

## CaNaSTA – Crop Niche Selection for Tropical Agriculture, a spatial decision support system

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**Introduction** Farmers in the developing world frequently find themselves in uncertain and risky environments, often having to make decisions based on very little information. Risks for smallholder farmers are often critical because of their poverty. In addition, in the tropics and subtropics, the natural environment is spatially and temporally variable and often harsh, thereby increasing the uncertainty faced by these farmers. This research aims to improve forage adoption decisions in the developing world, thereby increasing sustainable intensification and ultimately contributing to increased sustainable world food production and the alleviation of under-nutrition.

**Spatial Decision Support System** Decision support can facilitate the decision process by making available relevant data and knowledge. Spatial Decision Support Systems (SDSS) work with explicitly spatial data, and outputs usually include maps. An SDSS has been developed called CaNaSTA (Crop Niche Selection for Tropical Agriculture). The engine of the tool is Bayesian probability modelling. Six main criteria were identified for model selection. These are 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.

**Probability calculations** CaNaSTA calculates probability distributions for each forage species under specific sets of environmental conditions. These are related to predictor variables using Bayesian probability modelling techniques, with data drawn from forage trials and expert knowledge, including the forage knowledge base SoFT (Pengelly *et al.*, 2005). Probability of adaptation is classified as 'excellent', 'good', 'adequate' or 'poor', based on data in an existing forage database (Barco *et al.*, 2002). The predictor variables used are elevation, annual rainfall, length of dry season, soil pH, soil texture and soil fertility. Model outputs include a score value based on the probability distribution and a certainty value associated with the distribution. Stability measures are derived from changes in distribution when variables change states. From these, a ranked list of recommended species is calculated, along with suitability maps.

**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. Firstly, species are not automatically excluded when one variable is unsuitable, as all other variables may be highly suitable. Secondly, 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. Finally, 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.

**Conclusions** Incorporating spatial capabilities into an agricultural DSS, as in CaNaSTA, 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, 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 the information is delivered in a consistent and robust manner. Trial data and expert knowledge previously inaccessible to farmers are made available so that decisions taken are better informed.

### References

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