From *Ag*Climate to *Agro*Climate:
Case study of transition from research to operation

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Background

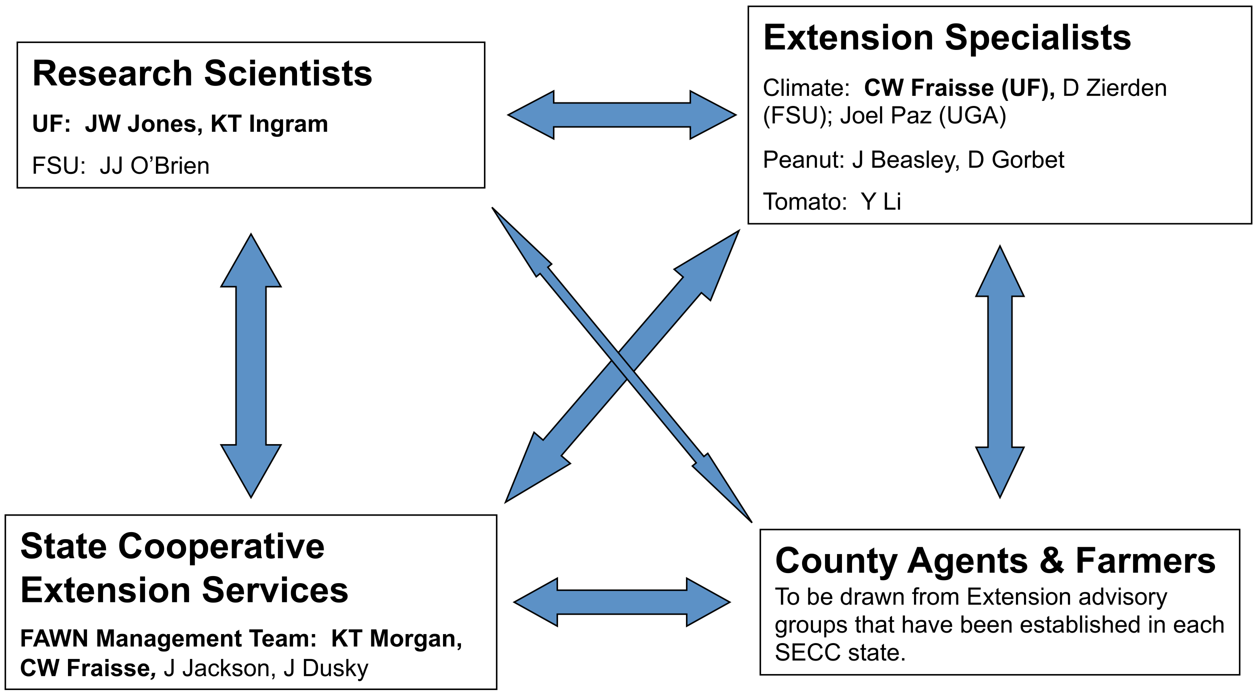
The Southeast Climate Consortium (SECC) developed a climate information system for the southeastern USA called *Ag*Climate, which was launched as a prototype in the fall of 2004 (Fraisse et al., 2008). This internet-based system was designed to disseminate climate forecasts and other climate information, together with decision support tools for agriculture and forest management. This system also includes provision of educational material and training programs to help stakeholders understand and use this technology effectively in their decision making process. The central hypothesis of this project was that improved access to relevant climate and weather information would enable agricultural resource managers to make better decisions at county and regional scales, to better manage risks leading to reduced insurance payments for crop losses, thereby contributing to an improved quality of life.

In late 2007, we began efforts to provide improved access to climate and weather information through the transfer of the prototype *Ag*Climate to an operational information delivery and decision support system under the Florida Cooperative Extension Services. While our long-range vision is to have *Agro*Climate mirror sites in each of the SECC states, with cooperation among the states to maintain databases and update forecasts, we have begun the transition with Florida. More specifically, we have made the transition of *Ag*Climate from a prototype decision support system under the control of the SECC, to *Agro*Climate, an operational system managed by the Florida Cooperative Extension Services. This paper gives a brief description of this transition effort and the lessons that we learned through the process.

Changing paradigm for the relationship between research and extension

The tripartite mission of the land-grant university system includes research, teaching, and extension. Ideally, the three mission areas work in concert to provide new technologies, an educated agricultural work force that is able to use the new technologies, and a system for extending new technologies for implementation on the farm. Historically, the three mission areas have been dominated by research, with mostly one-way communication from research to teaching and extension. This system worked well for the development of new varieties and crop management practices through the first 6 or 7 decades of the 20th century, but as agricultural systems and the problems they faced became more complex, it became clear that research and extension needed to work in partnership and that end-users needed to participate in the entire process, from research to extension and application (Breuer et al., 2009).

The traditional linear approach in agricultural research and development, which assumes that research scientists provide new technologies to extension specialists, who in turn would test and transfer the new technology to extension agents, who in turn disseminate new technology to farmers. Instead, we tried to create avenues of communication among all of these elements as shown in the diagram below. Participation of both the operational boundary organization, namely extension services, and the end users, including farmers and forest managers, is essential to a successful transition from research to operations.



Original project organization. Names in bold type face are included as investigators in this project, many others interact with this group through various SECC projects and activities

Methods for engaging stakeholders

We used a variety of methods to involve stakeholders, including end users and the operational boundary organization, in the research and development process (eg. Breuer et al., 2008, 2010a, b, c; Crane et al., 2008, 2010; Furman et al., 2009). These methods included:

1) Stakeholder surveys, interviews, and focus groups to both assess stakeholder information needs and to get their feedback on SECC products. Needs assessments focused on such issues as when and what kinds of decisions the stakeholders make, what information do they currently use and what are their sources, and how might they use climate information. Initial interviews relied heavily on *sondeo* techniques, which are purposive conversations between stakeholders and multidisciplinary assessment team members. *Sondeos* were particularly valuable for needs assessments to better understand.

2) Workshops and training programs that provide two-direction information exchange such that farmers and extension agents would give feedback to research scientists and extension specialists, whereas researchers and extension specialists introduce farmers and extension agents to information about climate, its predictability, and is potential applications.
3) Establishment of advisory groups and working groups that included farmers and extension agents and farmers who met with SECC researchers and extension specialists 3 to 4 times per year to review our progress and to provide guidance on product development. Such groups have been among the most successful activities, but they require all involved to commit time and energy.
4) Displays at farmer and extension meetings. These events were allowed us to provide information to relatively large numbers of people, but they were probably the least ineffective method for engaging stakeholders and getting them interested in using climate information.

Role of social sciences

Throughout the transition process, social scientists played a crucial role in working with extension agents and farmers to evaluate *Agro*Climate and to facilitate engagement of stakeholders with research and extension specialists (e.g. Breuer et al., 2008, 2010a, 2010b, 2010c; Crane et al., 2008, 2010; Furman et al., 2009). Anthropologists and sociologists led our efforts in stakeholder assessment to discover how stakeholders might use seasonal climate forecasts and other information. Once we had released the prototype web site, they participated in workshop designed to teach extension agents and farmers how to use the information and use that opportunity to get feedback from farmers to help guide improvements in existing tools and information and to identify needs for new tools. In addition to working with the physical and biological scientist that developed tools and information for the web site, social scientists also regularly meet with the SECC team of extension specialists and state climatologists who were responsible for development and dissemination of the product. Through their participation throughout the research and development process, the social scientists played a strong role in shaping both the messages and the means of conveying the messages of *Agro*Climate.

Through working with farmers and extension agents, SECC social scientists identified many needs that *Agro*Climate was able to accommodate. Initially, *Agro*Climate tools emphasized information on climate risks to the major crops in the region through the combined use of crop simulation models and historical climate data to show the effects of El Niño Southern Oscillation (ENSO) phase on crop yields. Farmers and extension agents requested several analyses that showed historical yields sorted by ENSO phase, which has been added to *Agro*Climate. They requested tools for forecasting growing degree days, chilling units, and disease susceptibility, all of which have been added to *Agro*Climate. They requested outlooks for climate and agriculture, which are prepared and added to *Agro*Climate at least quarterly and more often if conditions change. The climate outlooks are developed by all State Climatologists in the SECC. The agricultural outlooks are developed collaboratively by the climate extension specialists and commodity extension specialists. In addition to posting these outlooks on *Agro*Climate, these products are distributed by e-mail to all extension agents in the region so that they can then add information from the outlooks to their own newsletters.

Technical and personnel needs for transition

As mentioned above, an important element of the successful transition of *Agro*Climate to the Florida Extension Services was a high level of trust and commitment on both sides of that transfer. This commitment included support to personnel, equipment, and training.

Through the course of the transition, research grants initially covered part of the salary for a web designer and extension specialist. At the end of the transition, these positions are paid by state funds through Extension Services. Moreover, based on success of *Agro*Climate, the Extension Services has formed a new Climate Variability and Change Team, in their statewide environment focus area. This team includes about 15 county agents as well as the state climatologist, climate extension specialist, and sea grant climate extension specialist. Thus the Extension Service personnel commitment to climate variability and change is an order of magnitude greater than the support that was originally provided through research grants.

Transfer of equipment was another important aspect of the transition. Initially, research funds were used to purchase and maintain two web servers and associated software – one server for holding *Agro*Climate databases and one for the *Agro*Climate tools. Because we wanted to facilitate database sharing between *Agro*Climate and the Florida Automate Weather Network (FAWN), they were invited to share the *Agro*Climate servers. *Agro*Climate is still housed in these servers, which are now hosted by Extension Services. While we anticipate that *Agro*Climate and FAWN will outgrow these servers, Extension Services has also established sufficient web support that they can provide new equipment if needed.

Sustaining transition

A successful transition does not end the relationship between research and extension. The research and extension commitments to partnership remain essential. There is a continuing need for research to update databases, to provide new information and tools in response to changing stakeholder needs, and to provide educational programs for extension agents and other users. In order to improve the sustainability of *Agro*Climate, we have undertaken new research to for automation and open source product development.

Automation

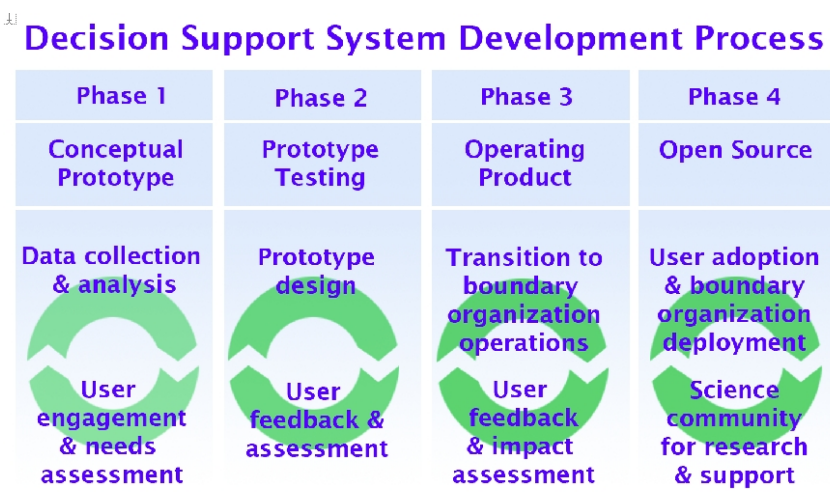
Because databases need regular updates, we have begun to develop systems to automate this process. Such automation is not trivial – it involves quality checking new data, filling data gaps, running simulation models with new data, and updating the probabilistic tools. Automation becomes more important as we have recently developed new tools that use daily data from automatic weather stations to update some of our products weekly or daily, such as the Lawn and Garden Moisture Index (LGMI) forecast, the Agricultural Reference Index for Drought (ARID), and the Strawberry Disease Risk Index (SDRI).

Open source

With the objective to enhance the sustainability of *Agro*Climate and to facilitate its adoption in other regions, we have begun the development of an open-source version of *Agro*Climate (Pavan et al., 2009). This effort includes the development of processes, procedures, and documentation needed to create a web-based open-source version of *Agro*Climate, that will help ensure that this system continues to evolve to meet the ever-changing needs for climate-based crop risk management that it is freely available for others to implement in other states and countries [http://open.agroclimate.org/s/]. The SECC has received requests from several other states outside our region to adapt *Agro*Climate for their states, as well as from research and outreach specialists in other countries. Although it is possible to develop bilateral implementation projects for each interested location, this approach would be logistically impractical. The open-source system approach is a proven method in other systems and has demonstrated its ability to help ensure the sustainability of the software and its relevance as new knowledge is gained. In addition to SECC members, current volunteer members of that participate in development of Open*Agro*Climate include researchers from the states of Arizona, Michigan, and Mississippi, and countries of Australia, Brazil, and Canada. All new *Agro*Climate tools are being developed in an open-source environment.

Process in retrospect

Looking back at the process of transition from the *Ag*Climate prototype to an operational *Agro*Climate, we have revised our original project diagram (above) to better describe the process that we discovered to be most effective is shown in the diagram below. The SECC approach to development of a decision support system has four phases, with user and boundary organization engagement or participation throughout. While the science community may initiate and motivate the first two phases, leadership is transferred to an appropriate boundary organization in phase three. By the end of the fourth phase, the appropriate boundary organization leads the effort with support from the science community. In other words, the SECC used a co-development process with Extension as a boundary organization that facilitated end-user participation to create the decision support system that we call *Agro*Climate. Co-development is a participatory, iterative, and multi-feedback process in which needs, ideas, suggestions, perspectives, and discussion lead to product improvement so to improve relevance and utility for the target clientele



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