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# Sustainable of tomatoes supply chain management – Cases of study

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Academic Work

# INTRODUCTION

- The tomato is a vegetable that has an important participation in the national value chain;
- Increasing importance of the Green Supply Chain Management (GSCM);
- The use of Linear Programming in GSCM offers the possibility to perform a simultaneous optimization, as well as to correlate with environmental issues;

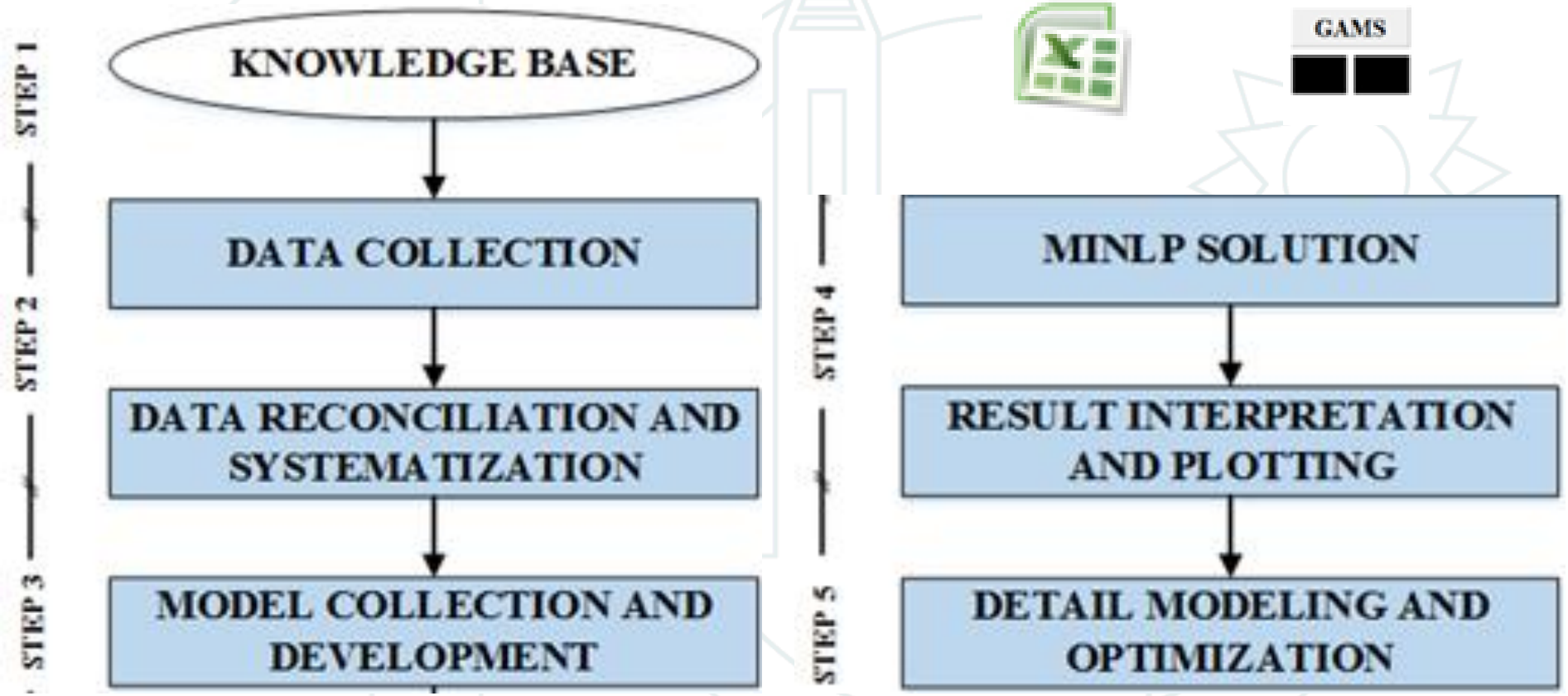
# INTRODUCTION

- There is a growing interest in this technique of assessing environmental impacts in the processing system for some horticultural products;
- One of the ways to incorporate environmental perspectives into optimization projects is to treat environmental requirements as objectives, focused on bi-bjective optimization;

# INTRODUCTION

- This work aims to deal with a performance evaluation of several scenarios of CS of tomatoes for the region of the municipality of Umuarama city based on a bi-objective mathematical model;
- Two aspects of the distribution process are considered: transportation costs between the farmers and market; and the environmental impact caused in the transport process.

# METHODS

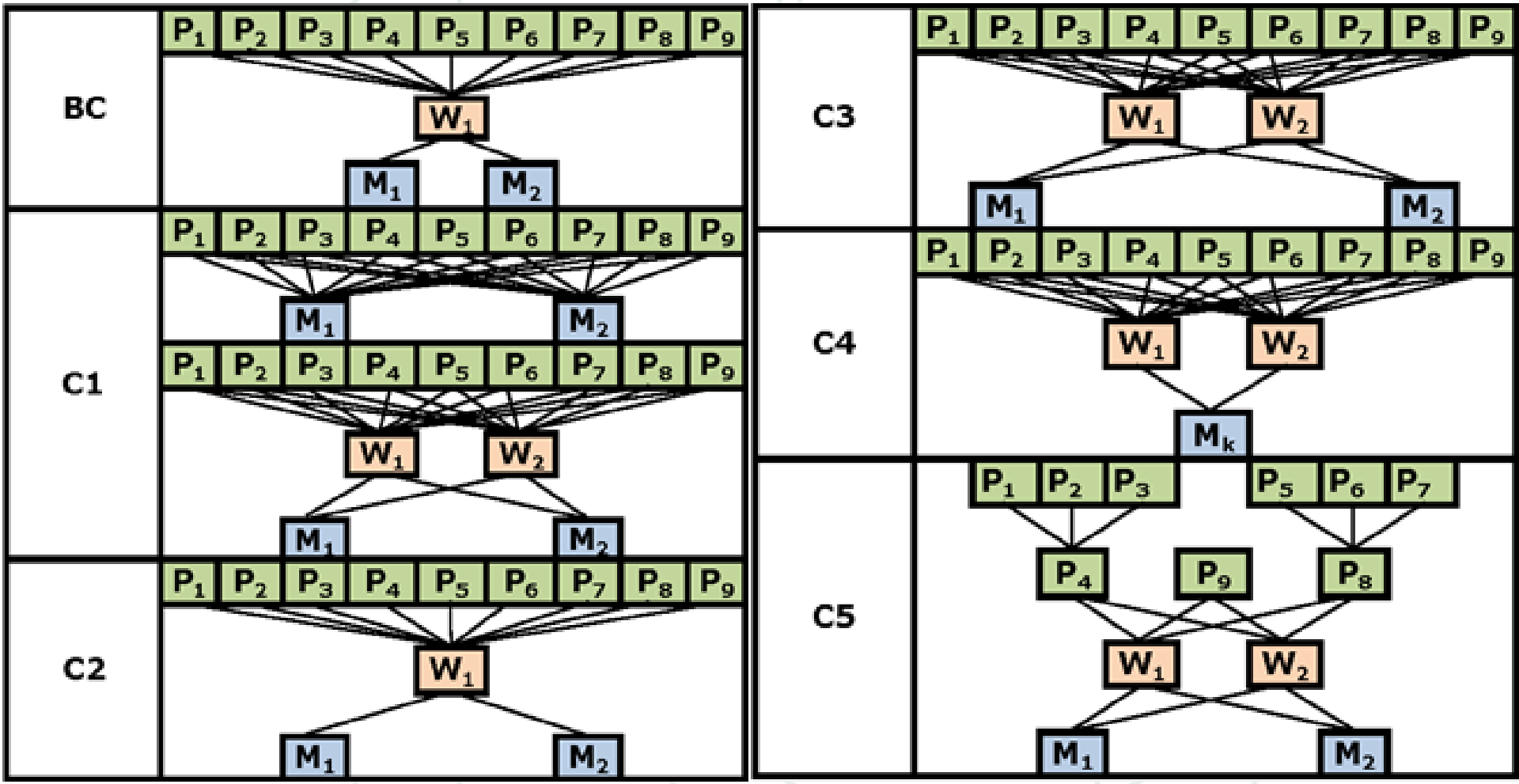

KNOWLEDGE BASE
STEP 1
DATA COLLECTION
STEP 2
DATA RECONCILIATION AND SYSTEMATIZATION
STEP 3
MODEL COLLECTION AND DEVELOPMENT
GAMS
STEP 4
MINLP SOLUTION
RESULT INTERPRETATION AND PLOTTING
STEP 5
DETAIL MODELING AND OPTIMIZATION

# PROBLEM STATEMENT (step 1)

- Into the traditional design SC, the environmental impacts of vegetable production receive low priority;
- Approaches the minimization of total cost and minimization of total environmental impact involved in the transport of tomatoes, employing bi-bjective optimization in the SC performance seeking balanced solutions;

# CASES OF STUDY (step 2)

- In this study, 5 cases of study are purposed;
- According to the field survey, base case (BC) corresponds to the usual supply chain adopted;
- Cases 1, 2, 3 and 4 approach two different scenarios;
- Case 5 takes into account a new form of distribution;




**Frame 1.** Limits of the product system of different scenarios for the cases of study

# MODELLING (step 3)

- objective function

$$\min F(f_1, f_2) = \left( \sum_{i,j} x_{1ij} cp_{ij} + \sum_{j,k} x_{2jk} ca_{jk}, \sum_{i,j} x_{1ij} tp_{ij} v_{1ij} + \sum_{j,k} x_{2jk} tw_{jk} v_{2jk} \right),$$

- constraints

$$\text{s.t.}: \left\{ \sum_j x_{1ij} \le sp_i, \quad \sum_k x_{2jk} \le sa_j, \quad b_i \le x_{1ij}, \sum_i x_{1ij} \ge da_j, \quad \sum_j x_{2jk} \ge dm_k, \right.$$

# MODELLING (step 3)

- Pareto frontiers were found in order to show the trade-off relations between the two objectives;
- The ε-constraint method was used to optimize one of the objective functions using the other functions as constraints;
- In the analysis of the Pareto frontier, reference was made to the "knee point";

# RESULTS AND DISCUSSION (steps 4 and 5)

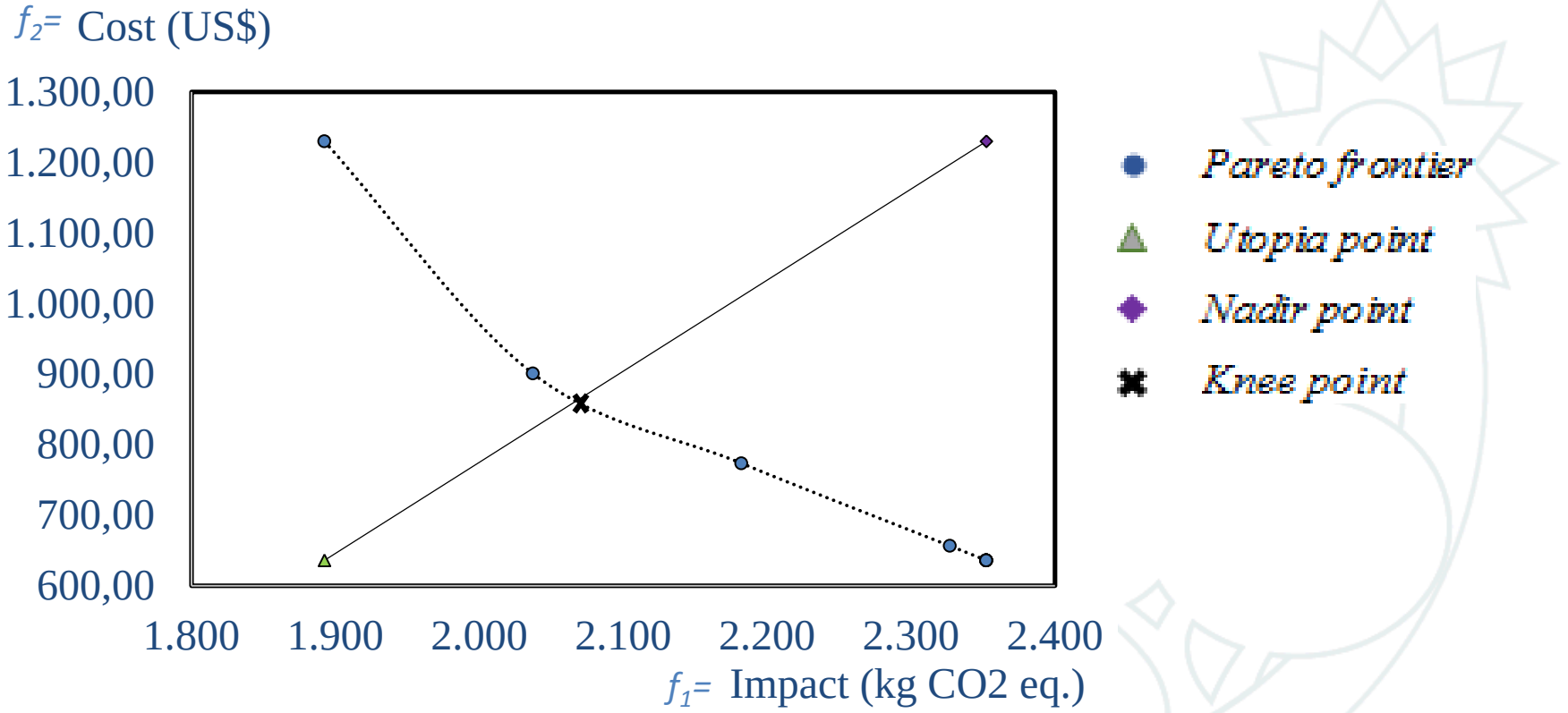



**Fig. 2.** BC – Original configuration with one warehouse

# RESULTS AND DISCUSSION (steps 4 and 5)

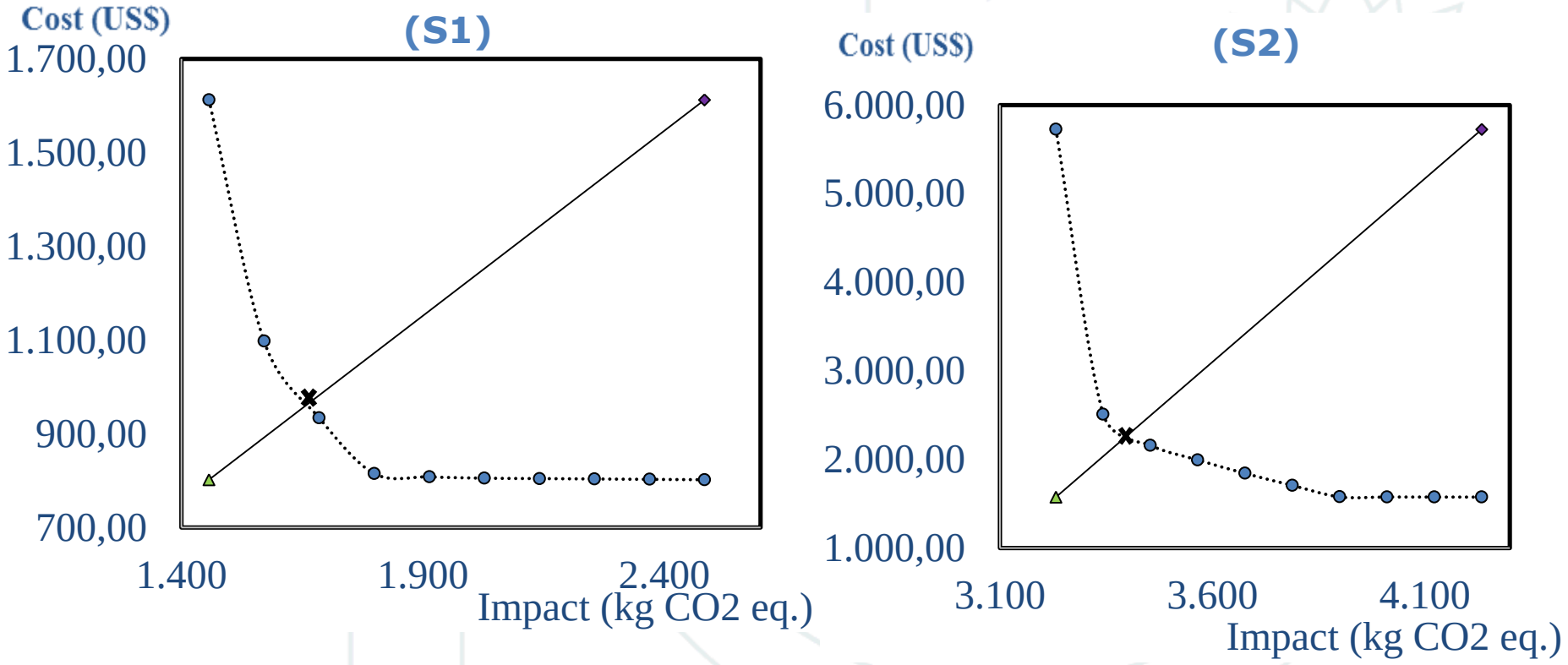



**Fig. 3.** Case 1 – Scenarios 1 (S1) and 2 (S2).

# RESULTS AND DISCUSSION (steps 4 and 5)

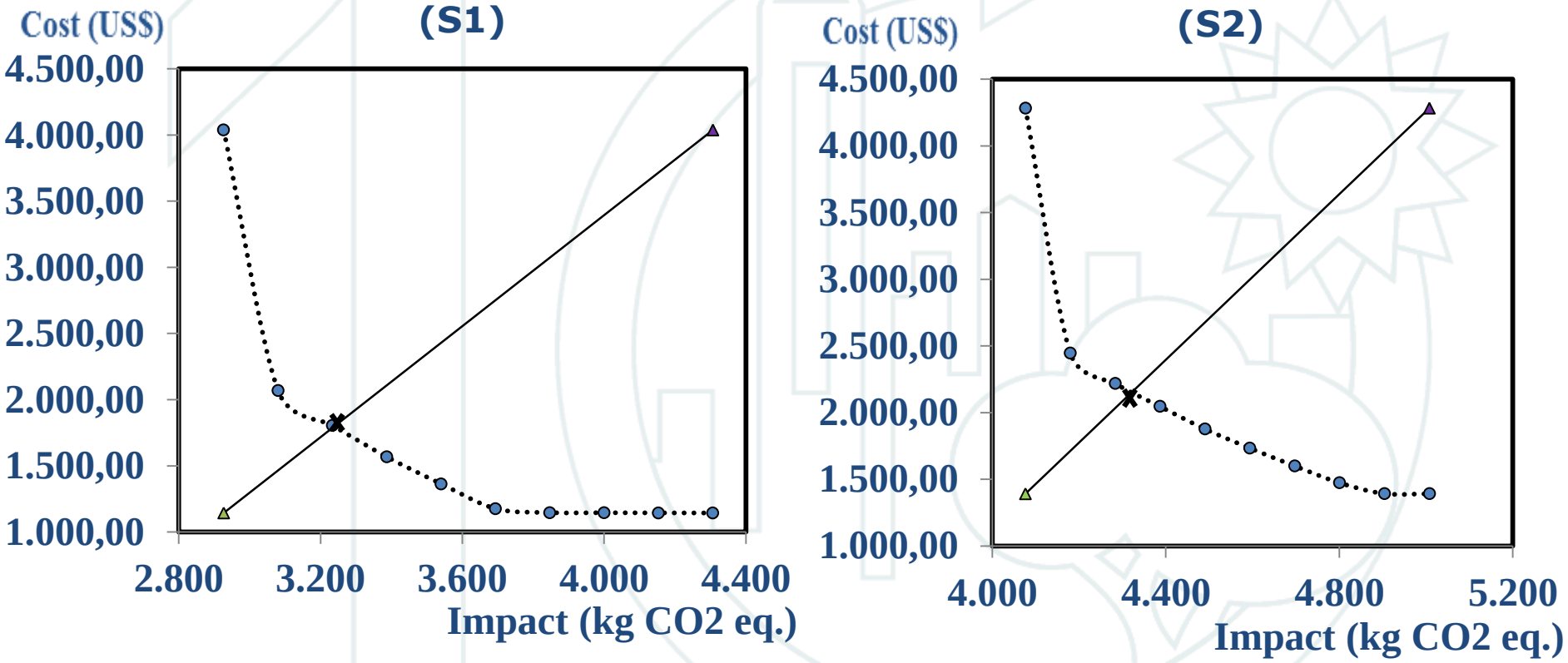



**Fig. 4.** Case 2 – Scenarios with different capacities (44% in (S1) and 82% in (S2)).

# RESULTS AND DISCUSSION (steps 4 and 5)

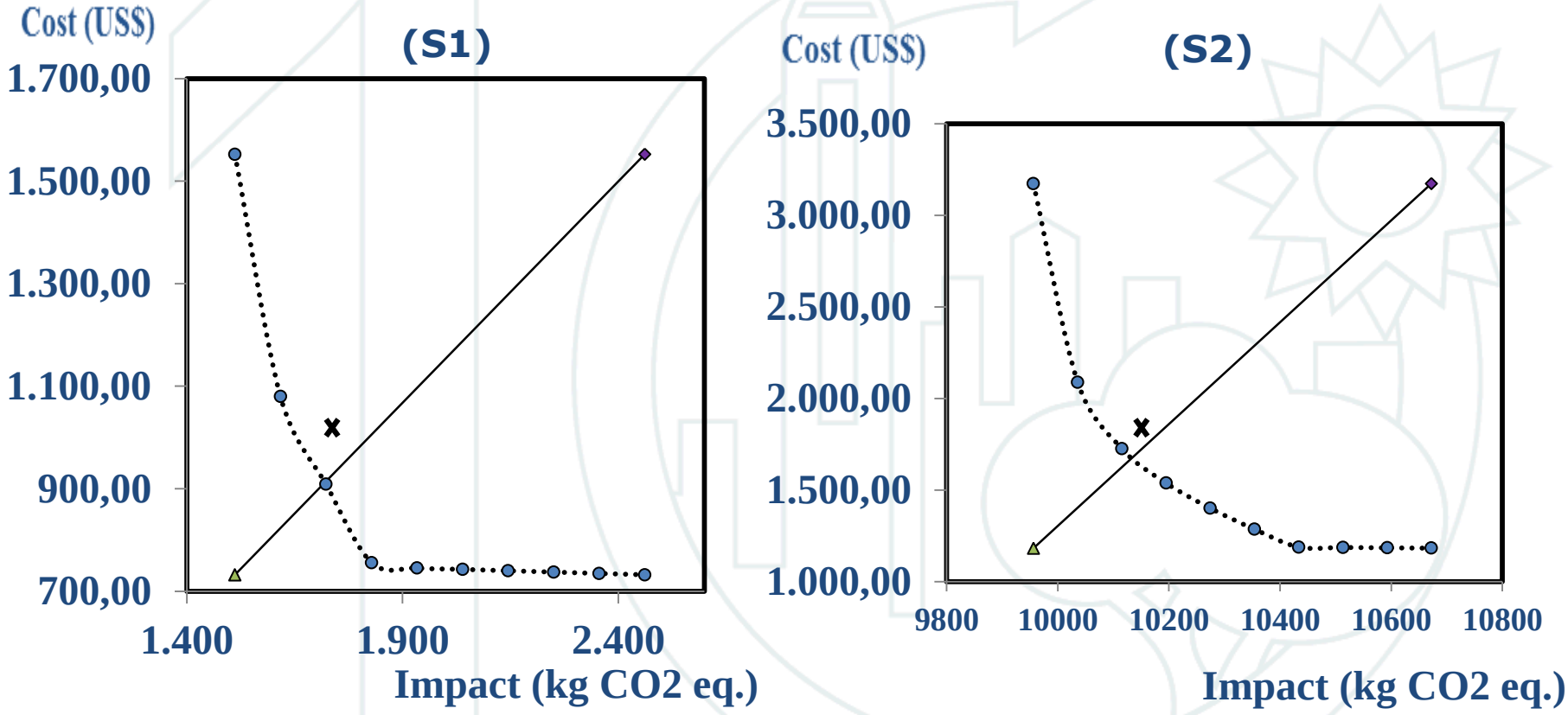



**Fig. 5.** Case 3 – Scenarios 1 and 2 with different distances of the warehouses.

# RESULTS AND DISCUSSION (steps 4 and 5)

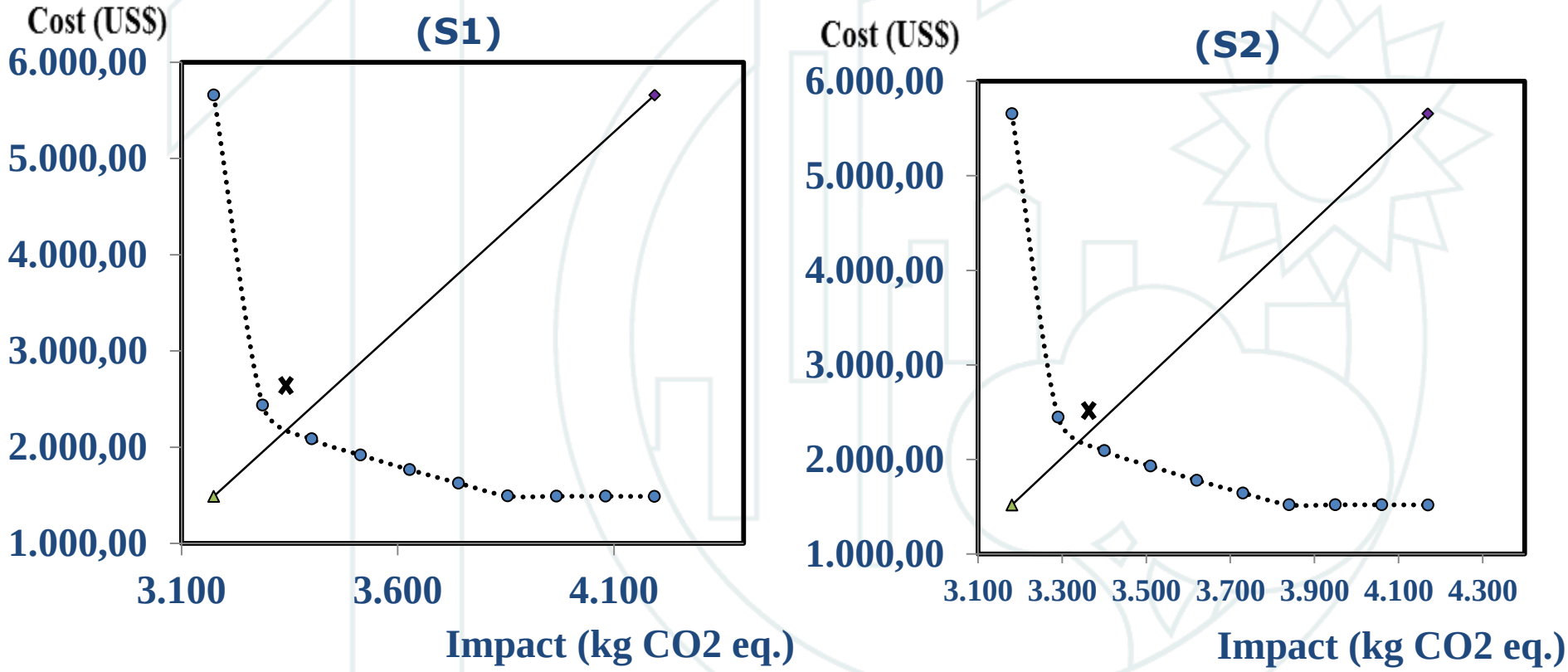



**Fig. 6.** Case 4 – Isolated markets: $M_1$ in (S1) and $M_2$ in (S2).

# RESULTS AND DISCUSSION (steps 4 and 5)

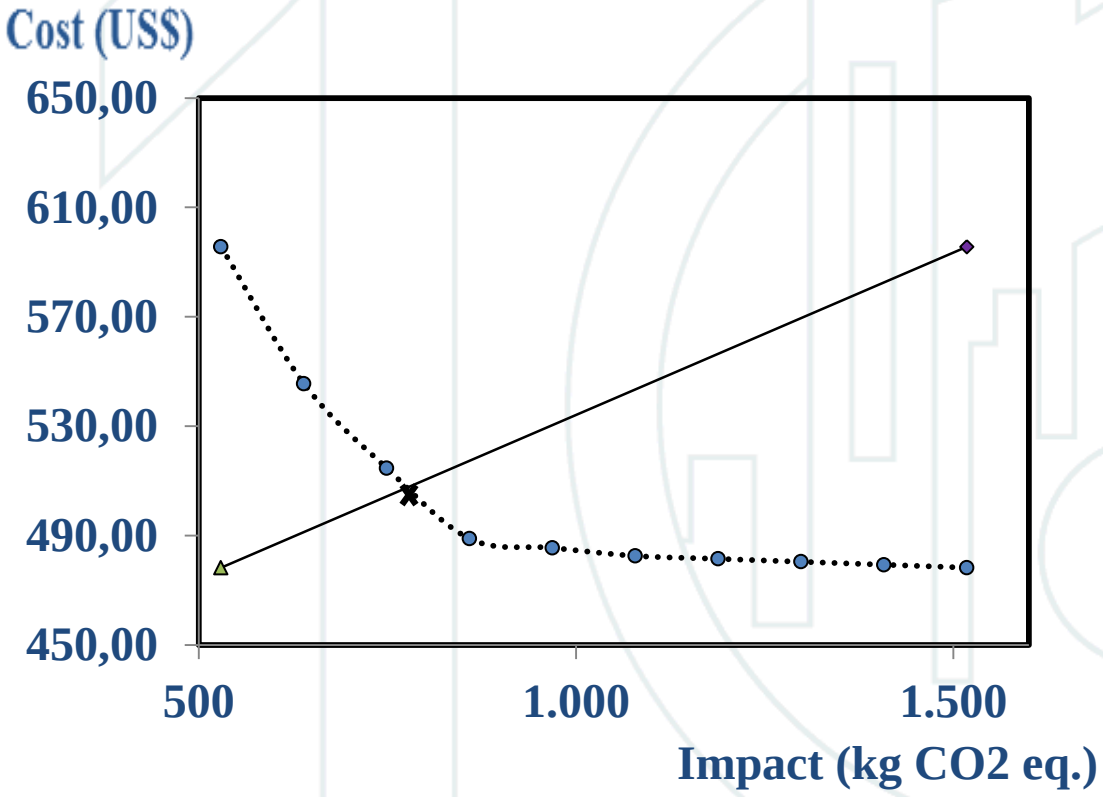



**Fig. 7.** Case 5 – New distribution form.

# RESULTS AND DISCUSSION (steps 4 and 5)

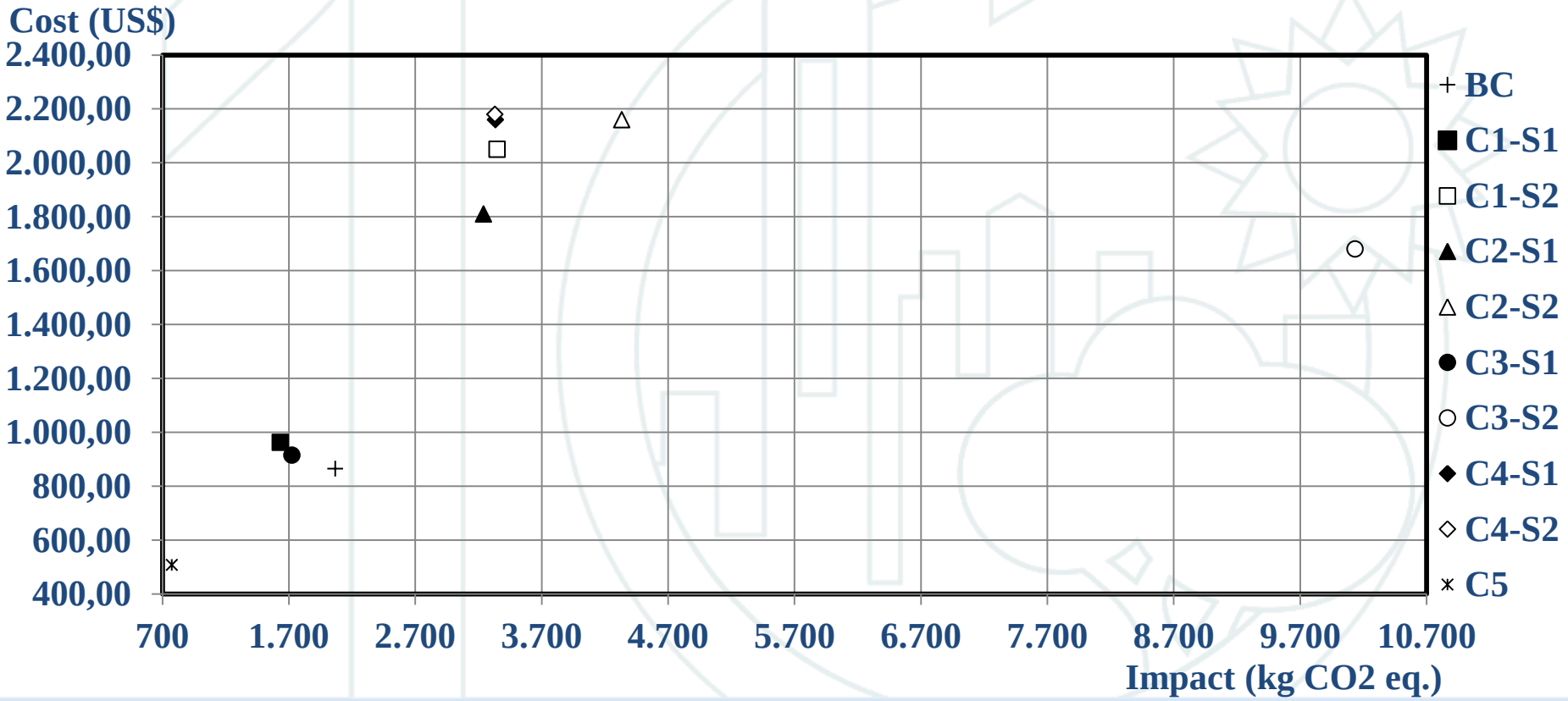



**Fig. 8.** Knee points of all cases and scenarios.

# CONCLUSIONS

- Comparing the Pareto knee point obtained in the BC with the knee points obtained for the other cases, it can be concluded that the configuration with one warehouse is a minimally satisfactory alternative;
- On the other hand, case 5 of this paper presents an SC that minimizes $f_1$ and $f_2$ and can indicate to the decision maker new strategies;

# CONCLUSIONS

- The best practicable options for SC management will depend on the decision maker's knowledge and appropriate analysis;
- The performance model presented here can be translated into improvements in the distribution process of fruit and vegetable products, bringing economic and environmental benefits to farmers, warehouses and supermarkets administrators;

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