PESTICIDES EFFECT EVALUATION IN LIFE CYCLE ASSESSMENT OF GREENHOUSE TOMATO CROP

Antón, A [(1)], Castells, F [(2)], Montero, JI [(1)] and Huijbregts, MA.[(3)]

assumpcio.anton@irta.es

[(1)]IRTA. Institut de Recerca i Tecnologia Agroalimentària. Spain

[(2)]Dept. d'Enginyeria Química ESTEQ. Univ. Rovira Virgili. Spain

[(3)]Dept. of Environ. Studies. Facult. of Science, Math. and Comput. Science. Univ. of Nijmegen. The Netherlands

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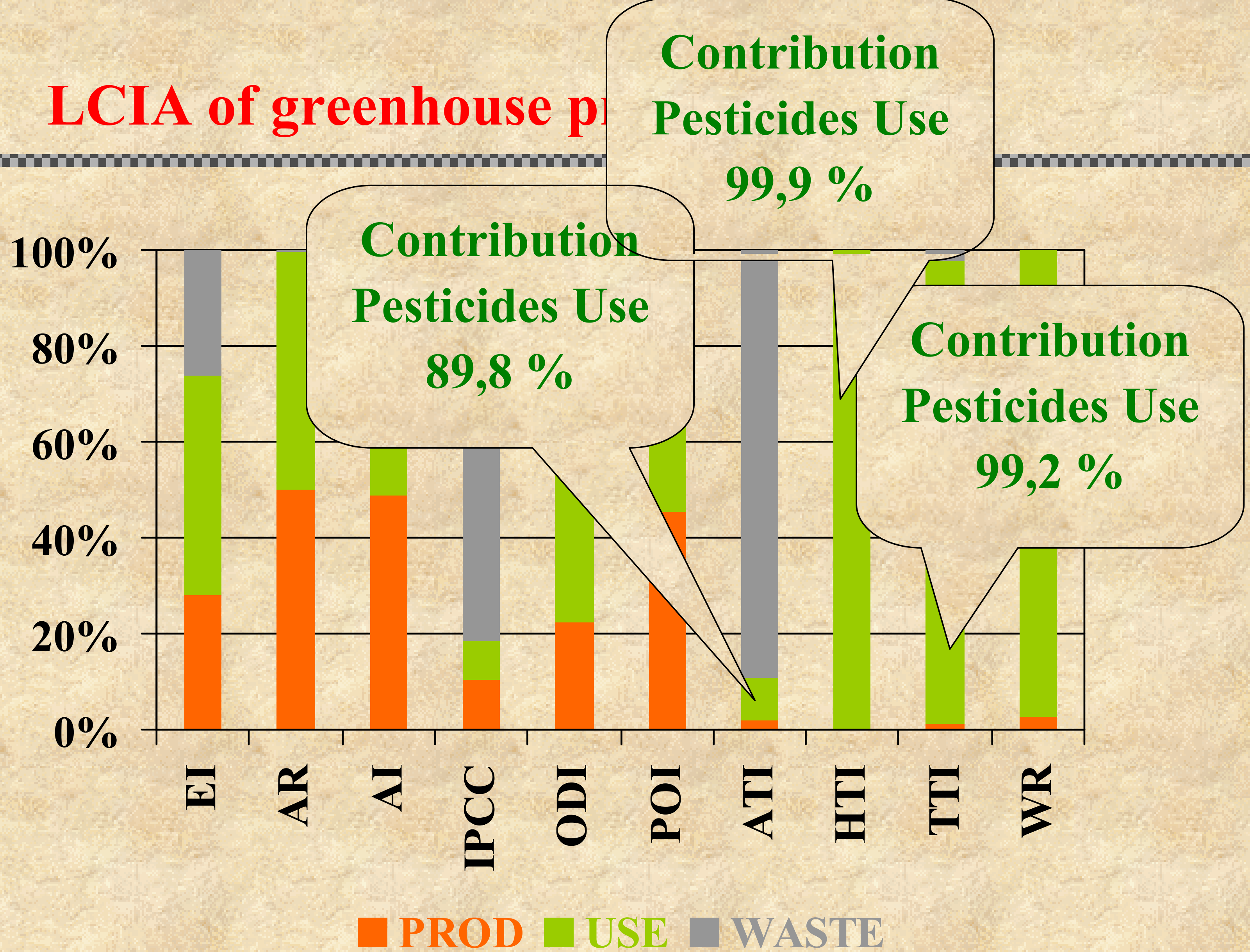
Abstract

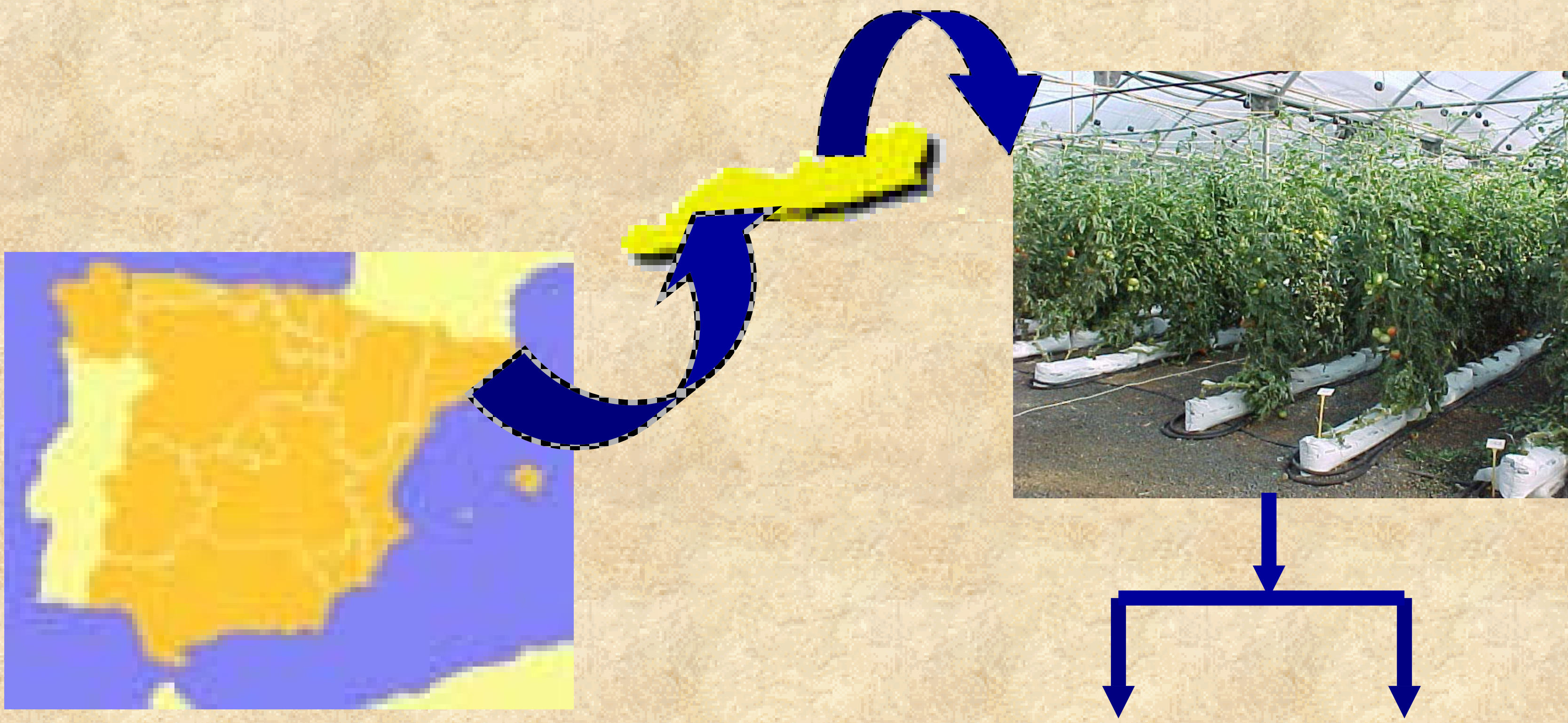
Toxicity evaluation is particularly important in Life Cycle Assessment of agricultural products in order to assess the potential side-effects of pesticides. This study compares Chemical Pest Management (CPM) and Integrated Pest Management (IPM) applied in Mediterranean greenhouse tomato crop. Two methodologies were used to evaluate potential toxic impacts of the pesticides applied in CPM and IPM. First of all, the empirical method, Critical Surface-Time (CST), from Jolliet and Crettaz (1998) was applied. Results obtained by this empirical approach were compared to those obtained by the nested multi-media fate, exposure and effects model, USES-LCA, developed by Huijbregts et al. (2000). Both methodologies showed in most cases higher level of potential contamination in greenhouses treated with CPM compared to IPM. Nevertheless, large methodological differences between CST and USES-LCA concerning the calculation of concentration residues in food hampered the evaluation of potential human impacts of pesticides. Future studies on pesticides transfer to food will be necessary to improve this situation.

Introduction

LCIA of greenhouse pr



Material and Methods



IPM CPM

Impact Scores

$$IS_j = \sum_n \sum_x TP_{x,n \to j} \times M_x \times f_{x,n}$$

$$TP_{x,n \to j} = \frac{F_{x,n \to j} \times E_{x,j}}{F_{ref,n \to j} \times E_{ref,j}}$$

IS: impact score
M: mass release of substance x
f: fraction of the substance x that is transported from the greenhouse to environmental compartment n
TP: characterization factor
F: fate and exposure factor
E: effect factor
n: environmental compartment
j: target
x: substance

CST (Jolliet and Crettaz, 1997)

$$F_{x,m} = \frac{\tau_{x,m}}{V_{x,m}}$$

USES-LCA (Huijbregts 2000)

$$F_{x,n \to j} = N_j \times \frac{dD_{x,n \to j}}{dM_{x,n}}$$

$\tau_{x,m}$: *overall residence time of the substance x in the medium m*
$V_{x,m}$: *equivalent dilution volume per unit surface for substance x in medium m*

N_j : *total number of targets j*
$dD_{x,j}$: *marginal change in exposure of substance x by target j*
$dM_{x,n}$: *marginal change in the emission of substance x to compartment n*

Transfer to food

CST

$$f_{tom} = \frac{0{,}05 \times MRL_x \times Y}{M_x}$$

USES-LCA

$$F_{x,gh\cdot soil \to h} = \frac{dC_{x,tom}}{dM_{x,gh\cdot soil}} \times Y_d$$

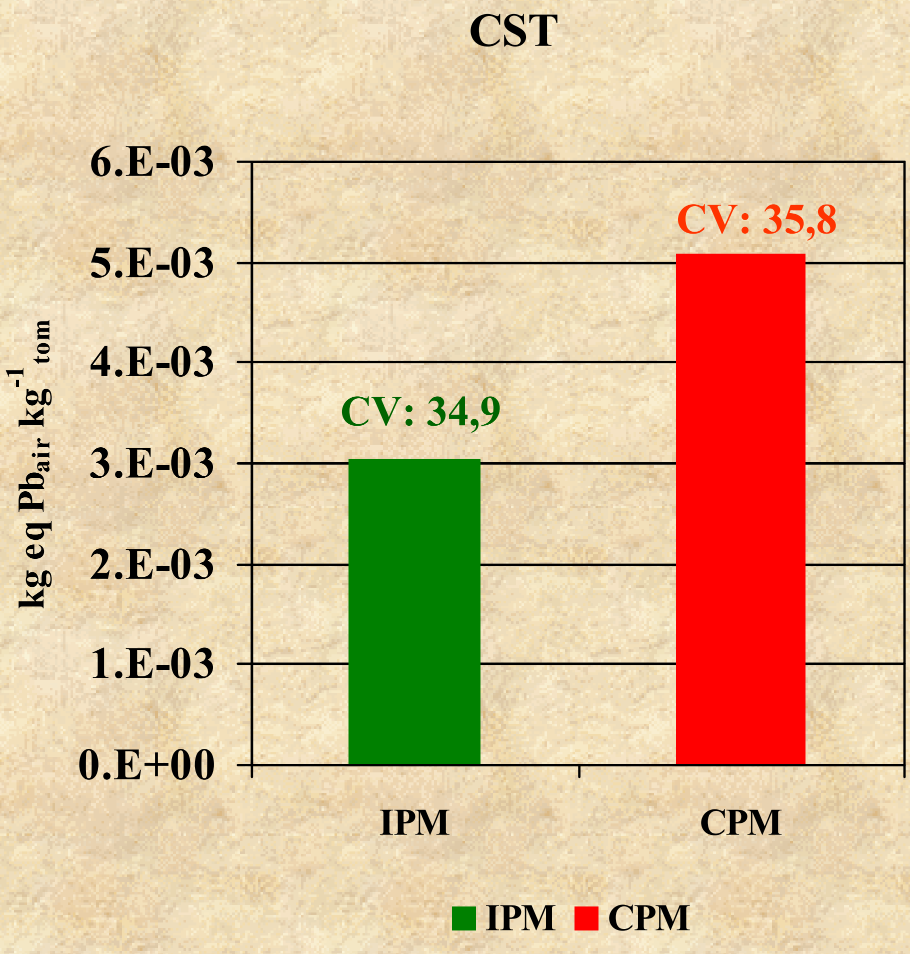
$$F_{x,tom \to h} = \frac{dC_{x,tom}}{dM_{x,tom}} \times Y_d$$

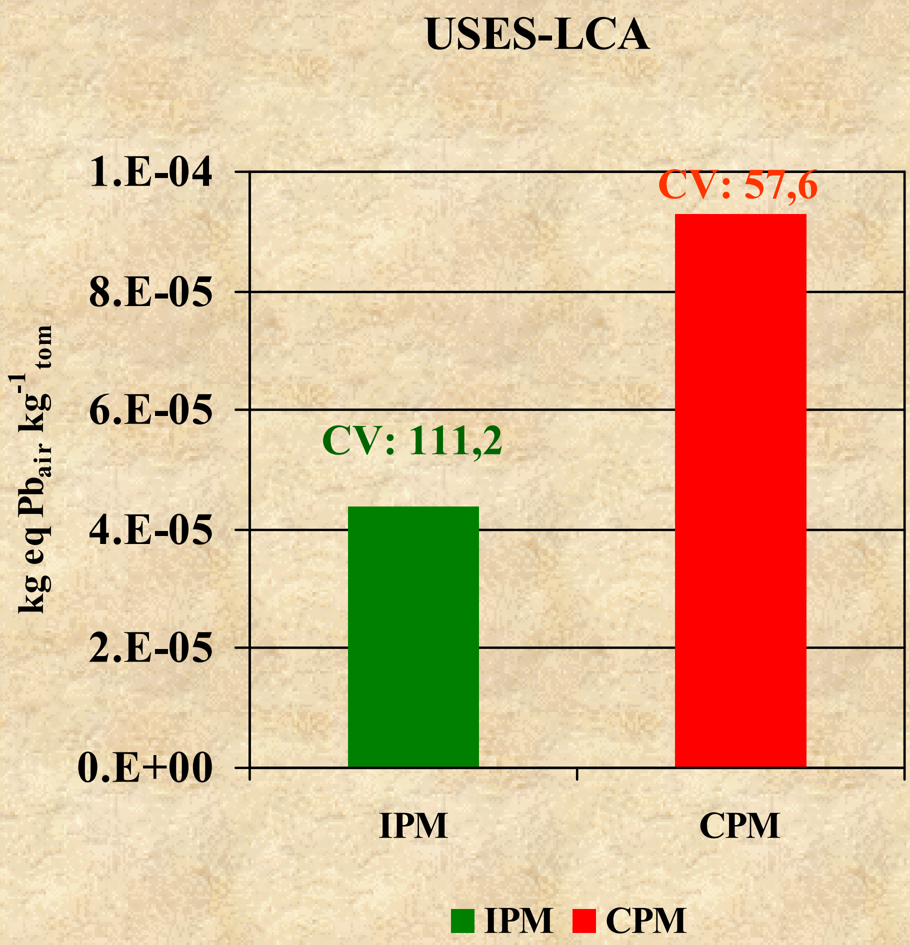
$$f_{gh-tom} \approx 0.06 \times f_{gh-plant}$$

MRL: maximum concentration of pesticide permitted in food according to the EEC directive
M_x: doses of active ingredient,
Y: average yield per area

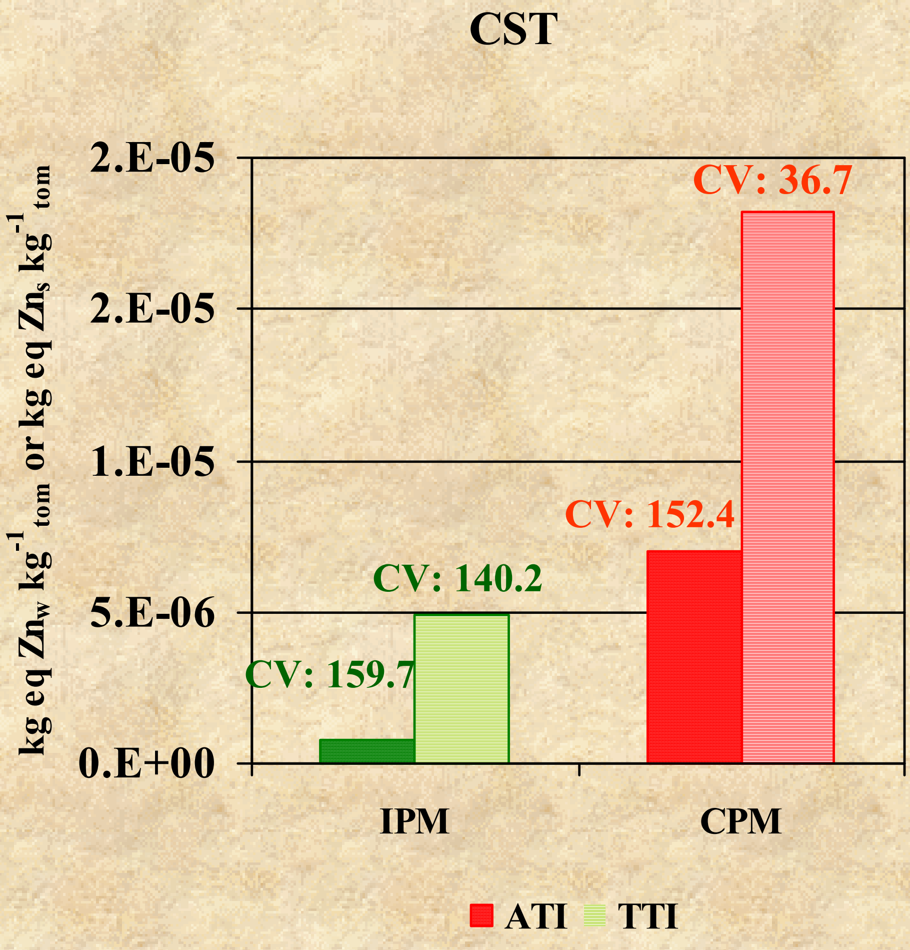
$dC_{x,tom}$: concentration of substance x in the tomato
dM: marginal emission change of substance x
Y_d is the yield (kg_t day^{-1}).

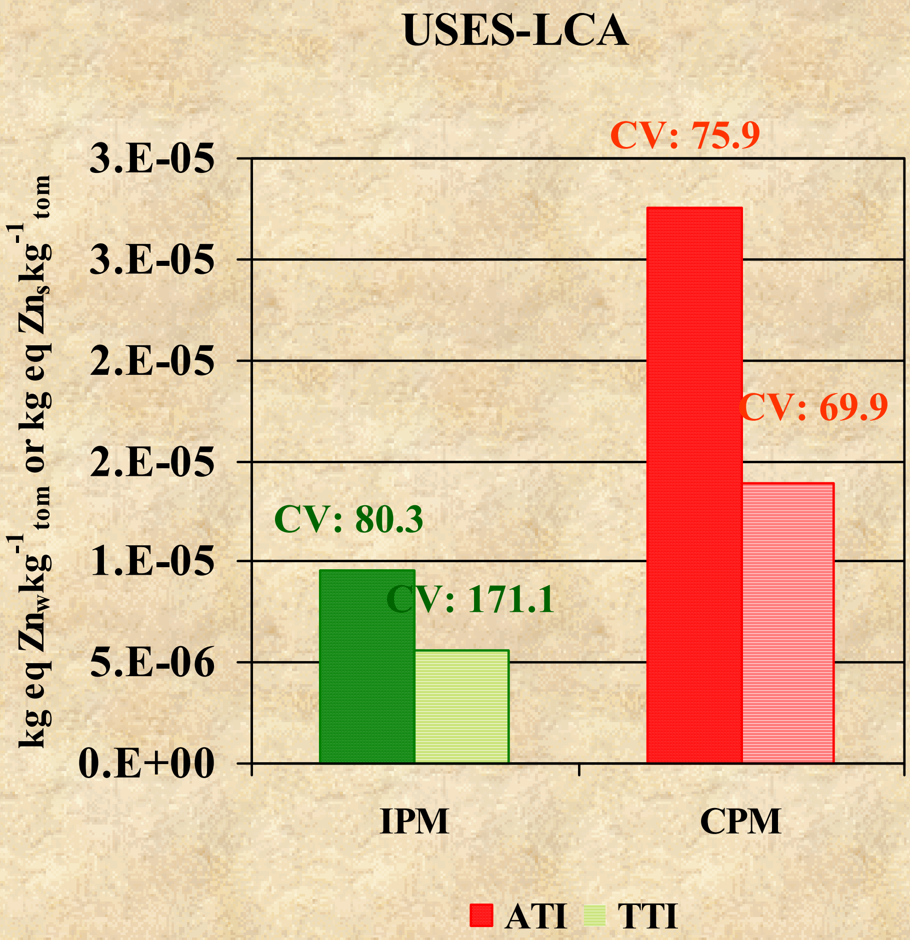
Results human toxicity





Results ecosystems toxicity





Ranking scores for insecticides and acaricides for human, aquatic and terrestrial toxicity calculated by CST and USES-LCA.

	HTI		ATI		TTI	
	CST	USES-LCA	CST	USES-LCA	CST	USES-LCA
Abamectine	1	10	5	5	6	3
Bromopropylate	4	4	8	7	8	2
Cyromazine	6	1	7	3	3	5
Deltametrin	8	12	4	6	9	1
Esfenvalerete	11	3	2	8	2	6
Etofenprox	10	6	9	11	7	9
Heptenofos	7	9	10	9	10	11
Imidacloprid	13	11	11	10	11	12
Metamydaphos	2	13	13	12	13	13
Methiocarb	12	8	1	1	1	4
Methomyl	9	7	3	2	5	8
Pymetrozine	3	2	12	13	12	10
Pirimicarb	5	5	6	4	4	7

Ranking scores for fungicides for human, aquatic and terrestrial toxicity calculated by CST and USES-LCA.

	HTI		ATI		TTI	
	CST	USES-LCA	CST	USES-LCA	CST	USES-LCA
Azoxystrobin	6	7	2	1	1	1
Benomyl	8	6	4	5	2	2
Captan	3	5	1	6	5	4
Carbendazima	5	3	3	2	3	8
Chlorotalonil	2	10	7	8	7	9
Fenarimol	4	8	8	7	8	6
Iprodione	1	11	11	11	9	10
Kresoxim-metil	11	9	6	3	6	3
Mancozeb	7	4	9	10	10	5
Metalaxyl	10	2	10	9	11	11
Pencycuron	9	1	5	4	4	7

Conclusions

- Although CPM shows highest impact than IPM, both methods could be improved with a good selection of pesticides
- In LCA it is necessary a consensus in which tool must be used to evaluate the impact of the phase of use of pesticides
- Promote standardised inventories of pesticides data and establishment of accessible databases
- Develop more knowledge on transfer factors taking into account local conditions and type of application for each pesticide
- Conduct research on fate and exposure factors, especially in relation to evaluate pesticide concentration in food

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