

Meisam Shahbazi¹, Javad Kavianpour², Behzad Bankipour³, Alireza Saranj⁴

¹Associate professor in operations management, University of Tehran, Iran

²MSc. in Supply chain management, University of Tehran, Iran

³Apitherapy department, Ghazal Danesh pazhouh institute of technology, Tehran, Iran

⁴Associate Professor of Finance at the University of Tehran

Background/PURPOSE: Climate change is one of the most significant challenges facing businesses and supply chains today. However, the impacts of this phenomenon on some supply chains are more significant, tangible and immediate. Beekeeping is one of these chains due to its direct interaction with nature and reliance on natural living resources such as bees, flowers and plants. On the other hand, the role of honeybees in pollination and providing healthy food for communities is vital, and disruption in its function has devastating effects on life and the economy. As a result, it is essential to recognize and predict the effects of climate change on the performance of beekeeping supply chain and adopt strategies to reduce risk, increase resilience, and maintain performance.

Problem description: In this study, the effects of two factors, "rainfall rate" and "dust rate" on the performance of the beekeeping supply chain were investigated. The research question is: What effect do "reduced rainfall" and "increased dusty days" have on beekeeping performance? And what are the appropriate strategies to prevent a possible drop in performance?

METHODOLOGY: We have used system dynamics modeling to answer the research questions. For this purpose, a number of performance variables were first identified using the research literature, and then the list of variables was modified and finalized with the opinions of experts. Then, through interviews with experts and receiving their mind maps, an initial framework of relationships and dynamics was prepared. After that, the relationships between the variables were formulated using appropriate functions and the model was run under different scenarios using vensim software.

Results and CONCLUSION: The results show that a decrease in rainfall and increase in the number of dusty days leads to a significant decline in production performance and a decrease in the number of forager bees during the simulation period. However, investment in new technologies can compensate for this decrease and improve performance even compared to current conditions.

Practical implications for beekeepers: Training and application of new methods and technologies, increasing production efficiency, using modern equipment, and using hybrid queens can help beekeepers overcome the challenges posed by climate change.



Impacts of climate change on the beekeeping supply chain; a system dynamics modeling approach

By:

Meisam Shahbazi, Javad Kavianpoor, Behzad Bankipour, Alireza Saranj

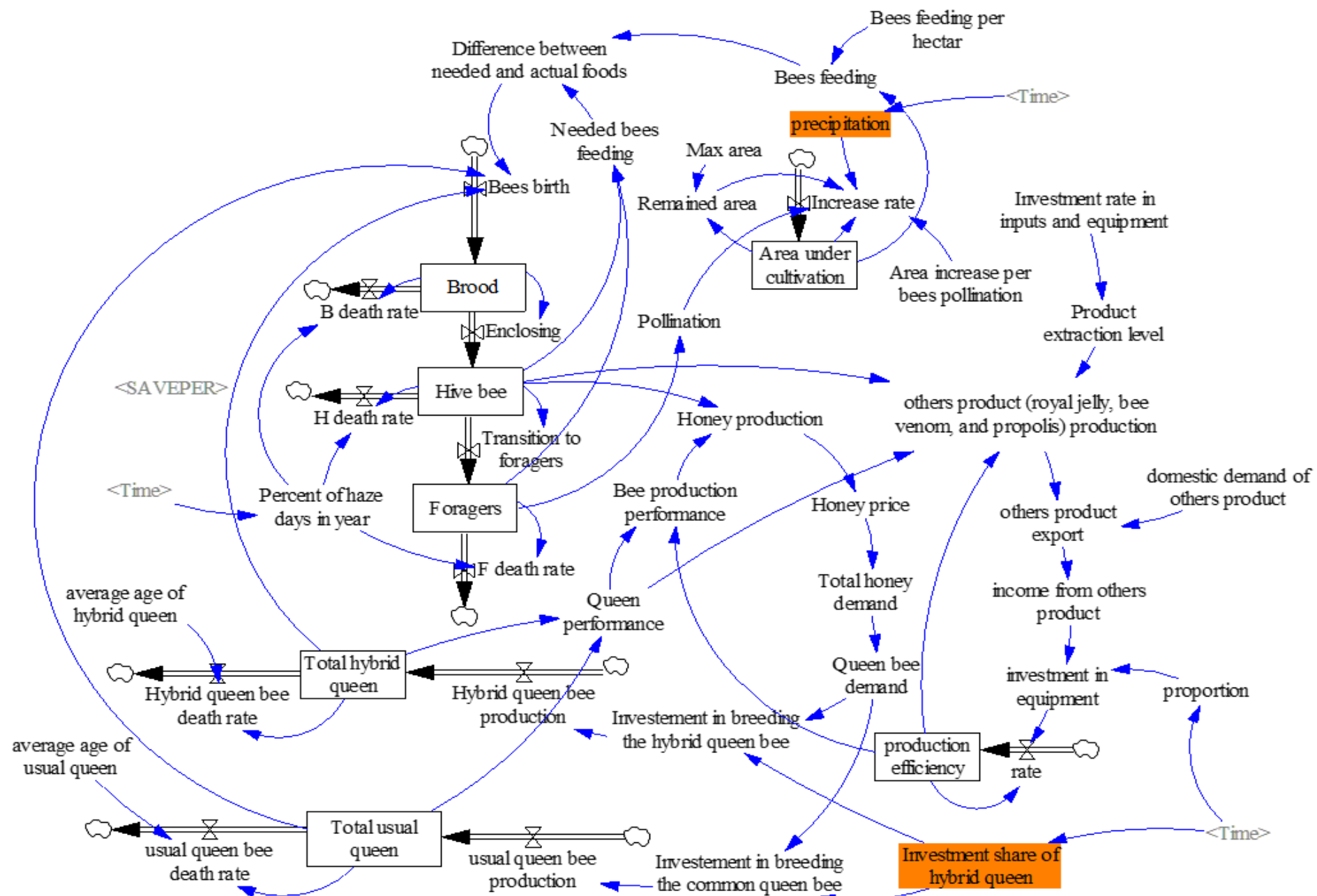
Research Questions

- ☐ What is a suitable model to show the direct and indirect effects of climate change on beekeeping performance variables?
- ☐ What is the impact of different climate change scenarios on beekeeping performance variables?
- ☐ What are the appropriate solutions to reduce the negative impact of climate change and maintain the resilience of the beekeeping supply chain?



Model Simulation

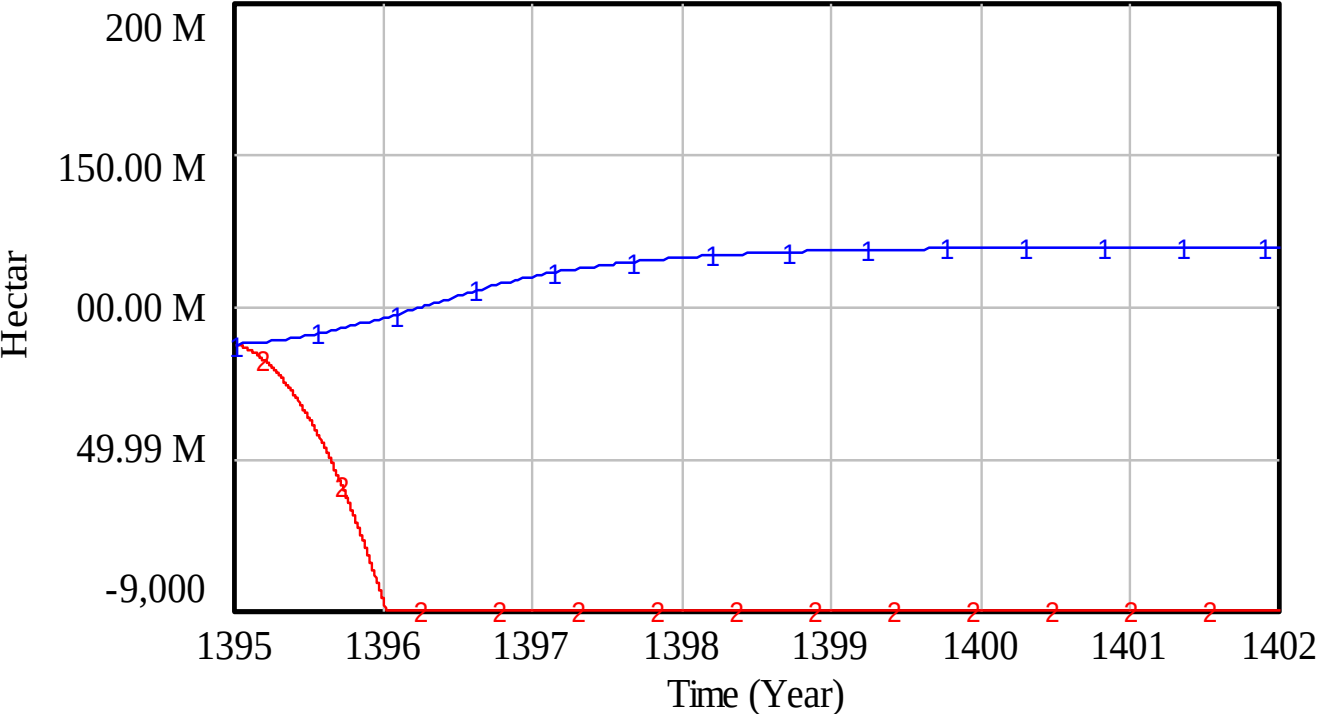




Model Test and Validation



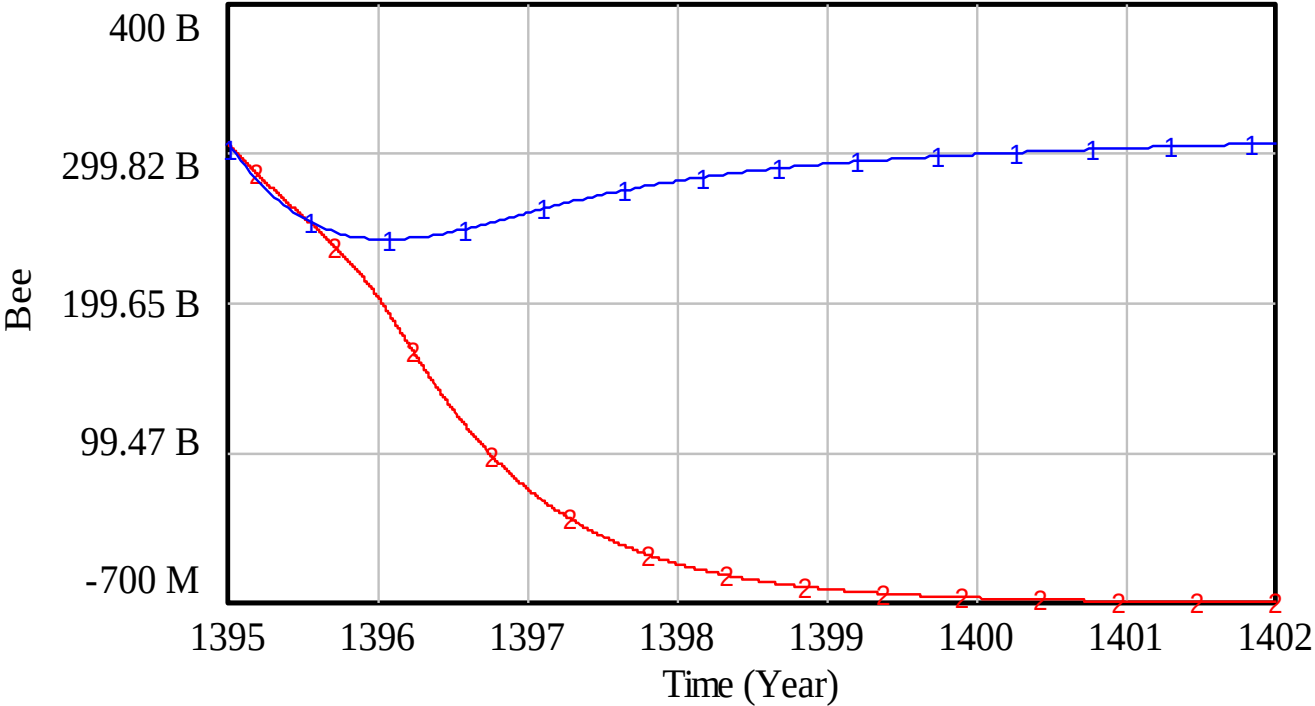
Area under cultivation



Area under cultivation : Current 1 1 1 1 1 1 1 1 1 1

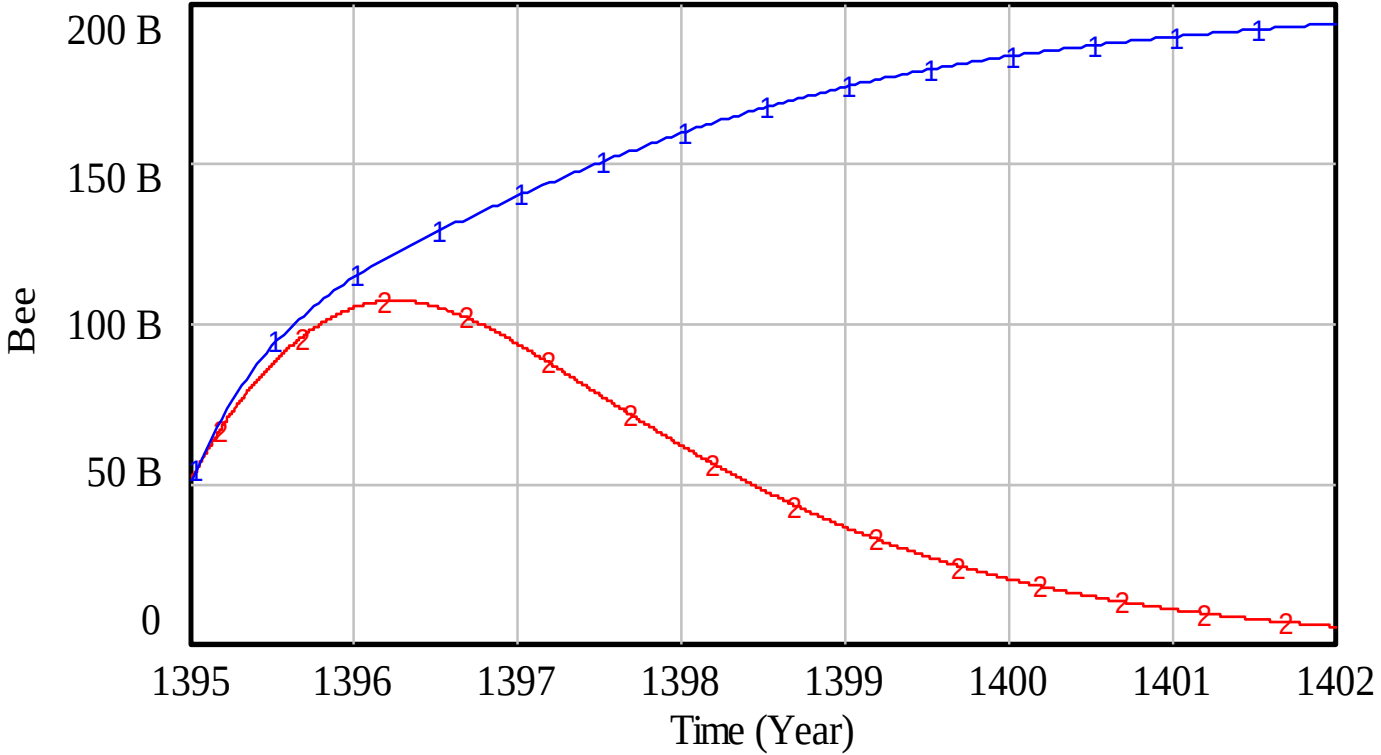
Area under cultivation : ExtremeConditionTest 2 2 2 2 2 2 2 2 2 2

Hive bee



Hive bee : Current 1 1 1 1 1 1 1 1 1 1 1 1
Hive bee : ExtremeConditionTest -2 -2 -2 -2 -2 -2 -2 -2 -2 -2 -2 -2

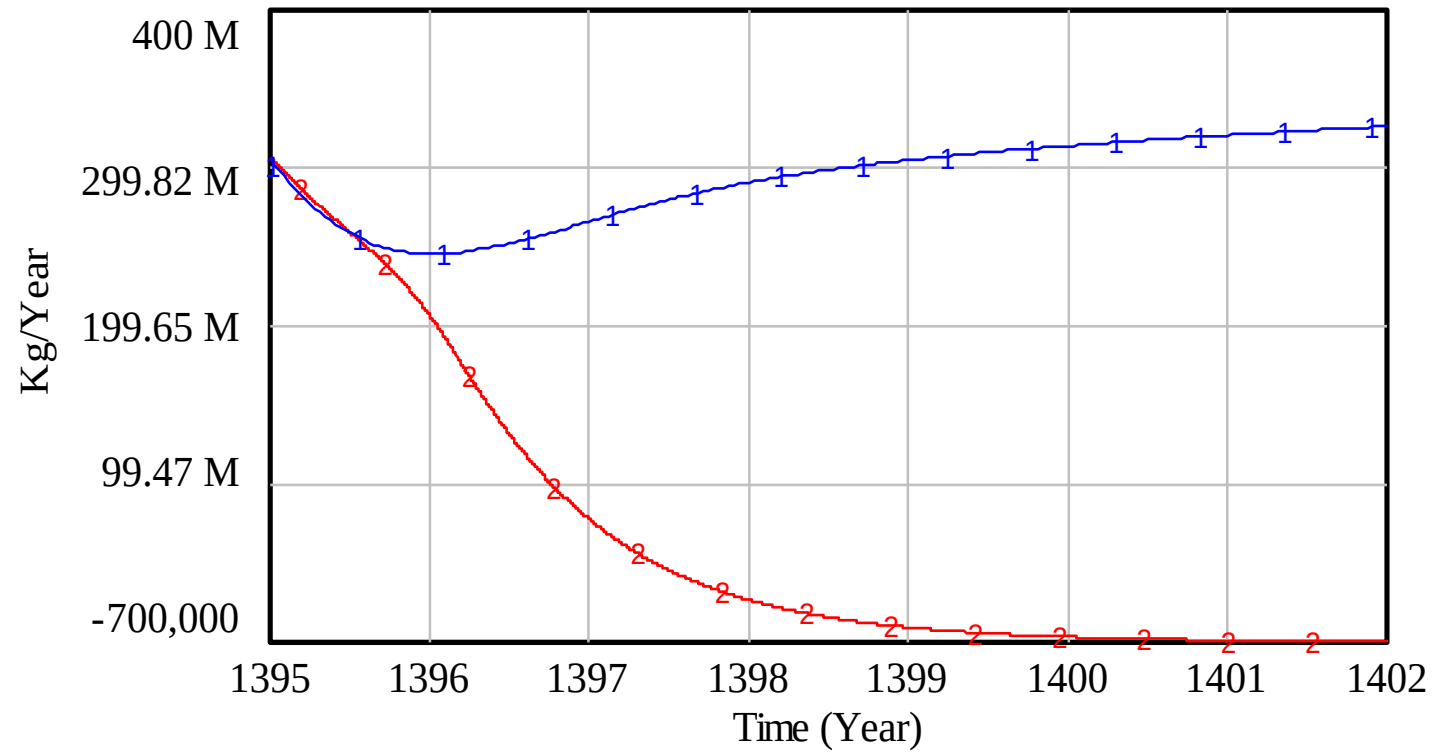
Foragers



Foragers : Current —1—1—1—1—1—1—1—1—1—1—1—1—

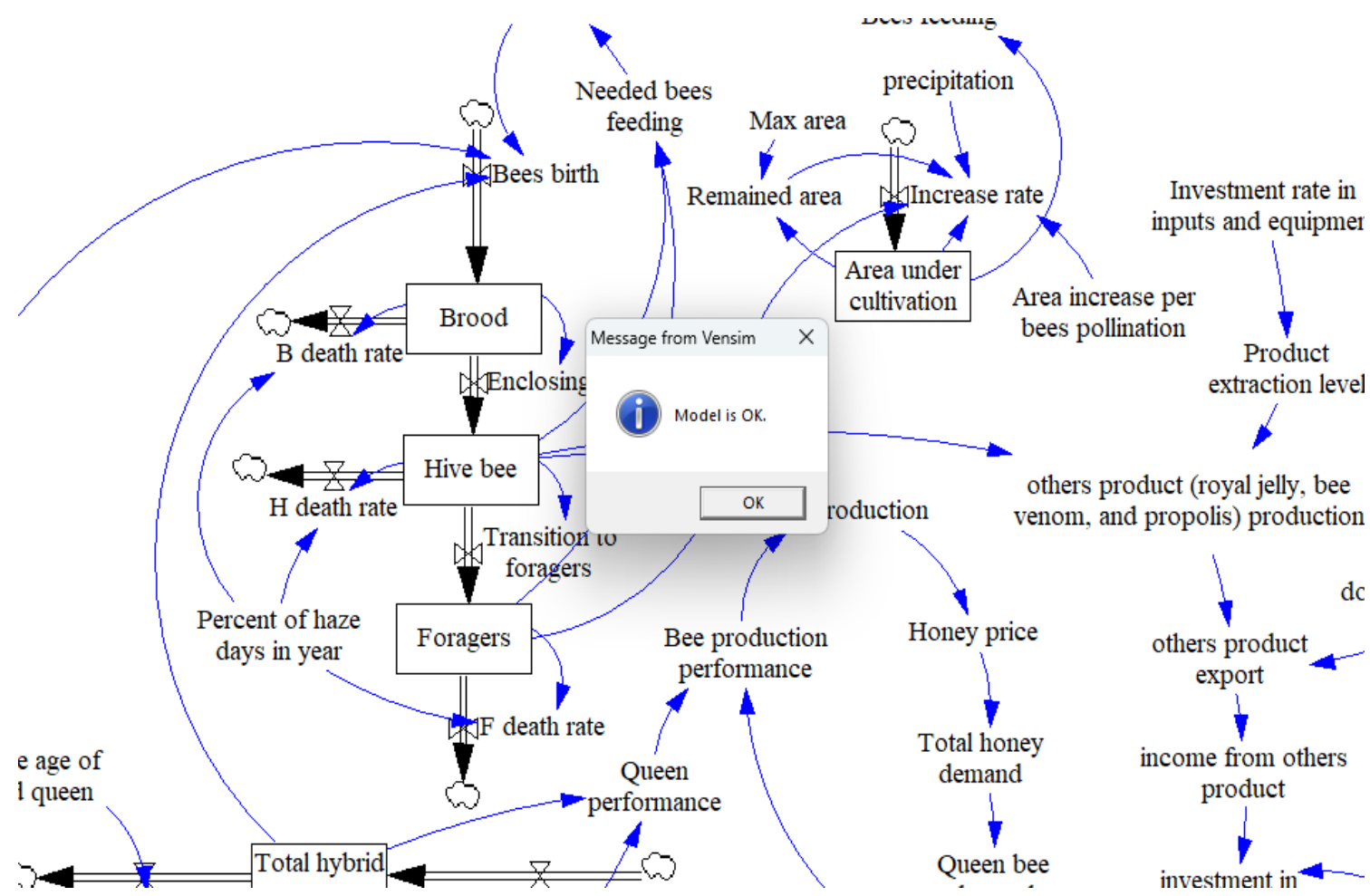
Foragers : ExtremeConditionTest -2-2-2-2-2-2-2-2-2-2-2-2-

Honey production



Honey production : Current — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1

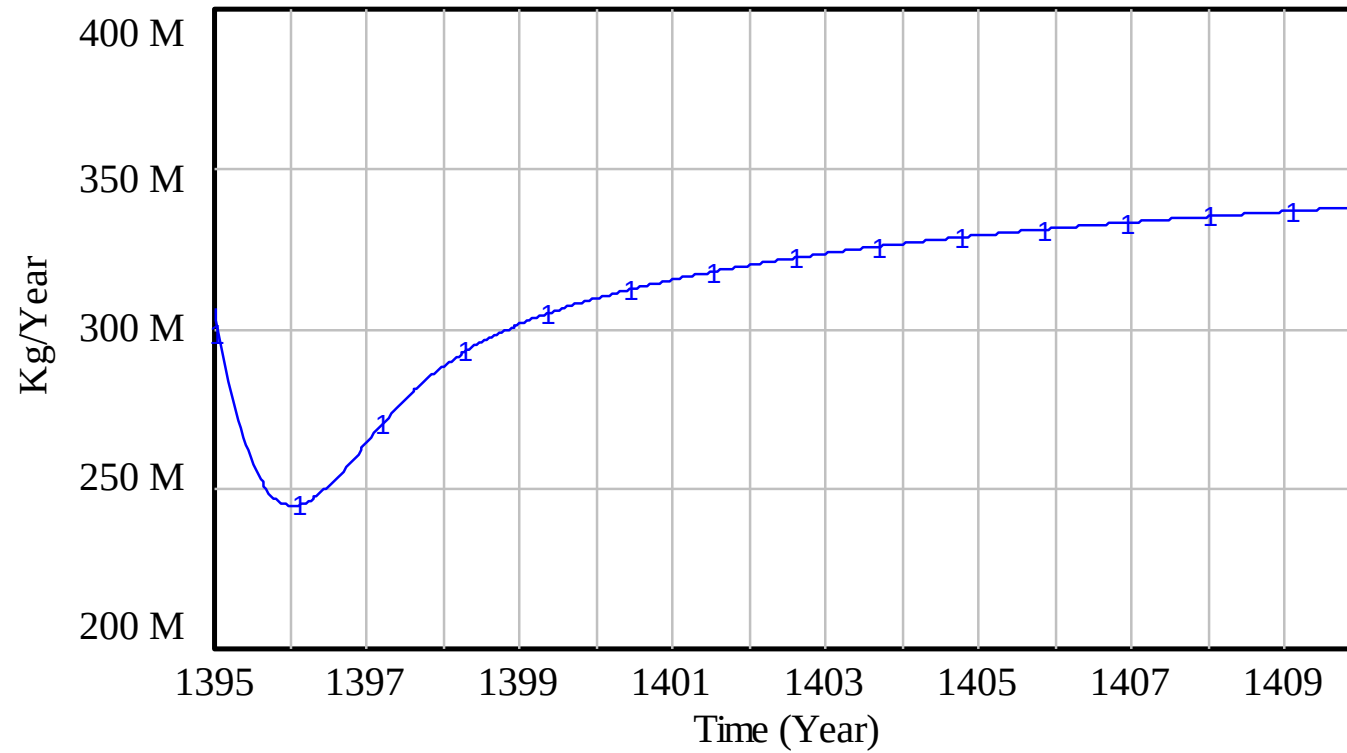
Honey production : ExtremeConditionTest — 2 — 2 — 2 — 2 — 2 — 2 — 2 — 2 — 2 — 2 — 2



First Scenario:
Continuation of The Status Quo

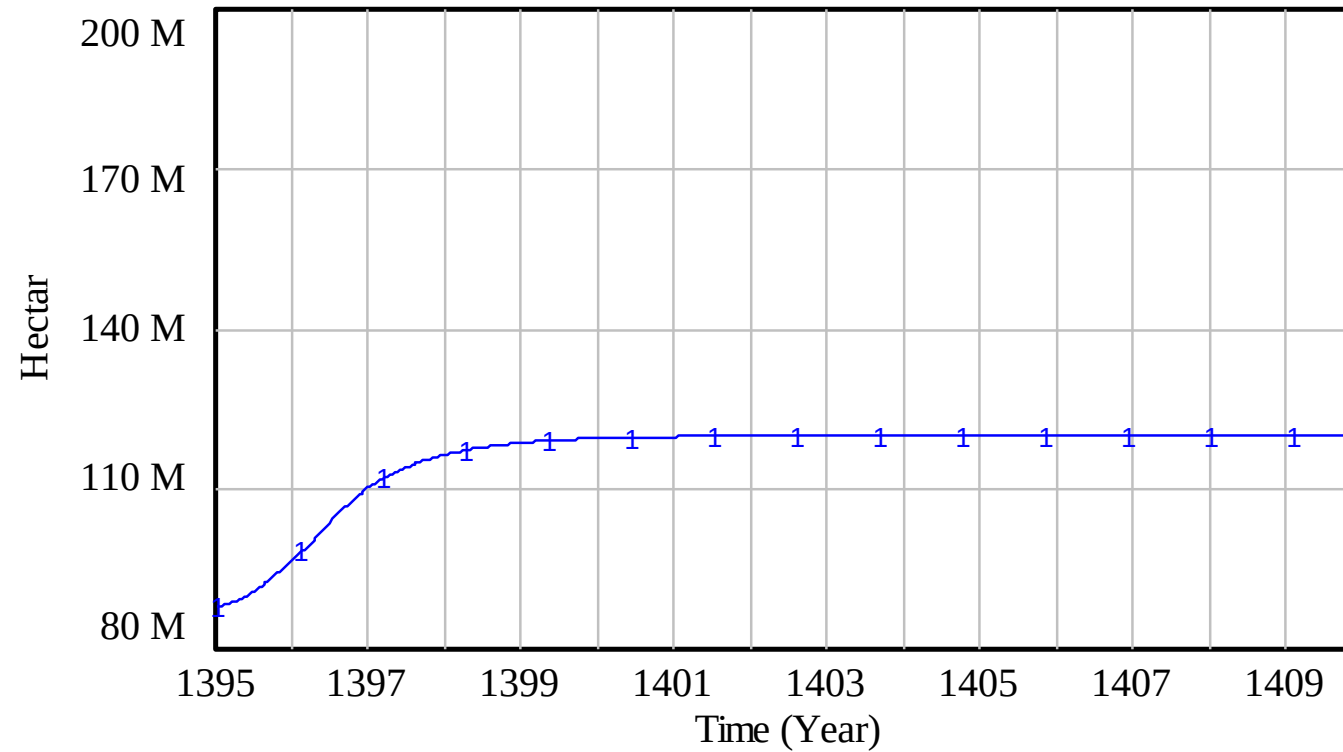


Honey production



Honey production : Current — 1 1 1 1 1 1 1 1 1 1

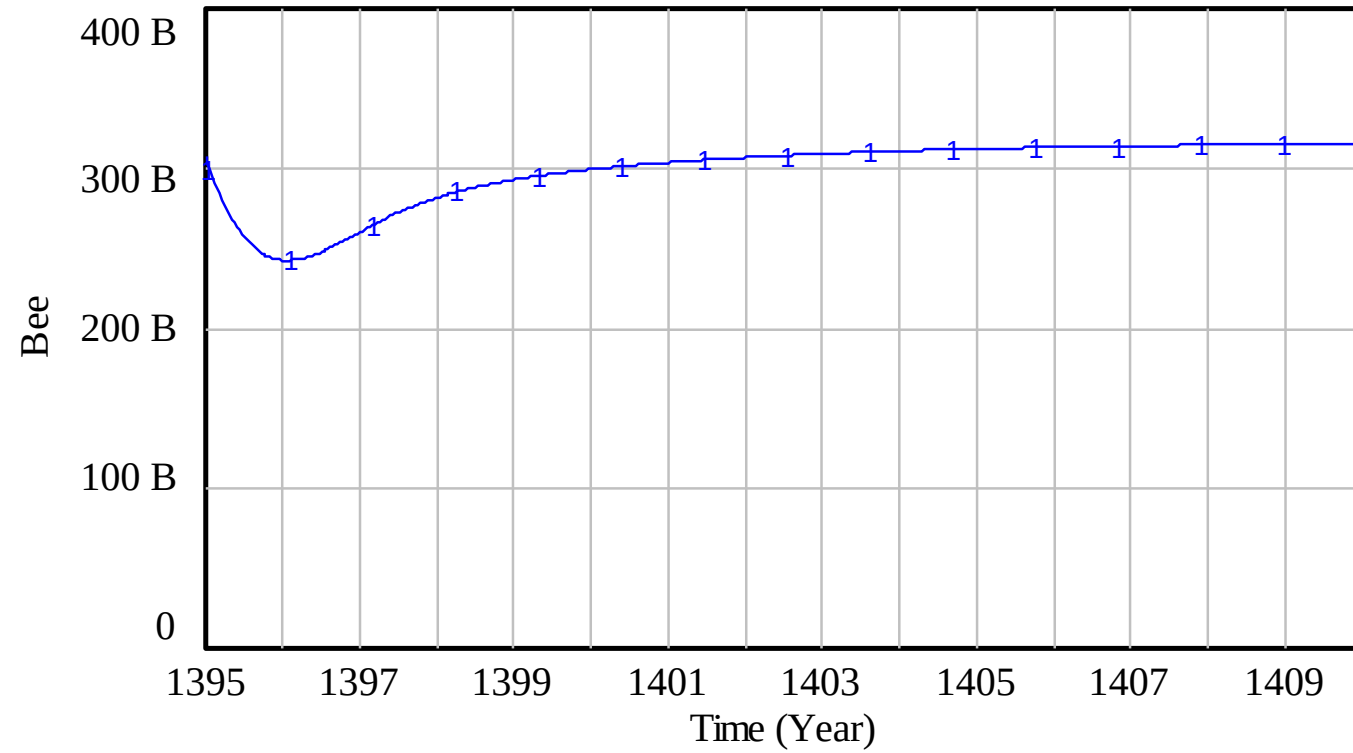
Area under cultivation



Area under cultivation : Current



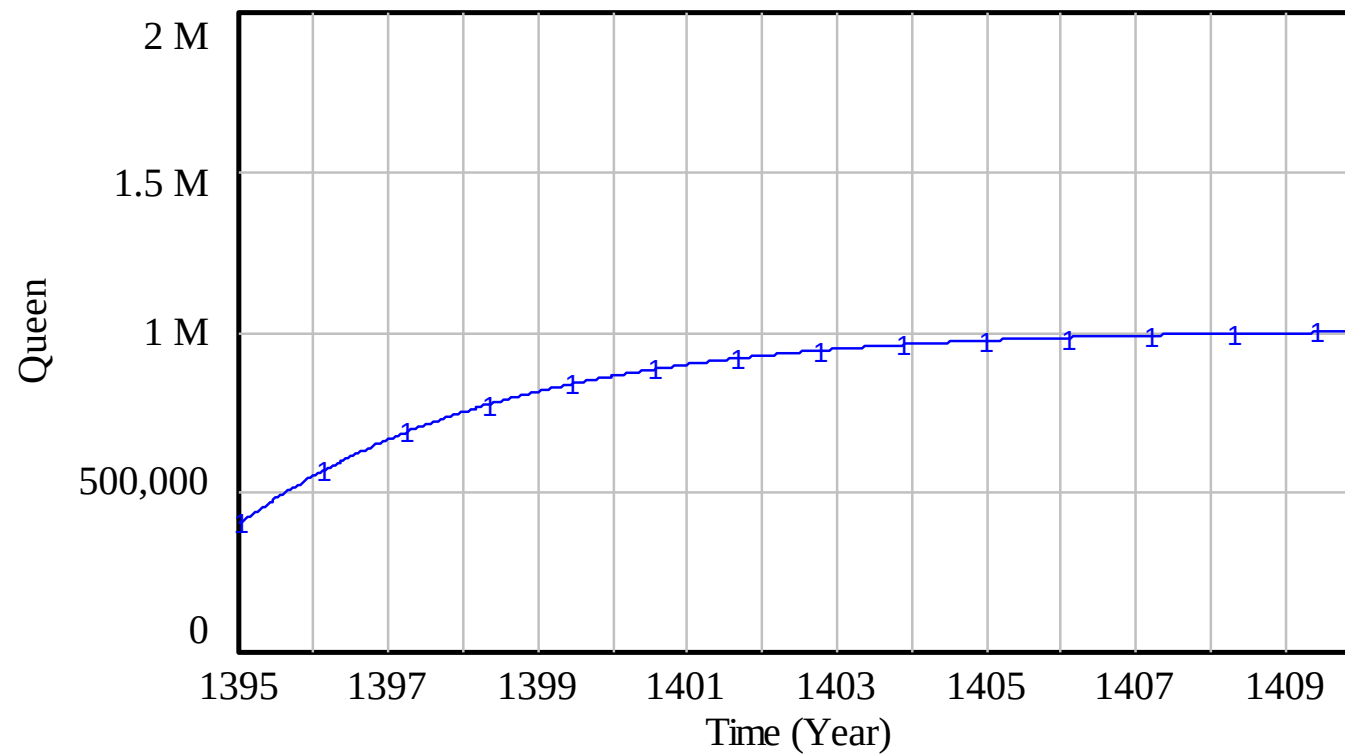
Hive bee



Hive bee : Current — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1 —

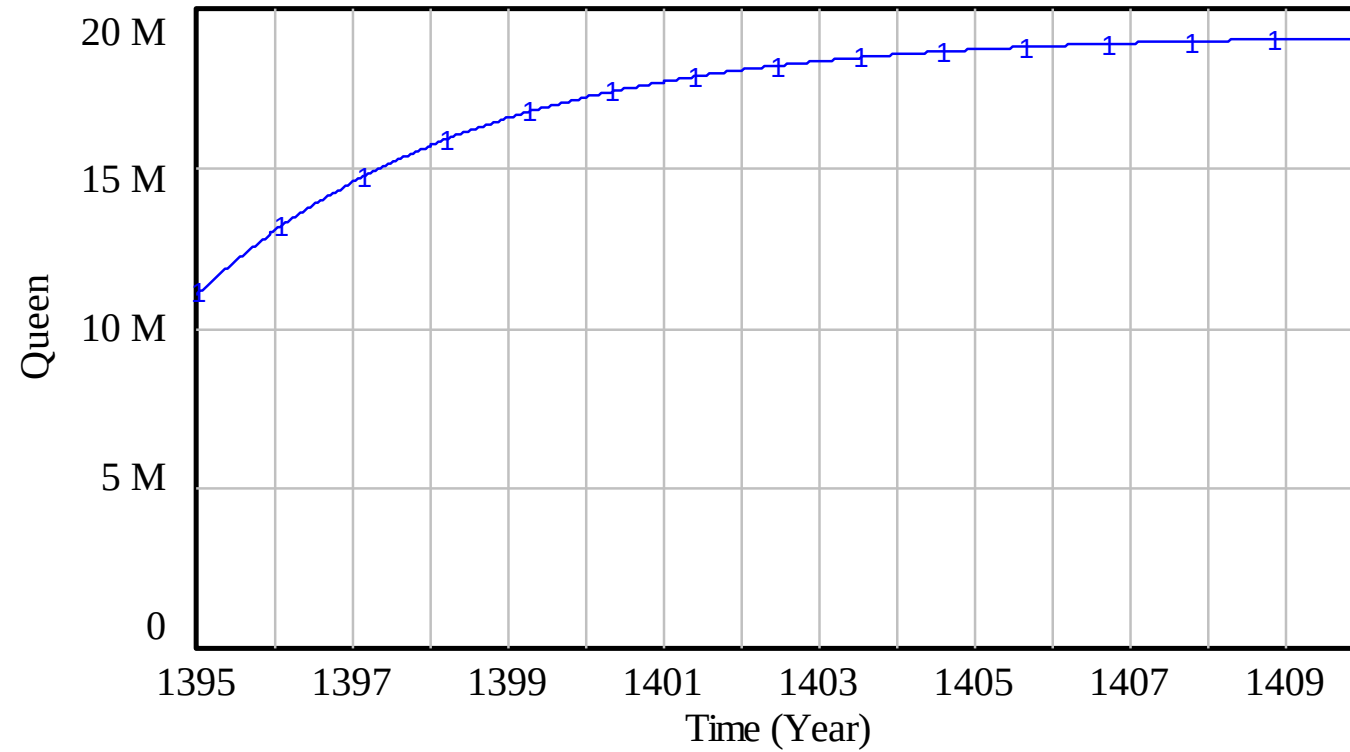


Total hybrid queen



Total hybrid queen : Current — 1 1 1 1 1 1 1 1 1 1

Total usual queen

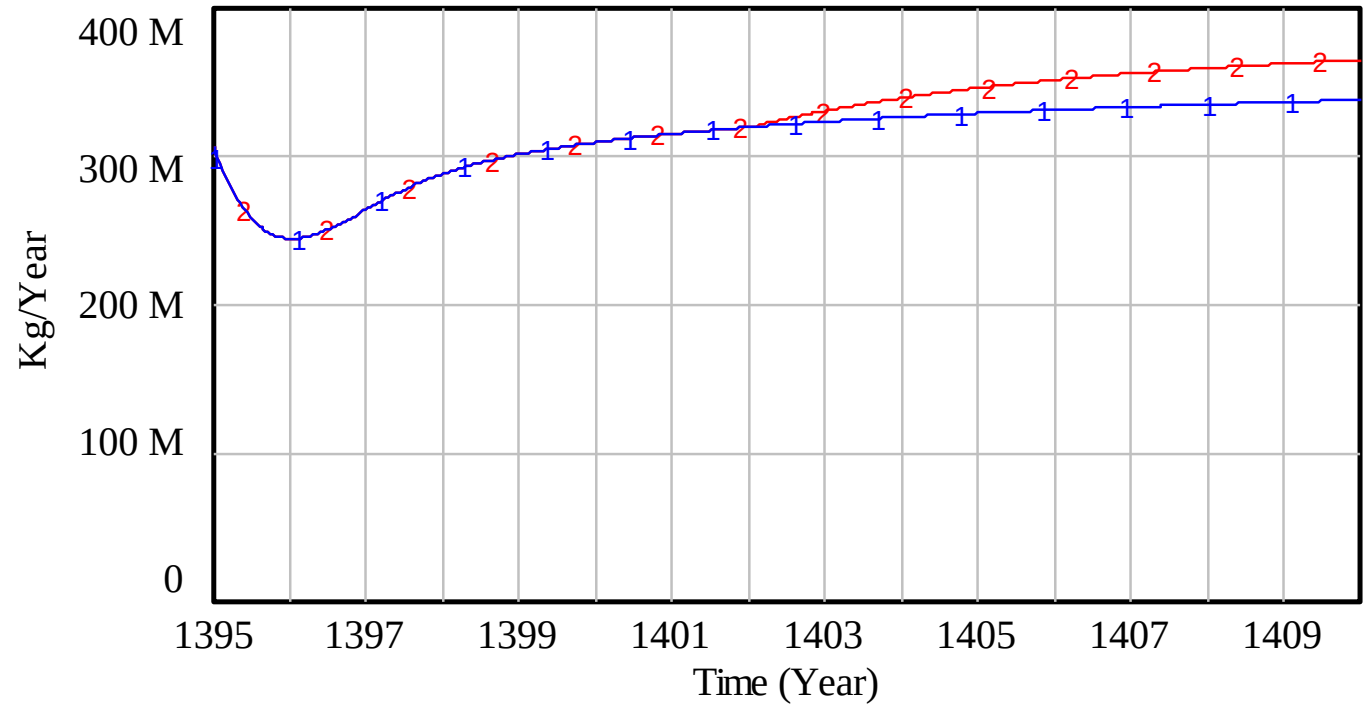


Total usual queen : Current 1 1 1 1 1 1 1 1 1 1 1 1

Second Scenario:
Increasing the number of hybrid queens



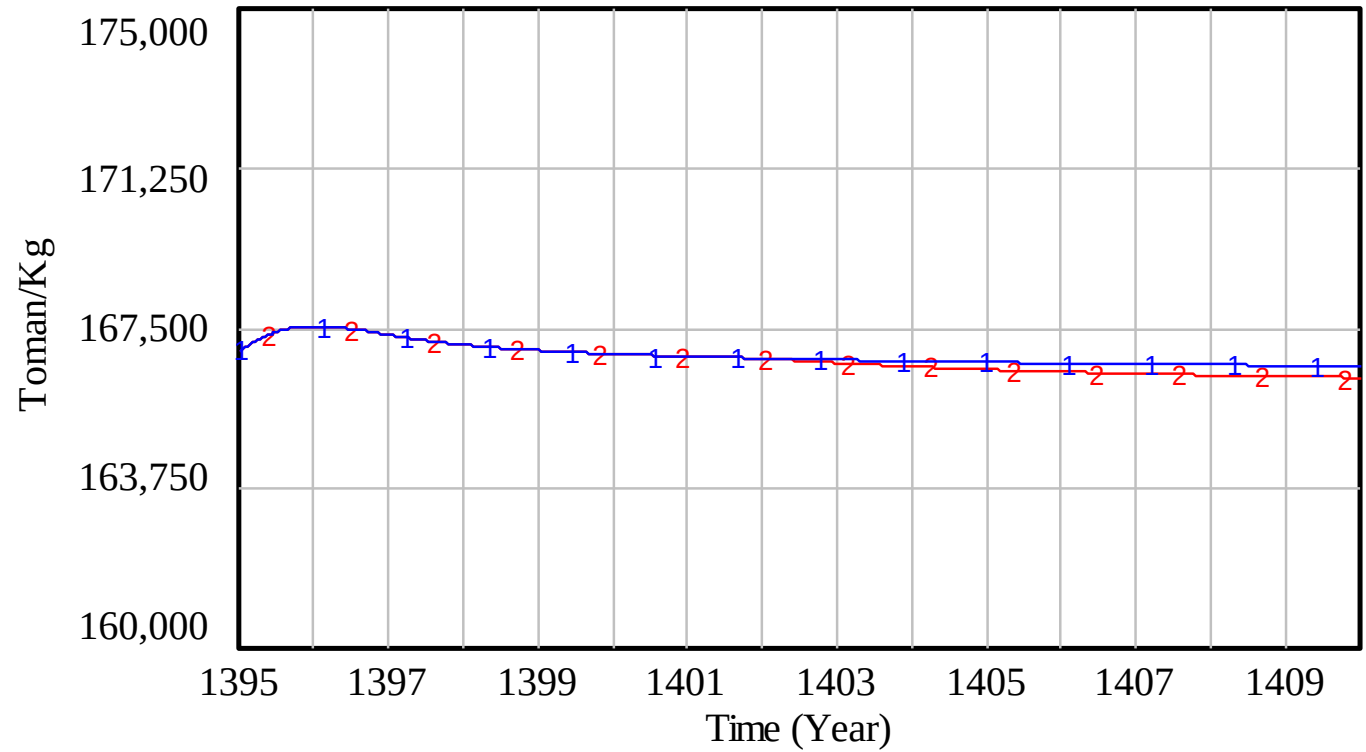
Honey production



Honey production : Current — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1 —

Honey production : scenario2 — 2 — 2 — 2 — 2 — 2 — 2 — 2 — 2 — 2 — 2 —

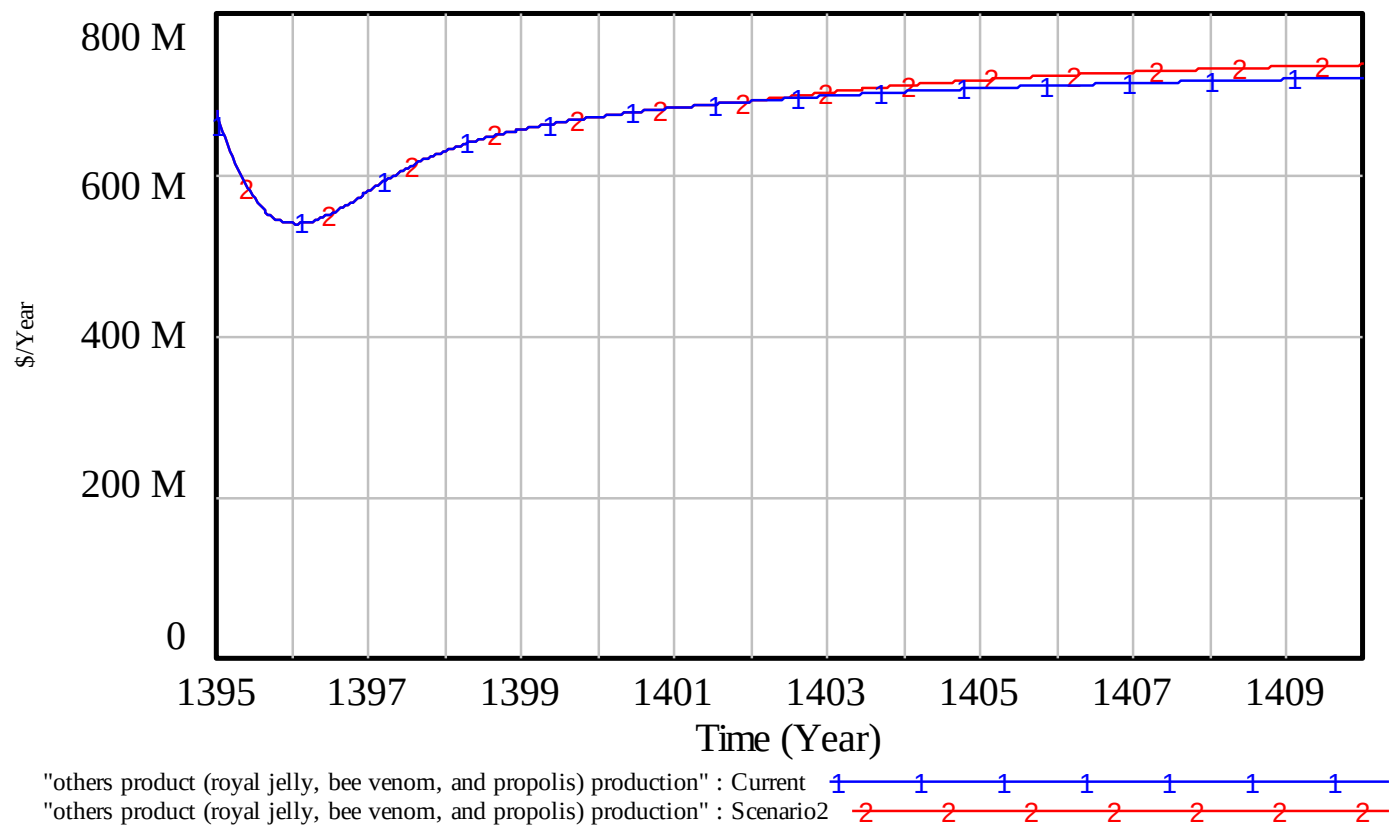
Honey price



Honey price : Current — 1 — 1 —

Honey price : scenario2 — 2 — 2 — 2

Others product (royal jelly, bee venom, and propolis) production

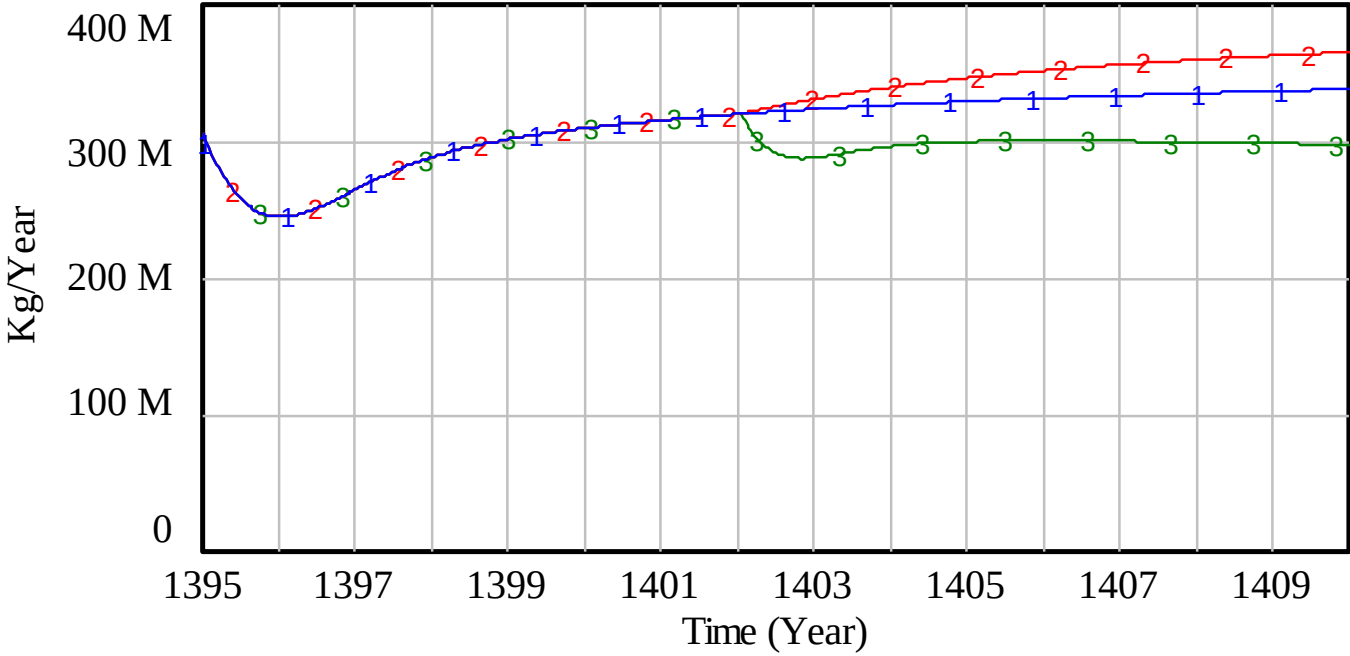


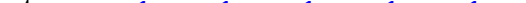
Third Scenario:

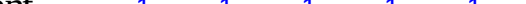
Decrease in rainfall and increase in dusty days



Honey production



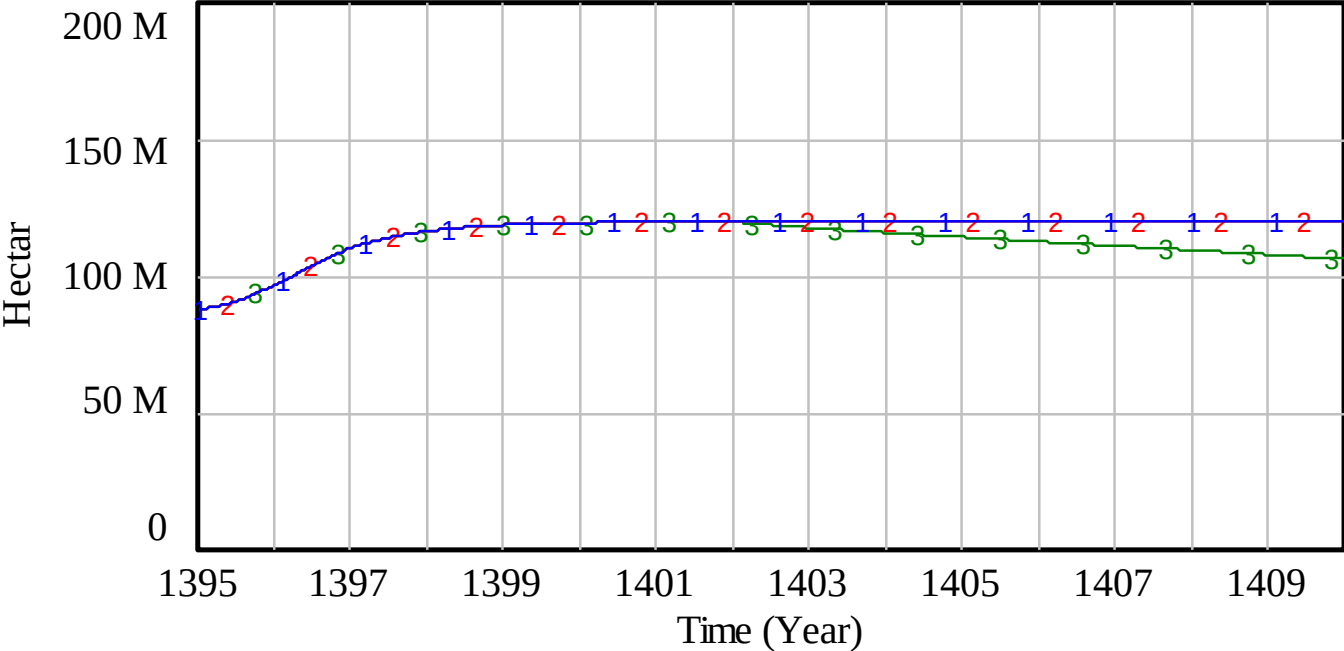
Honey production : Current 

Honey production : scenario2 

Honey production : scenario3 



Area under cultivation

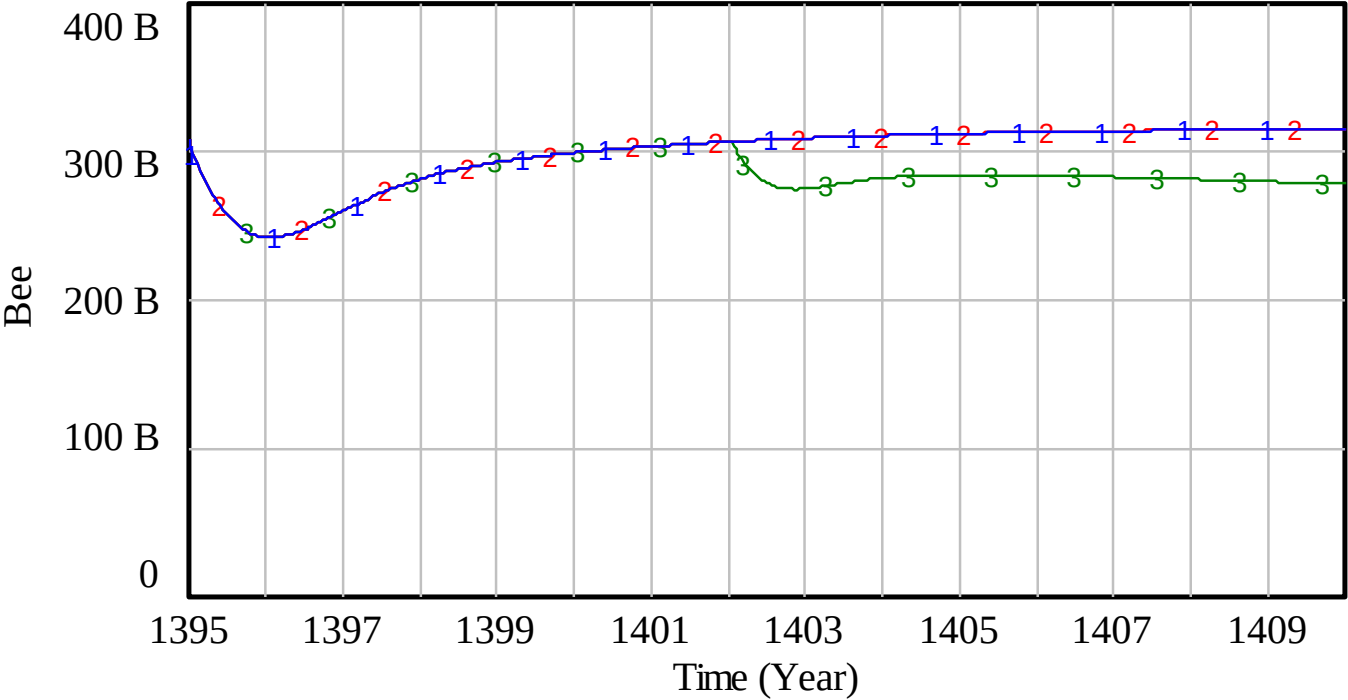


Area under cultivation : Current 1 1 1 1 1 1 1 1 1 1 1

Area under cultivation : scenario2 2 2 2 2 2 2 2 2 2 2

Area under cultivation : scenario3 3 3 3 3 3 3 3 3 3 3

Hive bee

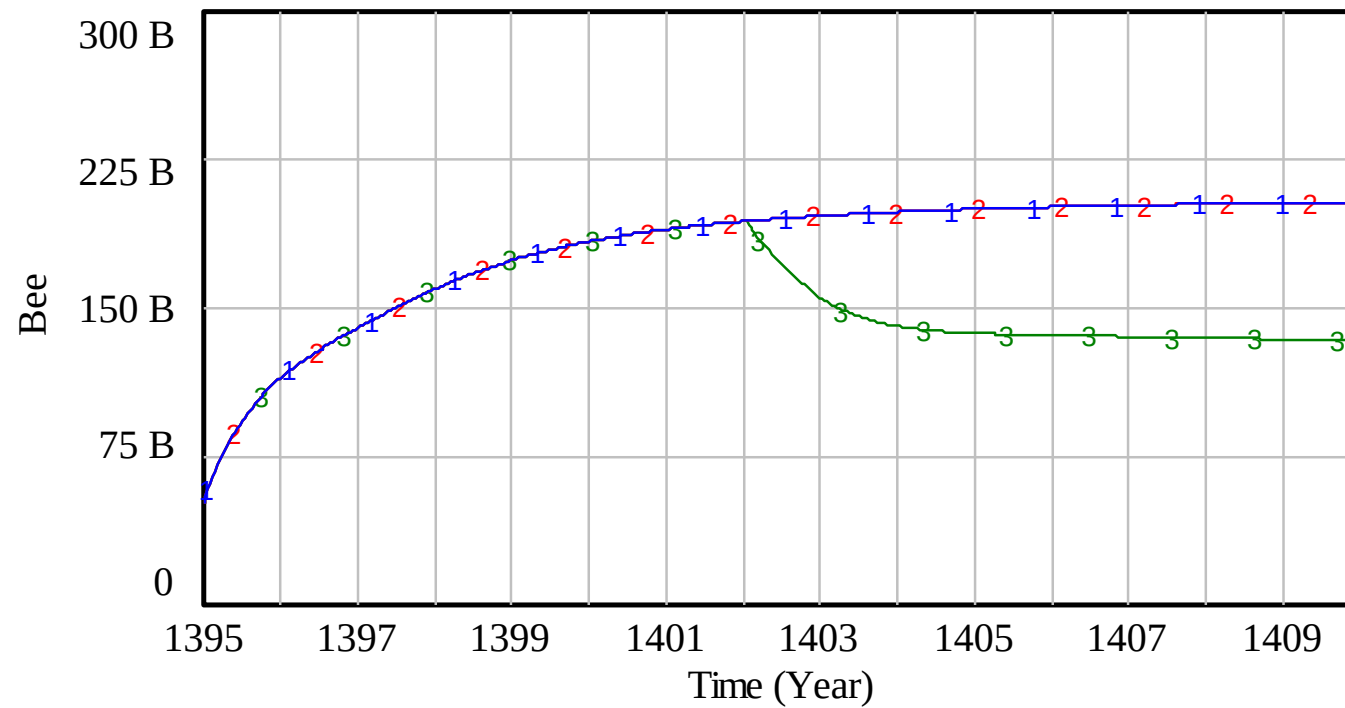


Hive bee : Current 1 1 1
Hive bee : Scenario2 2 2 2

Hive bee : Scenario3 3 3 3



Foragers



Foragers : Current — 1 — 1 — 1 —

Foragers : scenario2 — 2 — 2 — 2 —

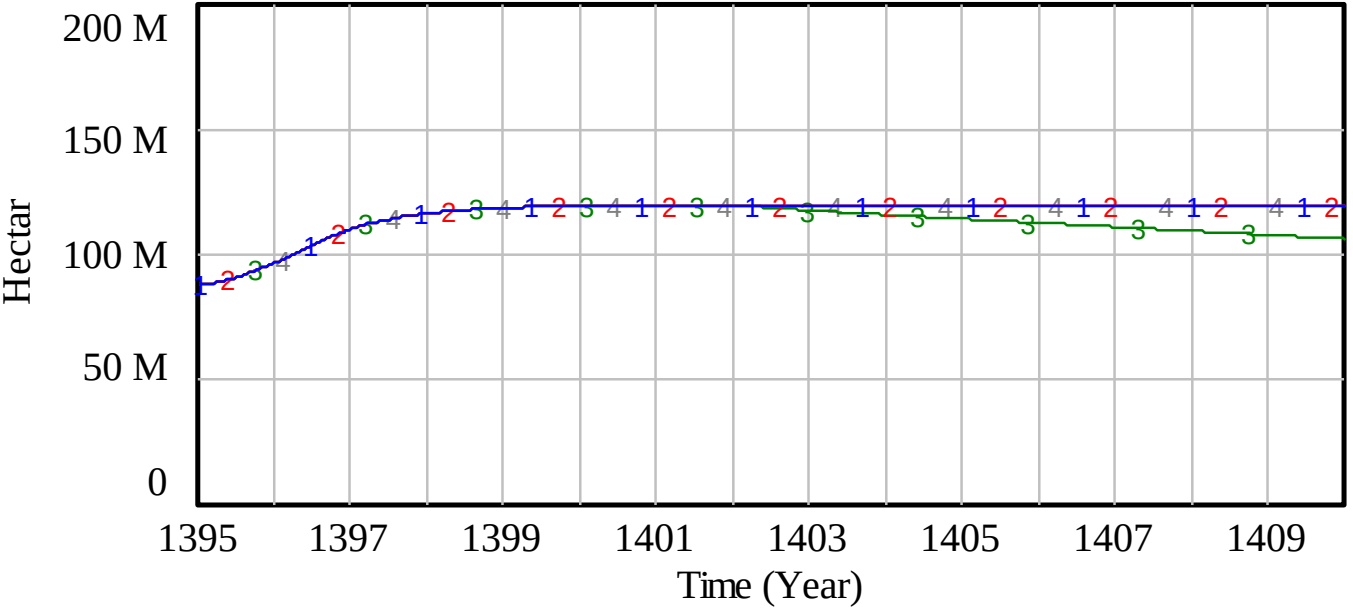
Foragers : scenario3 — 3 — 3 — 3 —

Fourth Scenario:

Increasing the share of investment in technology to 5% of total income



Area under cultivation



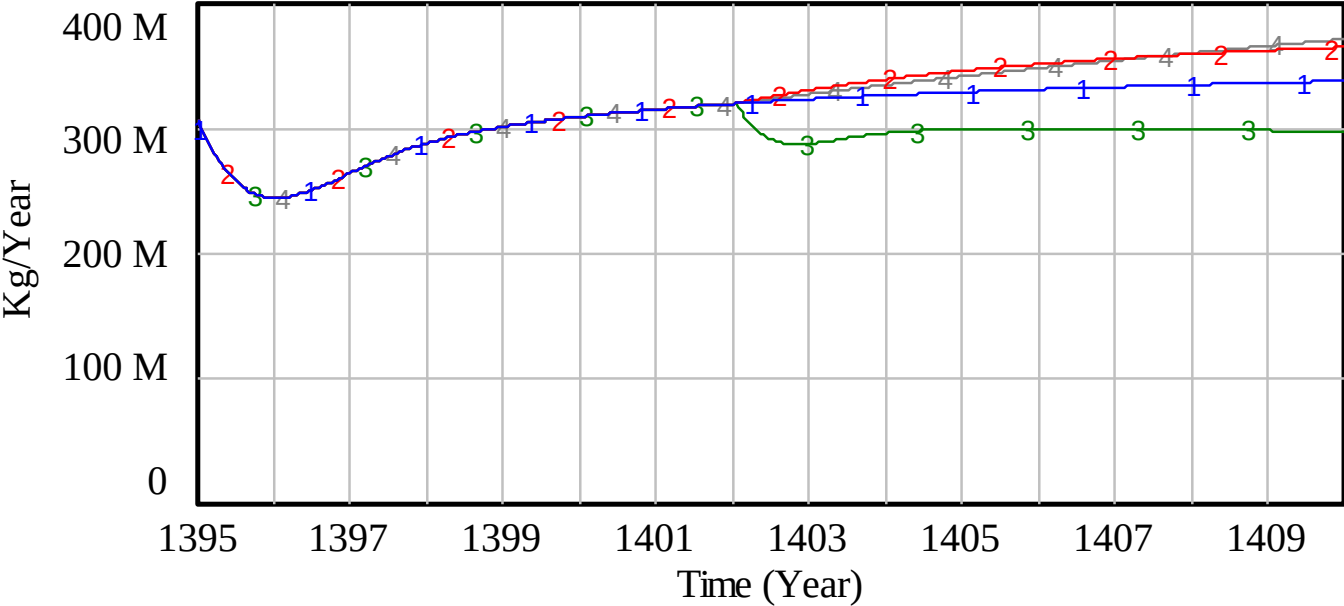
Area under cultivation : Current 1 1 1 1 1 1 1

Area under cultivation : scenario2 2 2 2 2 2 2 2

Area under cultivation : scenario3 3 3 3 3 3 3 3

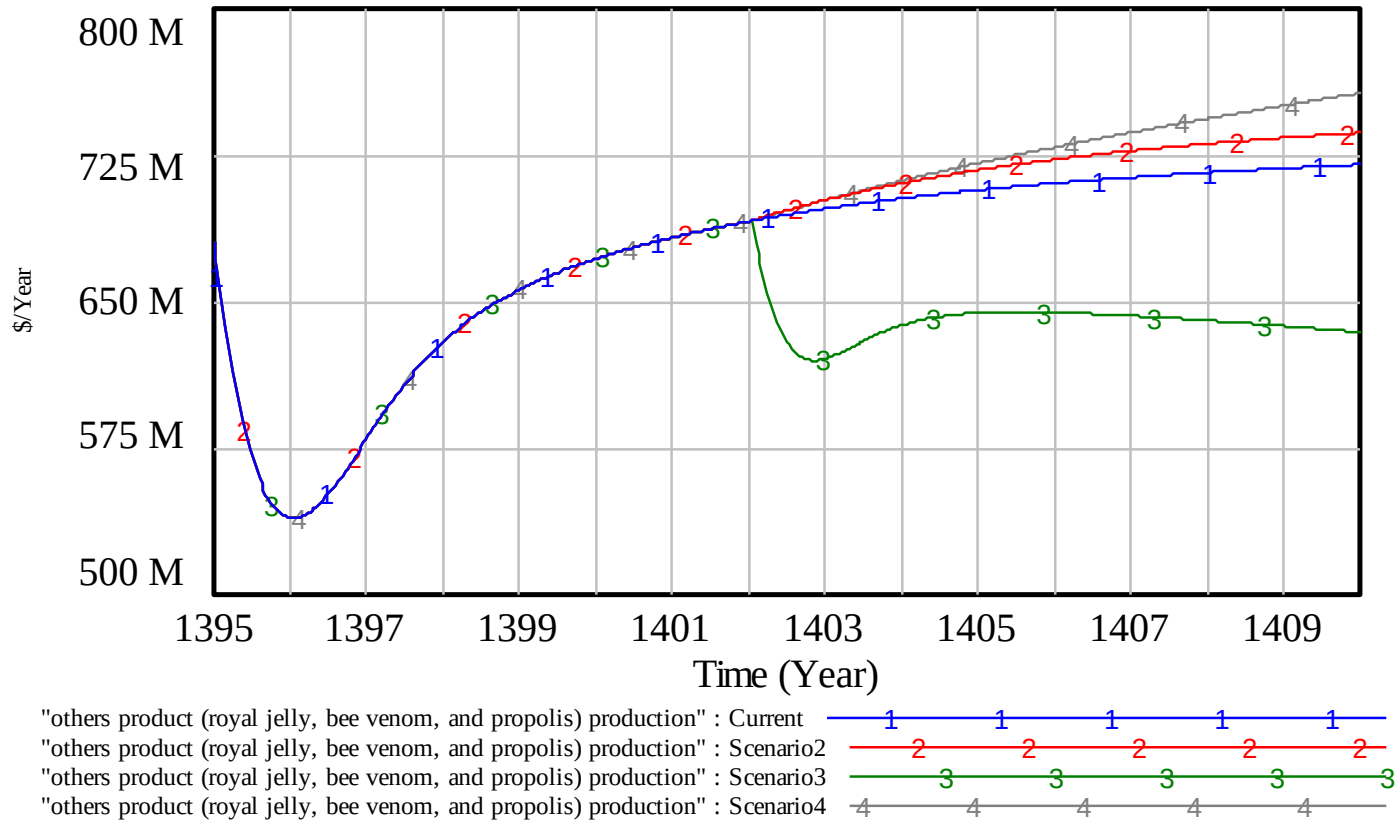
Area under cultivation : scenario4 4 4 4 4 4 4 4

Honey production



Honey production : Current 1 1 1 1 1 1 1 1 1
Honey production : scenario2 2 2 2 2 2 2 2 2
Honey production : scenario3 3 3 3 3 3 3 3 3
Honey production : scenario4 4 4 4 4 4 4 4 4

others product (royal jelly, bee venom, and propolis) production



Findings and Implications

- ❑ As rainfall decreases, the area under cultivation and, consequently, the food available to forager bees decreases.
- ❑ With a decrease in rainfall and an increase in dusty days, the population of forager bees and beehives will decrease significantly, resulting in a decrease in the production of honey and other products (royal jelly, bee venom, and propolis).
- ❑ Increasing the number of hybrid queens will increase honey production and reduce costs, but this research did not find evidence of a significant increase in the production of other products.



Findings and Implications

- ❑ Increasing investment in research, development, and technology in inputs, equipment, and production and harvesting processes, as a percentage of total revenue, will increase the production of honey and other products simultaneously. However, its impact on the production of other products is more obvious and faster.
- ❑ Beekeepers should not rely solely on the production and sale of honey, but rather, by investing in technology, they can increase the production of other products such as royal jelly, bee venom, and propolis, and sell them in domestic and international markets.

Thanks For Your Attention

