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Life Cycle Assessment to eco-design food products: study on industrial cooked dish

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AZTI presentation

AZTI-Tecnalia, Technological Centre, is a non-profitable organisation committed to the social and economic development of the food and fishing industries, and to the protection of the marine environment and its natural resources.

- **Technological research and development**
- **Technology transfer**
- **Technical services**
  - **Technical advice and consultancy services**
  - **Analysis and testing**
  - **Technological training and diffusion**

- **Marine Research Division**
- **Food Research Division**

- **197 personnel (162 employees & 35 trainees)**
- **16 Million € (income)**
- **30 European Projects running**

** facts 2005*

- **2 Research Centres (5.000 m²)**
- **3 Technical Offices in South-America (Chile, Argentina and Ecuador)**

Sukarrieta (Bizkaia)

Pasaia (Gipuzkoa)

Justification and objectives

The costs and environmental impacts attributed to the sale and consumption of any food product are associated to:

- Type of converted product,
- Its raw materials,
- Type and design of used packaging,
- Necessary manufacture to produce it,
- Distribution and commercialization,
- Consumer's use,
- etc.

The total costs and the global impact are accumulated throughout the whole agri-food chain.

During the **design or development of the product,** a great part of those costs and environmental impacts are determined.

The objective is to identify and develop techniques, measures and strategies to minimize those necessities during the development and design of the food products. It will allow to reduce costs and impacts along the whole agri-food chain, but maintaining the alimentary quality and safety

Methodology

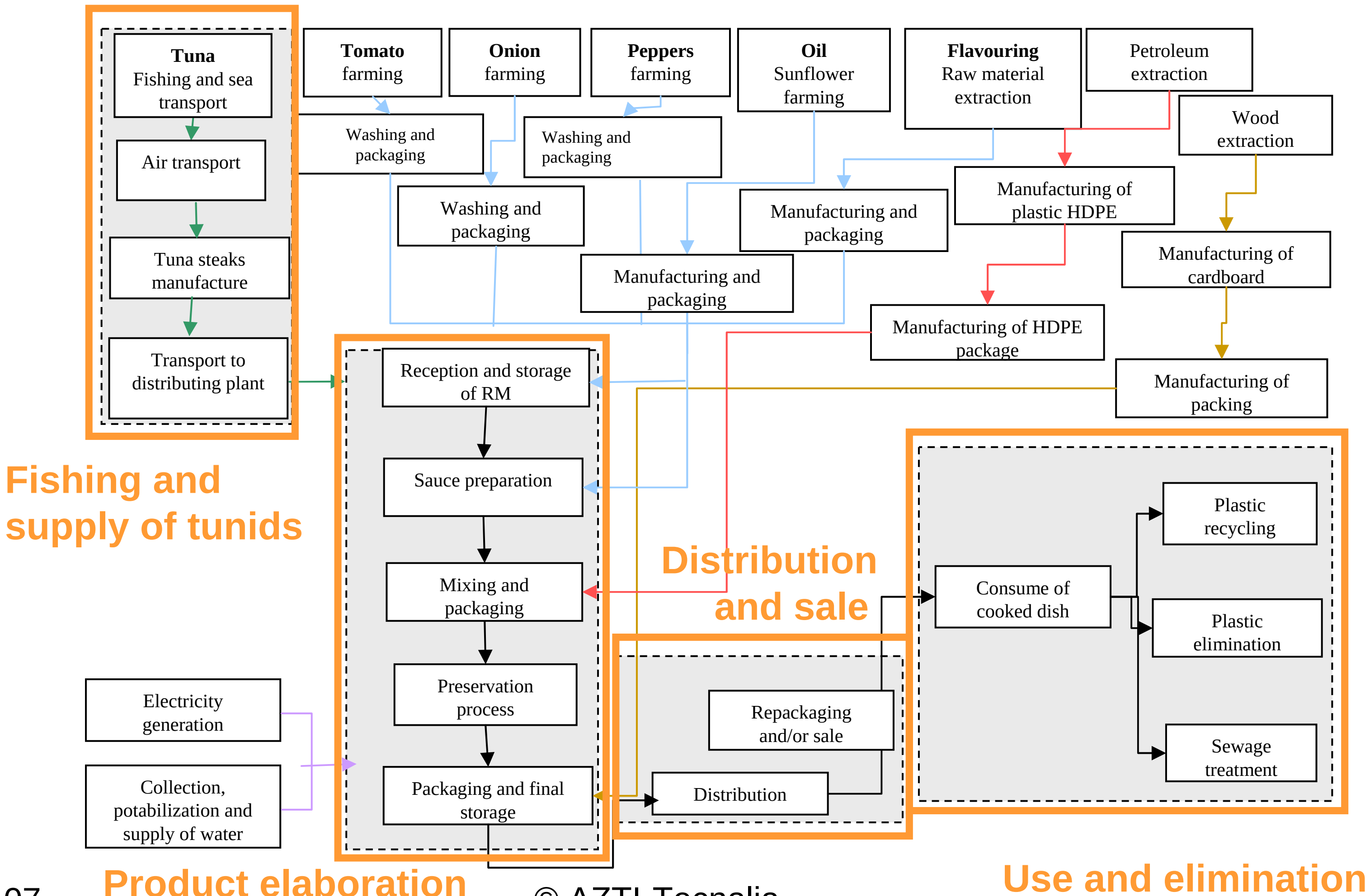
- **PHASE 1:** Selection of a food product as a model to develop and design. Definition of the product.
- **PHASE 2:** Product life cycle assessment. Ecobalance and impacts assessment.
- **PHASE 3:** Scenario analysis. Identification of main causes and critical stages in the food chain
- **PHASE 4:** Improvement objectives and measures development to increase the efficiency and to reduce losses in origin.
- **PHASE 5:** Definition of the new improved food product considering the previous measures. Evaluation of the improvement achieved.

PHASE 1: Selection and definition of the product

- ***Product selected***: Tuna with tomato cooked dish pasteurized tray of 2 kg. (functional unit)
- ***Reason of selection***: one of the highest complexity level in food sector (high number of raw materials; many stages of life cycle, etc.)
- ***Product characteristics definition*** to understand and respect its needs:

Product function:	Food ready to be packaged and sold by portions.
Target client:	Catering, retail store chains and distributors at national level
Product formulation:	Base: tuna Sauce: crushed tomato, onion, green pepper, red pepper, sunflower oil, fried tomato, sugar, salt, sweet pepper, dust garlic, fish soup
Package:	Rectangular tray of HDPE (high density polyethylene) of 70 g Top: film of OPA (oriented polyamide) and PE (polyethylene) with a weight of 10.2 g and a thickness of 30 µm
Preservation necessities:	Refrigeration at 4ºC Avoid perforations Preserve the vacuum maintenance
Shelf life:	90 days
Return level:	Rejections: 0,47 % Expiries are insignificant
Product characteristic:	Needs cold for its preservation It has no presentation for final consumer Microwavable package
Consume preparation:	Transference to a ceramic recipient of high esthetic value Transference to a ration package for final consumer sale. Cover retire, transference of the food to a plate or recipient, heating at 35ºC and consume.
Post-use necessities:	Washing of metallic recipient and/or plate and cutlery Cover+tray waste management

PHASE 2: Life cycle definition



PHASE 2: Ecobalance

- **Identification and quantification of inputs** (water, energy and materials consumption) **and outputs** (releases to the air, land and water) for every stage.
- Introduction of data in LCA software TEAM 4.0. **Local ecobalance** generation and **global ecobalance calculation**.

Example: Mixing and packaging

	Info	F	Flow	Units	Formula Value	Formula
Inputs:		☐	_lomos desembalados	kg	1.05991	BOP*0.3825
(9)		☐	_salsa	kg	0.94	0.94
	i	☐	Electricity	MJ elec	0.0216	0.006*3.6
	i	☐	Polyamide (PA 6)	kg	0.0051	PA
	i	☐	Polyethylene (HDPE)	kg	0.07	HDPE
	i	☐	Polyethylene (LDPE)	kg	0.0051	LDPE
		☐	Polypropylene (PP)	kg	0	PP
		☐	Water Used (total)	litre	5.5	inflow("Water: Public I
	i	☐	Water: Public Network	litre	5.5	5.5
Outputs:		☐	(w) Water (unspecified)	litre	5.5	inflow("Water: Public I
(4)		☒	_atún con tomate	kg	1.89153	inflow("_lomos deseml
		☐	Waste (total)	kg	0.00153	outflow("Waste: Non I
	i	☐	Waste: Non Mineral (inert)	kg	0.00153	(PA+LDPE)*0.15

HARDEST WORK!!!

PHASE 2: Global ecobalance

- 63 inputs
- 261 outputs

Flow	Unit	LCA tuna with tomato	1. Fishing and supply of tunids	2. Product elaboration	3. Distribution and sale	4. Use and eliminatio n
Inputs:						
Oxygen	g	10933.31	6674.90	1929.70	418.34	1910.43
Minerals	g	181.70	34.50	70.43	18.55	58.22
Fossil fuels	g	4332.83	3563.21	635.63	133.86	0.12
Biomass	g	2722.62	2613.71	108.52	0.39	0.00
Land use	cm^2	24.14	7.81	16.32	0.01	0.00
Water Used (total)	litre	49.83	22.50	19.98	2.75	4.60
Outputs:						
Air emissions	g	13738.40	11128.65	2117.34	492.08	0.39
Land emissions	g	0.07	0.01	0.02	0.00	0.04
Water effluents	g	317.67	297.59	17.46	2.61	0.02
Sewage water	litre	27.51	2.18	18.42	2.30	4.61
Recovered Matter (total)	g	20.33	3.97	5.88	0.12	10.36
Waste (total)	g	1887.17	1456.11	237.30	76.34	117.43

PHASE 2: Impact assessment

- **Impact categories** and **assessment methods** have been selected
- LCA software has generated the **quantification of each impact** for the total life cycle and main steps

Environmental impacts		Method	LCA tuna with tomato	1. Fishing and supply of tunids	2. Product elaboration	3. Distribution and sale	4. Use and disposal
Air acidification	geq.SO_2	CML2000	70.01	52.54	14.38	3.09	0.00
Aquatic toxicity	geq.1,4-DCB	CML2000	102.39	82.06	18.01	2.31	0.01
Depletion of the stratosphic ozone	geq.CFC-11	CML2000	0.0012	0.0008	0.0003	0.0001	0.0000
Eutrophication	geq.PO43	CML2000	11.19	8.59	1.98	0.63	0.00
Greenhouse effect	geq CO2	CML2000	13822.95	11126.15	2186.63	509.85	0.38
Human toxicity	geq .1,4-DCB	CML2000	1057.01	782.03	242.56	32.39	0.03
Terrestrial toxicity	geq .1,4-DCB	CML2000	29.71	23.28	5.23	1.19	0.00
Depletion of non renewable resources	yr-1	EB(R*Y)	0.25	0.20	0.05	0.01	0.00

***CML**:Centre of Environmental Science*

***EB:**Ecobilan*

PHASE 3: Scenario analysis

- **Establish different hypothetical changes in the product under study to:**
  - Identify main causes of the global inputs, outputs and impacts
  - Find stages in which those impacts are produced
  - Focus the most important changes in the product to obtain the maximum environmental and cost improvement
- **Hypothetical "what if" scenarios analysed:**

➢ **Elimination of PP**	➢ **No road transport for distribution**
➢ **Total elimination of LDPE and double OPA**	➢ **No rejections**
➢ **Elimination of HDPE**	➢ **No repacking water**
➢ **Reduction of sea transport**	➢ **No natural gas consumption in preservation**
➢ **No air transport**	➢ **No water and power consumption in manufacturing**

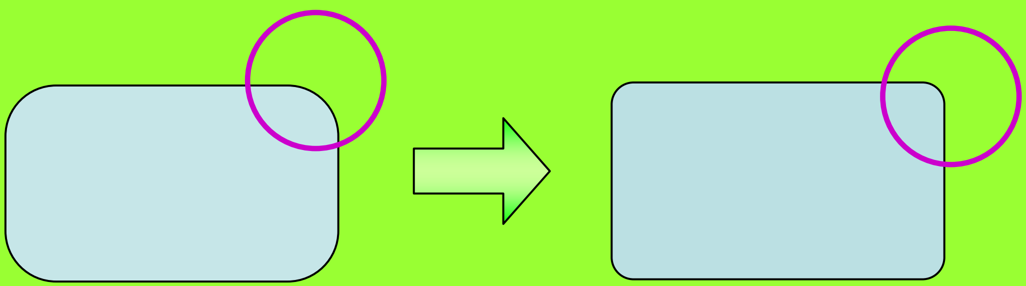
PHASE 3: LCA conclusions

- **Most critical aspects and steps:**
  - Tuna fish air transport: ingredient with more weight and longer distances.
  - Power consumption: raw materials and final product storage, preservation process
  - Plastic package: HDPE
  - Final product road transport for distribution

PHASE 4: Identification of improvements

OBJECTIVES	PRODUCT OPTIMIZATION MEASURE *through an expert panel*	IMPROVEMENT EXPECTED
	Tuna from the Pacific transported by plane once steaked in origin	55% reduction of transport effort
	Triple wave cardboard separator replaced by bee nest ones	18% reduction of cardboard
	HDPE package replaced by a new one	20% weight reduction

TRAY FORM OPTIMIZATION:



- Transport effort saving (smaller empty space 10%)
- Film saving 7%
- Storage and cold preservation effort saving

PHASE 5: Obtained results

		ORIGINAL product	ECODESIGNED product	% Reduction
Inputs				
Oxygen	g	10933.31	8493.91	22.31
Minerals	g	181.70	182.68	-0.54
Fossil fuels	g	4332.83	3134.87	27.65
Biomass	g	2722.62	2342.55	13.96
Land use	cm^2	24.14	24.58	-1.82
Water Used	litre	49.83	48.90	1.88
Outputs				
Air emissions	g	13738.40	9996.38	27.24
Land emissions	g	0.07	0.07	-0.74
Water effluents	g	317.67	309.20	2.67
Sewage water	litre	27.51	26.37	4.14
Recovered matter	g	20.33	18.06	11.17
Waste	g	1887.17	1615.85	14.38

PHASE 5: Obtained results

Impacts		ORIGINAL product	ECODESIGNED product	% Reduction
Air Acidification	geq.SO_2	70.01	58.09	17.03
Aquatic Toxicity	geq.1,4-DCB	102.39	103.42	-1.00
Depletion of the strastosphic ozone	geq.CFC-11	0.01	0.001	0.28
Eutrophication	geq.PO43	11.19	9.41	15.99
Greenhouse effect	geq CO2	13822.95	10104.68	26.90
Human Toxicity	geq .1,4-DCB	1057.01	1047.52	0.90
Terrestrial Toxicity	geq .1,4-DCB	29.71	29.78	-0.25
Depletion of non renewable resources	yr-1	0.25	0.19	24.71

Conclusions

- There are a wide range of improvable aspects in food products although a priori have a low degree of freedom.
- That makes necessary to focus the effort in the aspects of greater impacts in the LCA.
- The modifications raised in the product generate potential satisfactory reductions, that could be greater designing a completely new product.
- LCA is an effective tool although requires an arduous data collection and a complex analysis.
- Currently it exists difficulties to overcome in the ecodesign of agri-food products

  - Criteria of different managers of the agri-food chain
  - Lack of environmental awareness (economic costs)

- It is necessary to publicise the economic, environmental and image benefits of the eco-design to promote the understanding between the different agents of the agri-food chain.

Thanks very much for your attention

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