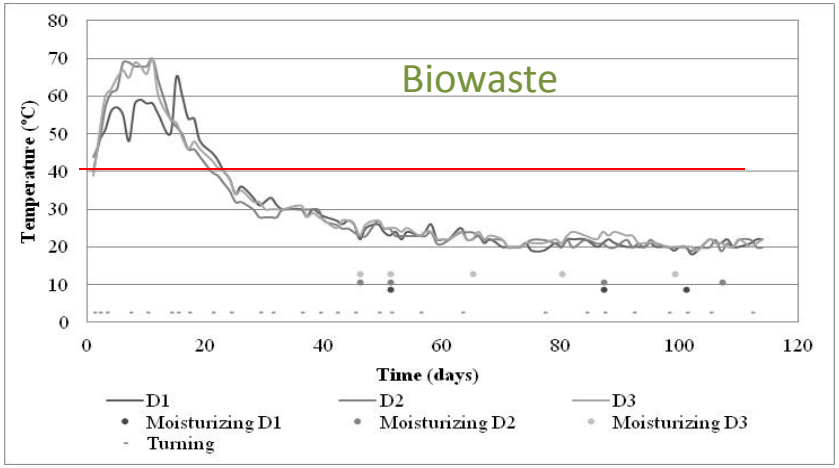
Experiment 1





Experiment 2





Effect of adding selected amendment or bulking materials

Quality of the obtained products in piles of the experiments 1 and 2

Parameters	Experiment 1			Experiment 2			NTC 5167
	Piles B	Piles A	p-value	Piles D	Piles C	p-value	
pH	8.01 ± 0.13	7.38 ± 0.07	0	10.10 ± 0.28	9.90 ± 0.17	0.318	> 4 and <9
Moisture, % wb	39.00 ± 0.87	49.47 ± 11.14	0	32.77 ± 5.62	34.50 ± 3.29	0.714	< 35
TOC, % db	12.77 ± 1.97	17.77 ± 1.46	0	13.73 ± 0.40	18.87 ± 2.70	0	> 15
N_{Total}, % db	1.54 ± 0.51	0.90 ± 0.69	0.092	0.90 ± 0.12	2.02 ± 0.50	0	> 1
C/N	9.43 ± 5.37	28.23 ± 18.79	0.122	14.77 ± 1.89	9.67 ± 3.13	0.098	--
Ashes, % db	62.63 ± 1.93	57.23 ± 1.00	0	65.67 ± 2.28	61.03 ± 1.33	0	< 60
K_{Total}, % db	3.78 ± 0.37	3.11 ± 0.40	0	3.23 ± 0.38	3.92 ± 0.13	0.293	> 1
P_{Total}, % db	1.45 ± 0.17	1.04 ± 0.08	0	1.32 ± 0.06	1.26 ± 0.10	0	> 1
BD, g cm^{-3}	0.61 ± 0.03	0.44 ± 0.07	0	0.55 ± 0.07	0.34 ± 0.04	0	< 0.6
WHC, % wb	124.4 ± 7.1	168.83 ± 9.91	0	120.4 ± 6.9	165.6 ± 18.6	0	> 100
EC, dS m^{-1}	0.74 ± 0.23	0.43 ± 0.07	0	0.49 ± 0.07	0.49 ± 0.07	0.907	--
CEC, meq 100 g^{-1}	52.3 ± 0.9	56.2 ± 1.87	0	49.7 ± 1.56	50.0 ± 2.7	0.694	> 30
TFC, NMP g^{-1}	809.3	751.0	0.888	10.0	7.7	0.703	--
TC, NMP g^{-1}	17.0	23.0	0.814	0.0	0.0	0.903	--
Germination index, %	35	88	--	30	45	--	--

Conclusions

The research developed has allowed a better understanding of the composting process performance in developing countries, identifying strategies that can contribute to its improvement.

The quality of the biowaste composting substrates is variable, and limits the consistency in the quality of the end-product.

However, the adequate selection of bulking materials improves the process and quality of the composting product and can contribute to its positioning as a biowaste management technology in developing countries.

Publications

Oviedo-Ocaña, E. R., Torres-Lozada, P., Marmolejo-Rebellon, L. F., Torres-López, W. A., Dominguez, I., Komilis, D., & Sánchez, A.: A systematic approach to evaluate parameter consistency in the inlet stream of source separated biowaste composting facilities: A case study in Colombia. **Waste Manage. (2017).** doi: 10.1016/j.wasman.2017.02.010

Oviedo-Ocaña, E. R., Dominguez, I., Torres-Lozada, P., Marmolejo-Rebellón, L. F., Komilis, D., & Sanchez, A.: A qualitative model to evaluate biowaste composting management systems using causal diagrams: a case study in Colombia. **J. Clean. Prod. (2016).** doi: 10.1016/j.jclepro.2016.05.115

Oviedo-Ocaña, R., Marmolejo-Rebellón, L. F., Torres-Lozada, P., Daza, M., Andrade, M., Torres-López, W. A., & Abonia-Gonzalez, R.: Effect of adding bulking materials over the composting process of municipal solid biowastes. **Chil. J. Agr. Res. (2015).** doi: http://dx.doi.org/10.4067/S0718-58392015000500013

Gracias por su atención

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