CaNaSTA - Crop Niche Selection for Tropical Agriculture

A Spatial Decision Support System

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1 OBJECTIVES

- ❖Investigate ways of providing decision support in uncertain and risky environments
- ❖Develop an appropriate model to provide decision support
- ❖Implement the model as a Spatial Decision Support System (SDSS)

2 BACKGROUND

Smallholder farmers in the developing world frequently find themselves in uncertain and risky environments, often having to make decisions based on very little information; risks are often critical because of their poverty and harsh environments.

This research aims to improve forage adoption decisions, thereby increasing sustainable intensification and ultimately contributing to improved livelihoods.

3 SPATIAL DECISION SUPPORT SYSTEM (SDSS)

Decision support can facilitate the decision process by making available relevant data and knowledge.

An SDSS has been developed called CaNaSTA (Crop Niche Selection in Tropical Agriculture).

The engine of the tool is Bayesian probability modeling (see below), with parameters derived from data and from expert knowledge.

Six main criteria were identified for model selection. These were the ability to work with small datasets, the ability to work with expert knowledge and the ability to predict a range of species responses. In addition, a low structural complexity is required as well as ease of communication and the ability to implement the DSS spatially.

4 PROBABILITY CALCULATIONS

$$P(Y \mid X) = \frac{P(Y, X)}{P(Y)}$$

Joint probability

Conditional probability

Prior probability

Posterior probability

$$P(Y \mid X^1, X^2, \ldots, X^n) \propto P(Y) \prod_k \left(\frac{P(Y \mid X^k)}{P(Y)} \right)$$

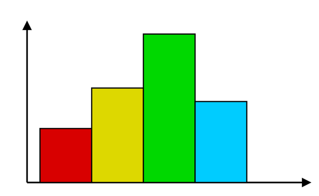
Adaptation

- Excellent
- Good
- Adequate
- Poor

Predictor variables

- Elevation
- Annual rainfall
- Length of dry season
- Soil pH
- Soil texture
- Soil fertility

Model outputs



Probability distribution for adaptation

Score value based on probability distribution

Certainty value associated with distribution, derived from trials data and expert knowledge

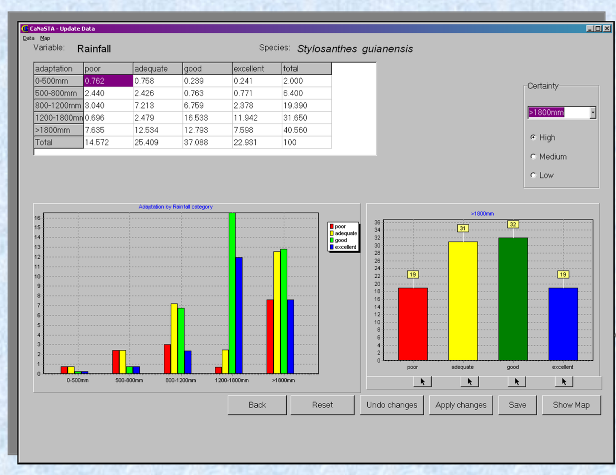
Stability value derived from changes in distribution when variables change states

Ranked list of recommended species

Maps, additional information

5 Which forage species should the farmer trial here?

Naturalized pasture, Nicaragua

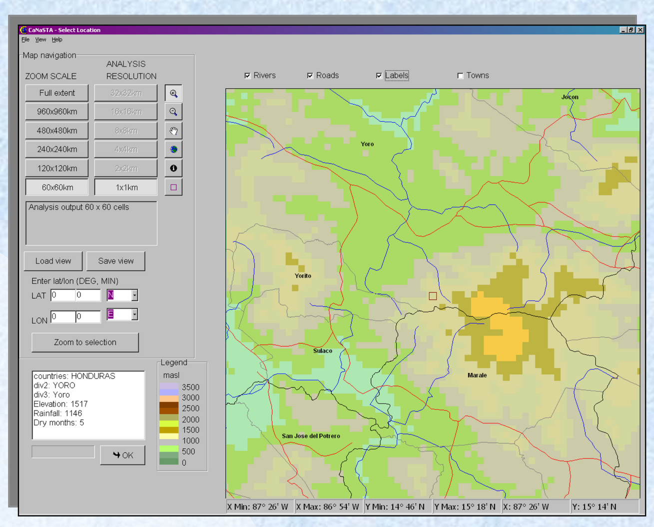


Knowledge base

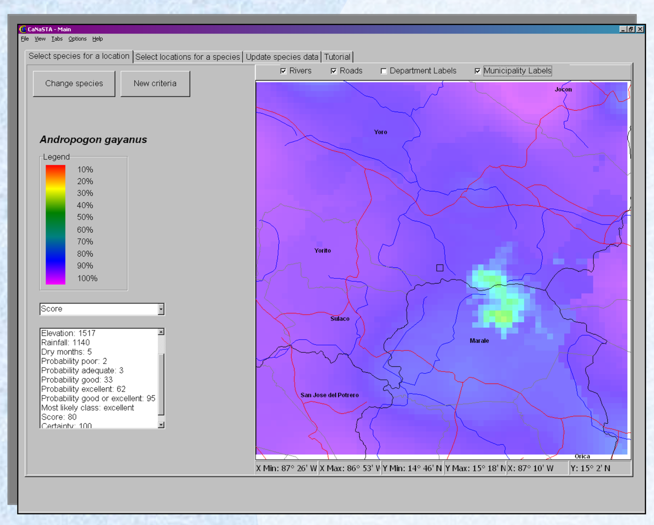
Existing trials databases
Existing knowledge bases
Expert knowledge
Farmer knowledge

Testing
Trials
Feedback

Decision based on CaNaSTA output and other factors



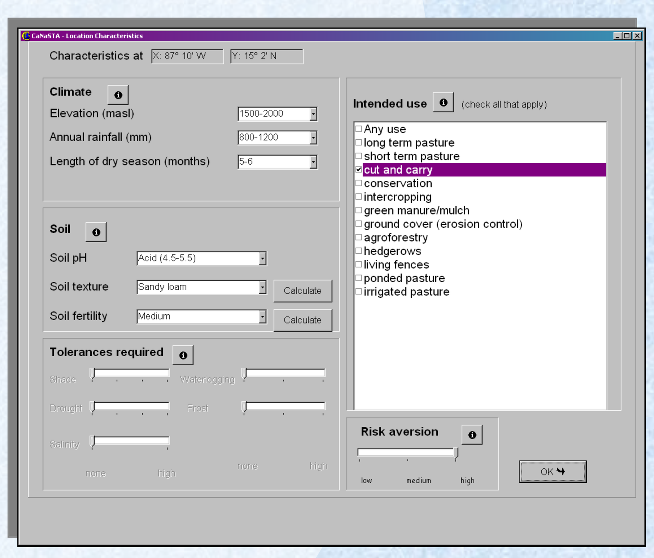
User selects a location of interest



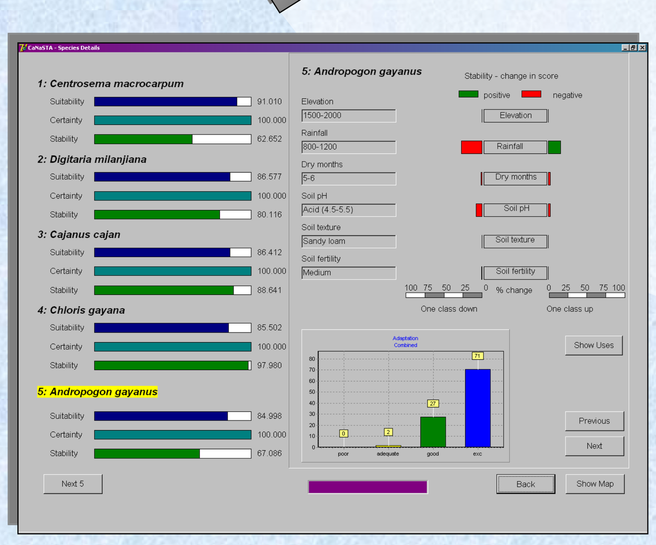
Spatial variability can be examined

Consultation with extension worker / forage expert

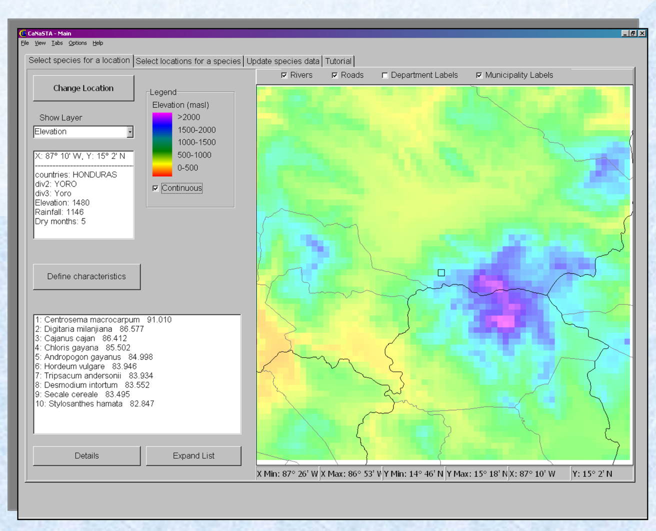
Farmer consulting extension worker, Esquipulas, Nicaragua



User defines desired characteristics



Details on selected species can be examined



Crop recommendations are returned

6 RESULTS

Results from CaNaSTA were compared with results from three existing tropical forage knowledge bases and direct elicitation from forage experts, highlighting a number of strengths of CaNaSTA.

- Species are not automatically excluded when one variable is unsuitable, as all other variables may be highly suitable.

- The score and ranking system allows more suitable species to be considered first, rather than the user being presented with an unranked list of all species which fit the criteria.

- CaNaSTA produces suitability maps dynamically; most other available knowledge bases do not have inherent spatial functionality and maps can only be produced on an ad-hoc basis.

7 CONCLUSIONS

- Incorporating spatial capabilities into an agricultural DSS, as in CaNaSTA, facilitates data input, allows more informative output of results, and allows spatial variability to be made explicit, both of results and of uncertainties related to the results.

- Even with limited data and knowledge, results can be obtained which support the farmer’s decision-making process. When uncertainties are made explicit, farmers can then make less-risky decisions by taking these uncertainties into account.

- Providing access to decision support through an SDSS, such as CaNaSTA, ensures that trial data and expert knowledge previously inaccessible to farmers are made available so that decision taken are better informed.

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