

# THE MODULE "AVAILABLE CELLS" IN THE APIPOP MODEL

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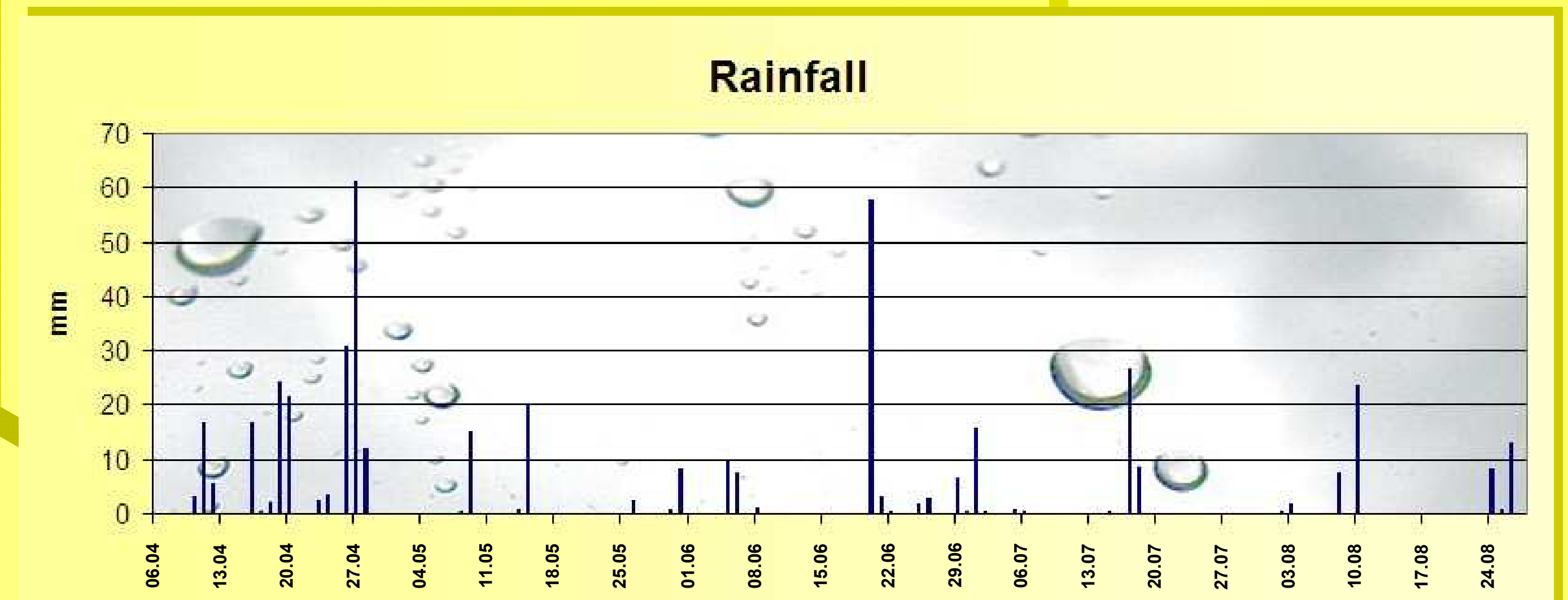
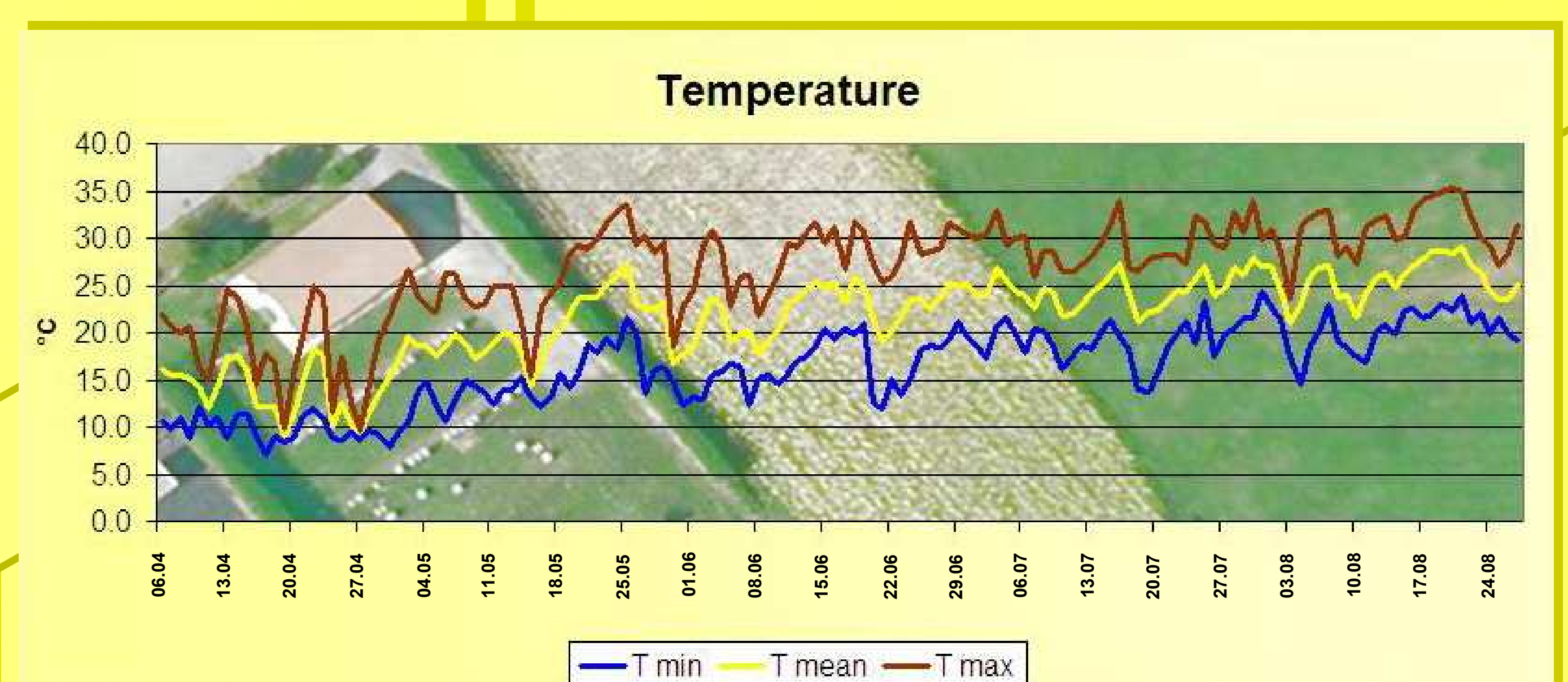
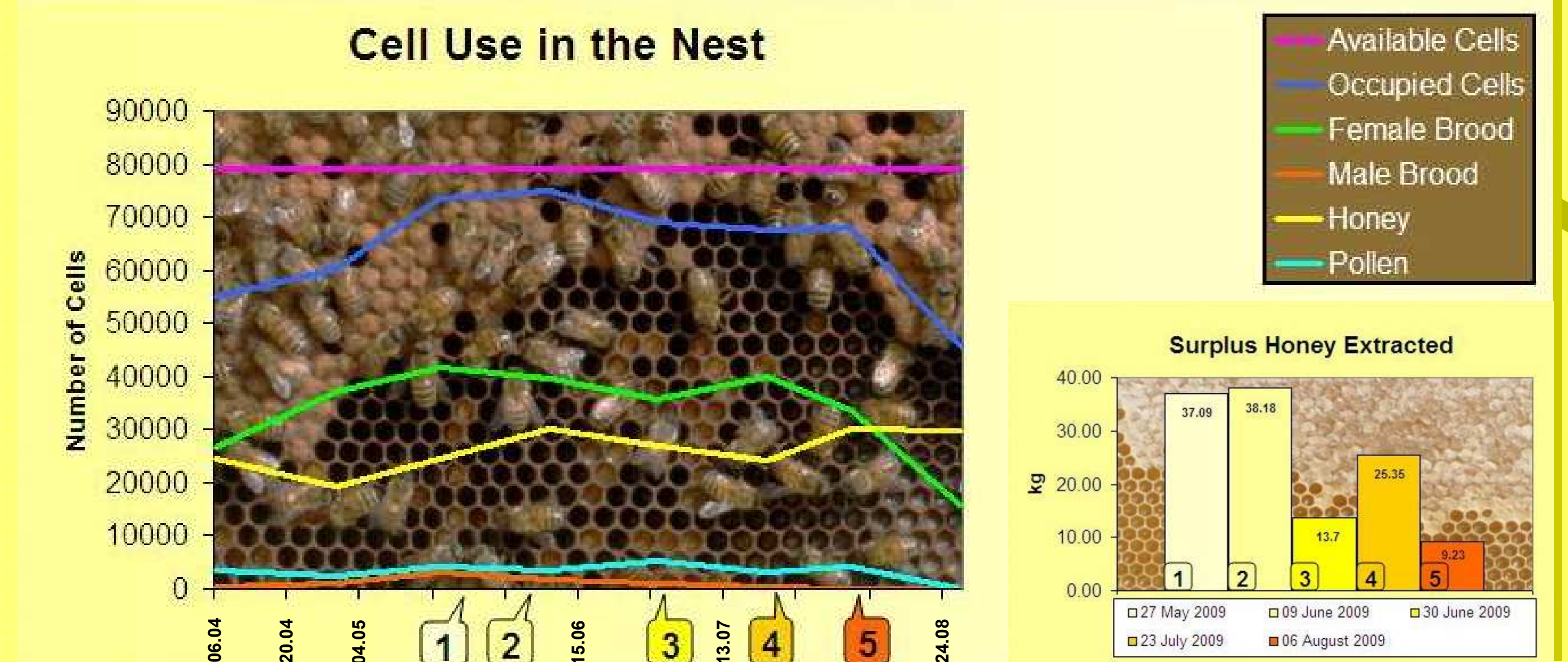
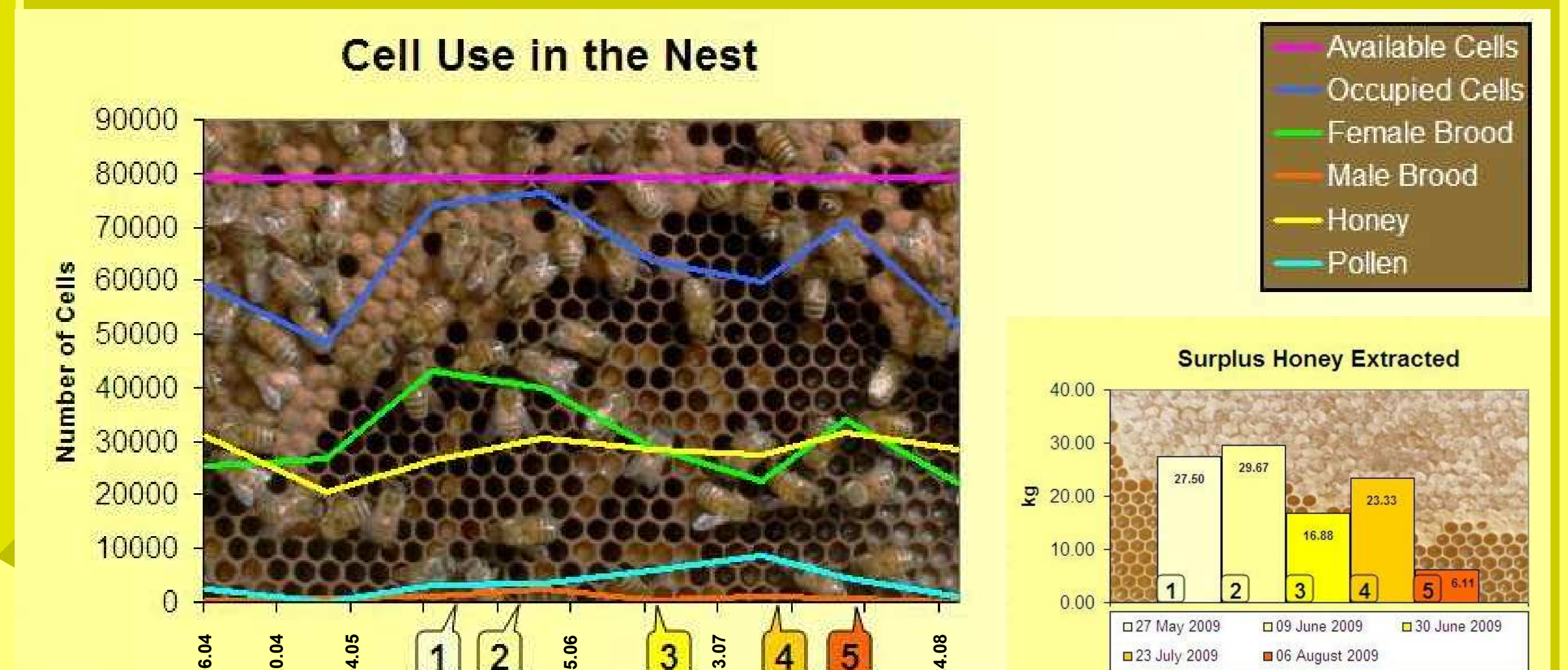
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Under the Italian research project "Integration of bee knowledge through the development and calibration of a model for the simulation of the beehive", the model ApiPop, developed within the modelling environment SEMoLA (Simple, Easy to use, Modeling Language), aims to simulate the complex interactions of the beehive, a very articulate biological system often considered as a "super-organism", influenced by strong interactions between its components, either internal (population, availability of stocks, etc) or external (plant resources, honey bee activities, etc).

The model is formed by seven modules developed by five working units: queen behaviour (AP\_queen) based on BeePop model (DeGrandi-Hoffman et al., 1989), colony dynamics (AP\_colony), available cells (AP\_cells), hive management (AP\_beekeeping), vegetation (AP\_vegetation), foraging activity (AP\_foraging), honey and pollen production (AP\_production), and enemies and poisoning - at present, only for the varroa mite population (AP\_varroa), mainly based on Fries, Calis et al. (1994) and Martin (1998) models.

The development of five honey bee colonies in ten Dadant-Blatt hive frames was monitored in the Di.Va.P.R.A. experimental apiary in Grugliasco (province of Turin, Italy), to detect the area of the nest combs occupied by worker and drone brood, and by honey and pollen stores. The extracted surplus honey was weighed whenever supers were removed.

The results obtained in two hives representing different development dynamics are given as an example; temperature and rainfall recorded at Grugliasco in the same period of time, both in line with the averages of the locality, are shown to evidence their influence on colony development.



**REFERENCES**

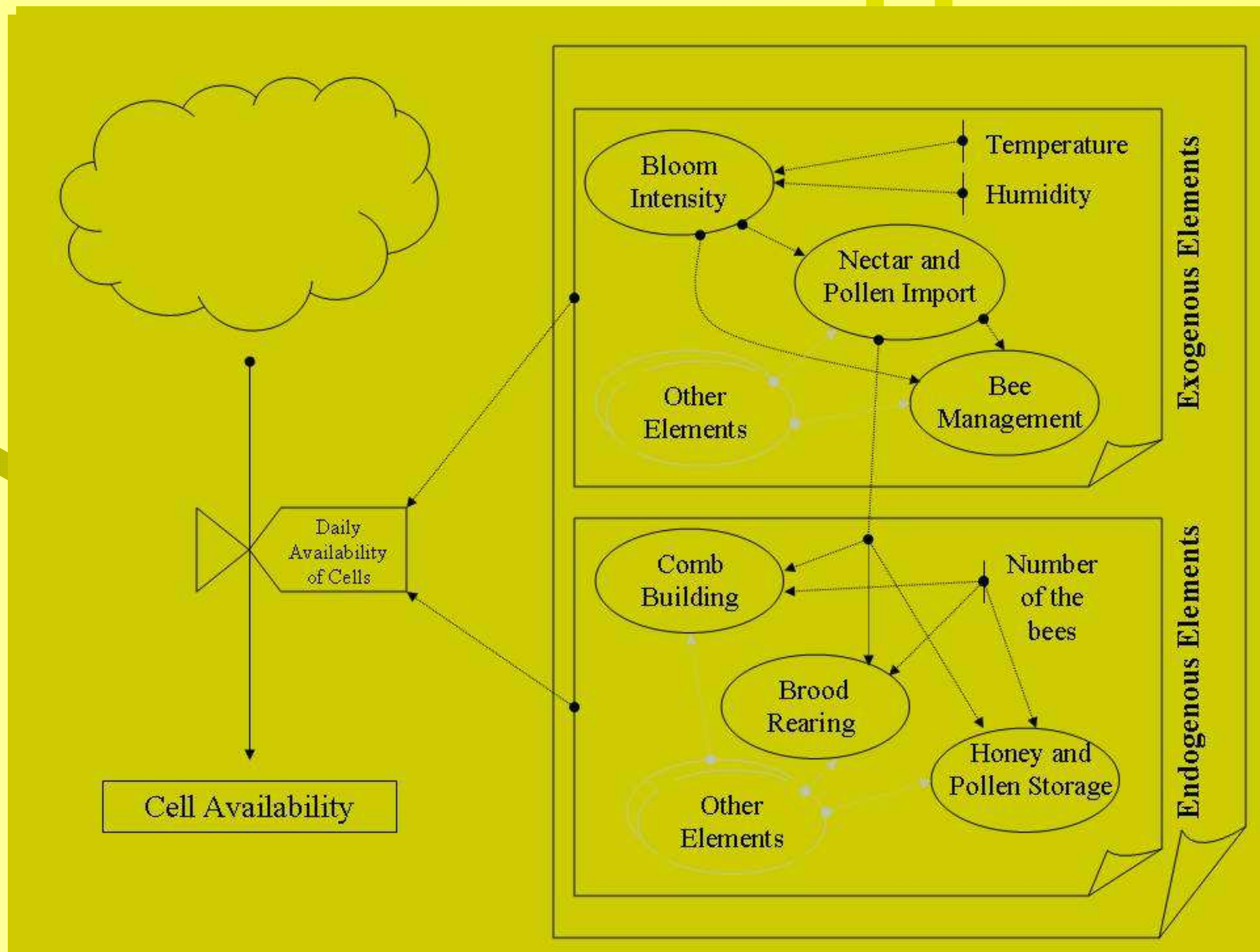
DeGrandi-Hoffman G., Roth S.A., Loper G.L., Erickson E.H., Jr., 1989. BEEPOP: a honeybee population dynamics simulation model. *Ecological Modelling*, 45:133-150.

Fries I., Camazine S., Sneyd J., 1994. Population dynamics of *Varroa jacobsoni*: a model and a review. *Bee World*, 75, 5-28.

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## SCHEMATIC REPRESENTATION of the MODULE "AVAILABLE CELLS"

According to data collected in the field and to information on honey bee biology from the literature, a flow chart of the key relationships regulating cell use within the hive and a first draft of the module have been developed.



Flowchart of the Module

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===== APIPOP: AP_CELLS module (Cells building) =====
----- Materials -----
M SuperCells state(CSpace,CSempty,CSHoney,CScap) "Super cells" (nCS)
M NestCells state(CNspace,CNdepply,CNDegg,CNRegg,CNWhoney,CNPollin) "Nest cel"
G Super=0 newton(SuperInst) dropon(SuperRem) "Super"

----- Super cells -----
' un malarico ha 9 telai, un telaio 500 posizioni
S Super.CSpace=5000 "Number of spaces of super cells" (nCS)
S Super.CSempty=0 "Number of empty super cells available" (nCS)
S Super.CShoney=0 "Number of super cells with honey" (nCS)
S Super.CScap=0 "Number of super cells capped" (nCS)

R Super.CSpaceNew=0 ?->CSpace onevt(SuperInst,?) "Spaces for super insertion" (nCS)
R Super.CSemptyNew=0 ?->CSempty onevt(SuperInst,?) "Empty cells for super insertion" (nCS)

----- casso costruzione celle malarico -----
R Super.CSbuild=KCSB*CSpace CSpace->CSempty "Super cell building rate" (nCS/d)
A KCSB=KCSBmax*FHflux "Fraction of honey cell building"
A FHflux=tab(Hharvest(0,0\1,5000)) "Fattore flusso nettario" (-)

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First Draft of the Model