The UW - Madison College of Agricultural and Life Sciences

An Update for the Legislature

June 7, 1995

achieved plan 1 yr. earlier to downsize ($3 million deficit ?)

CALS is 8% smaller than 1½ to 2 yrs. ago

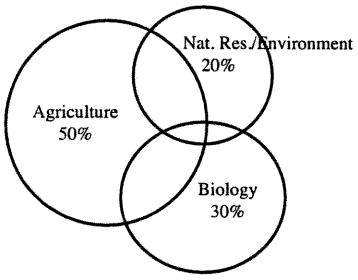
- $ 950,000 from this budget
- 400,000 carried over

100 faculty less than in mid-80's

relatively small resource supporting ag in WI + its shrinking + a large # of students compared to other states (MI State + Minn.)

Programs and Effort

Agriculture and Much More !



National Status

- Considered the premier land - grant College
- Outstanding Faculty
  - More members of the N A of Science
  - Presidential Medal of Science Winner
  - Hughes fellows
  - #1 in Grants from USDA
- All Departments rank in Top 10
- Tops in Scientific impact
- 75% of WARF income from CALS patents

Understanding Biological Principles

- Foundation for Biotechnology
- Contributes to human health and nutrition
- Protect environment and wise management of natural resources
- Reduce risk and enhance agricultural productivity

Sustaining the Resource Base

- Key Elements in College
  - Biology / Agriculture
  - Environment/Natural Resources
  - Socio/Economic Sciences
- Waste Management
  - Farm/Animal
  - Processing/municipal
  - Clean-up / Remediation

Sustaining the Resource Base

- Water Quality
  - Integrated Pest Management
  - Nutrient Control
- Agriculture and the Urban Fringe
  - Land Use

Agriculture & Agribusiness Management

- High Need Area
- Reallocation to Dairy Profitability Center
- Master's in Ag Business Planned
- International Opportunities/Challenges
- Public Policy Analysis (dairy)
- New Product, Uses, Markets
  - Center for Dairy Research

Animal Agriculture & Dairying

- Stress and Transition
- Interdisciplinary, Integrated Efforts Launched
- Challenged by -
  - Environmental Issues
  - Government Marketing policies
  - Processing Infrastructure Aging or Gone
  - Changing Consumer Demands
- Interstate Cooperation

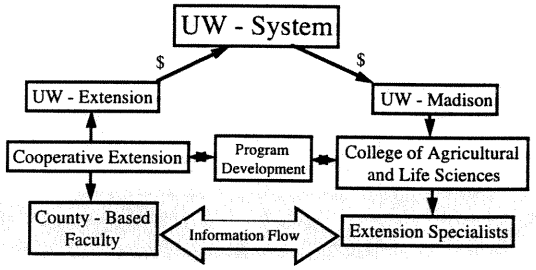
Rural Community Vitality

- National Extension Center for Rural Development
- Applied Population Laboratory
- Geographic Information Systems
- Top Economic and Rural Sociology Depts.
- Strong Extension Network at County Level
- New Links to Dept. of Development

Instructional Program Outlook

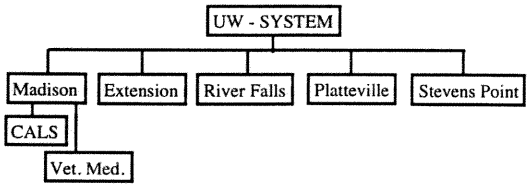
- Enrollment
  - 2,200 Undergrads -- up from 1980's decline
  - 100 Short Course -- New Training Initiatives
  - 1,200 Graduate Students
- Reputation for Supportive Undergraduate Programs
  - Increased faculty and dept. incentives
- Core Curricula
- UW System and Interstate Cooperation

CALS Linked To Extension



CALS In UW - System

The Agriculture and Natural Resources Consortium



Sources of Funding

- See handout
- Approx. $115 million total
- Highly leveraged state dollars (2.5 :1 in research)
- Good mix (state, federal, private industry, commodity groups, foundations)

The State Budget is a Moving Target

- **$ 3 million deficit**
- **1% across the board imposed - 1993**
- **DIN dies - 1994**
- **1.25% Recession - 1994**
- **FY 95 - 97 Budget - At least 3%**

!@#&

Budget Reality, July 1995

Category	Change	Amount
Deficit reduction to date	**8%**	
$3.0M		
FY 95 - 97		
Deficit carryover		**$0.4M**
Legislative Budget Reduction		**$0.958M**

Future

Insufficient non - salary funds to support programs

Redirection Actions

- Reduced faculty, staff, and administration by 75 FTE's
- Closed out Construction Admin. and Ag Mech and Mgt.
- Merging Landscape Architecture
- Closed Continuing and Vocational Education
  - Intercollege Degree in Science Education with Ag option developing

Redirection Actions, con't

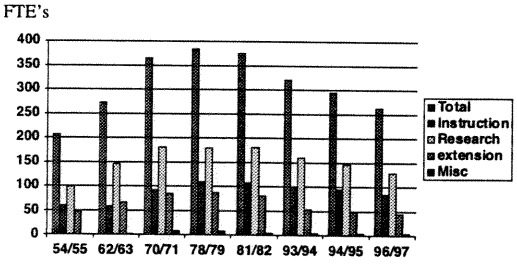
- Merging Meat and Animal Sciences and Poultry Science
  - Regional Center Of Excellence in Avian Sciences
- Dropped low enrollment majors
- Spooner and Ashland Stations Given New Missions (Sold Dairy herd)
- Developing Interdepartmental Programming

Redirection Actions, continued

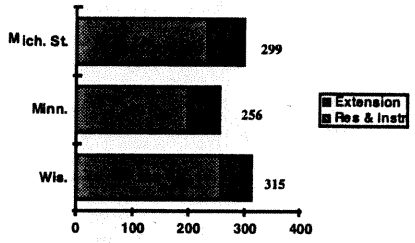
- Refocusing departments and programs
  - Agriculture Journalism
  - Agriculture Engineering
- Two Centers Are Identified for Termination -- Efforts Incorporated Elsewhere
- New budget management policies being implemented
- Expanded Center for Dairy Profitability

Trend in Faculty FTE's

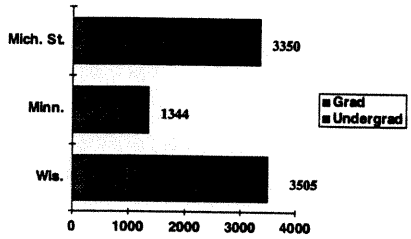
Approaching a minimum critical mass !



Faculty (full time positions)



Total Enrollment



Response to Budget

- Downsize by attrition
- Reallocate to priorities
- Seek new sources of funding
- Eliminate programs
- Propose opportunities for state reinvestment

Situation Critical

- Significant reduction in capacity
  - Fewer faculty and staff
  - More time spent in acquiring resources
- Excellence is in serious jeopardy

The Future

- Agriculture
  - Environmental impact
  - Profitability: Business mgt
  - Markets & new uses
  - Rural community development
- Biology
  - Basic science
  - Stronger links to application
- Natural resources
  - Sustainable management
  - Minimize human impact

Our plan

- Great Science
  - Discovery of new knowledge training the next generation of scientists
  - Problem solving research
- Quality undergraduate education
  - Fewer majors and more interdepartmental
  - Strong research linkage
- Responsive to stakeholders
- Neutral forum for public policy debate

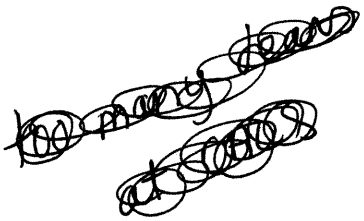
Al - Kim
DuWayne
John - Jacque
Rick
Carol
Scott G.
David
Plombon
Dueholm
Wilder
? Wirch
Bobbi
Luther
Cliff
Zukowski
Baumgart
Springer
Reynolds
Sheryl
Hutch
Hasenohrl
'22) Boyle

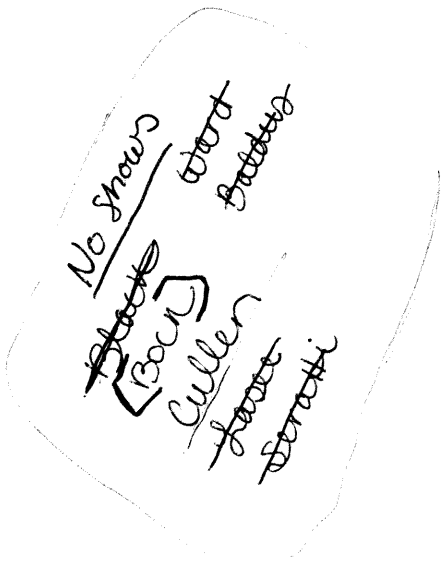
Sheila
Stude
Padronski
Paul Zimmerman - Farm Bureau
Ron Statz - Farmers Union (?)
Dr. Howard

+ others

Julie Aulick - DOJ

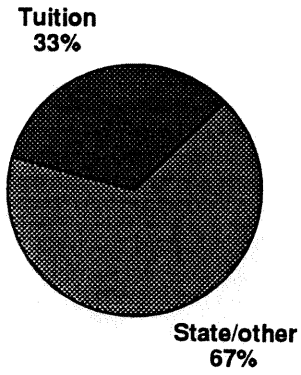
get key from Al



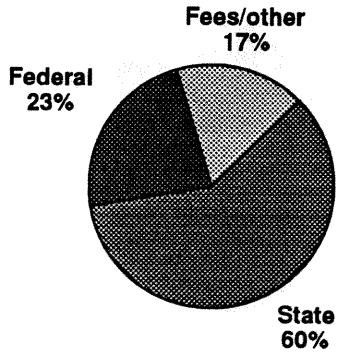


Bock
Cullen

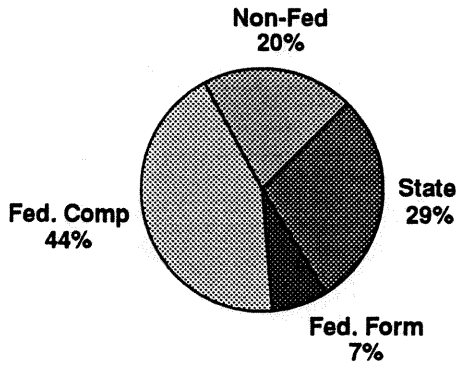
CALS Instruction Funding Sources 1994



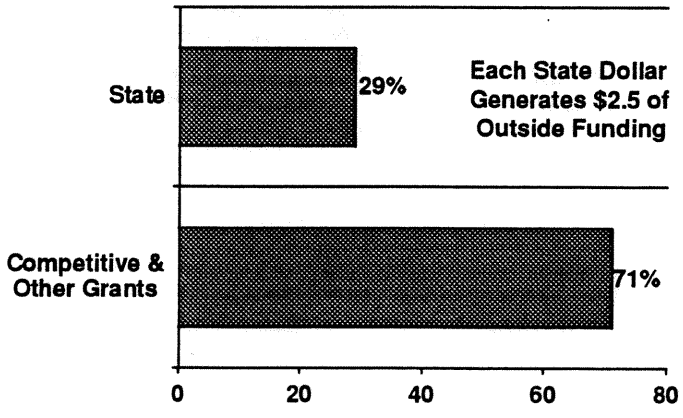
CALS Extension/Outreach Funding Sources 1994



CALS Research Funding Sources 1994



State Contribution to CALS 1994 Research Funding



COLLEGE OF AGRICULTURAL AND LIFE SCIENCES

Centers, Institutes, Programs*
June 7, 1995

DAIRY

Babcock Institute
- Established in 1992-93 with a special grant from USDA

)

Center for Dairy Profitability
- Established in 1985 by the Wisconsin Dairy Task Force as an inter-university (UWEX, CALS, UW-Platteville, UW-River Falls) unit

Center for Dairy Research
- Established in 1986 following a 1983 federal check-off policy of $.15 per cwt

DAIRY/ENVIRONMENT

Agricultural Technology and Family Farm Institute
- Established in 1990 in accordance with Senate Bill 344
- Appointed Advisory Board

Center for Integrated Agricultural Systems
- Established in 1989 through Legislative Initiative

ENVIRONMENT

Environmental Resources Center
- Established in the late 60s as an extension unit

Environmental Toxicology Center

- Established in 1971 by UW-Madison faculty initiative as an inter-college unit (CALS, Schools of Medicine, Pharmacy and Veterinary Medicine)

Integrated Pest Management Program

- Established in 1979 under a USDA-CES grant
- Funding Sources:

Nutrient and Pest Management

- Established as part of the Center for Integrated Agricultural Systems

Small Scale Waste Management Project

- Established in 1971 by the Wisconsin State Legislature
- Funding Sources:

RURAL DEVELOPMENT

Applied Population Laboratory

- Established in the 1960s through faculty initiative (Doug Marshall)
- In 1994/95 experienced major downsizing

Center for Community Economic Development or Center for Community Economics

- Established in July, 1990

FOOD

Aquaculture Program

- In operation since the late 1970s. Designated to implement the State Plan on aquaculture in 1989 by Assembly Joint Resolution 104
-

Food Research Institute

- Established as a University - Industry Consortium

MISCELLANEOUS

Agricultural Safety and Health

Center for Biology Education

- Established in July, 1989 through inter-college UW-Madison faculty initiative and with the aid of a grant from the Howard Hughes Medical Institute

University Center for Cooperatives

- Established in 1962 by federal initiative (International Cooperative Development). In early 70s moved to a domestic agenda.

Land Information and Computer Graphics Facility

- Established in 1982 as an inter-college unit

Land Tenure Center

- Established in 1962 through UW-Madison faculty initiative

FUNDING SOURCE SUMMARY:

State Funds: $2,670,324 Non-state Funds: $5,100,248

Extension $941,000

federally funded

Integrated Pest Management

WISDOM

An integrated computer program for crop and pest management

Minimum System Requirements

PC using a 386 processor (Pentium or fast 486 recommended)

Microsoft Windows 3.x

6 megs RAM (8 or more megs recommended)

14 megs hard drive space available

VGA monitor (SVGA with 256 colors or more recommended)

CD-ROM drive is optional

From Wisconsin's Integrated Pest Management program

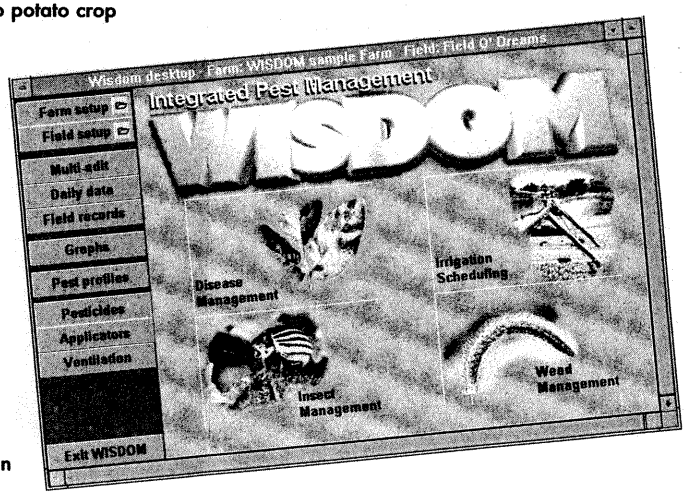
University of Wisconsin-Extension
Cooperative Extension

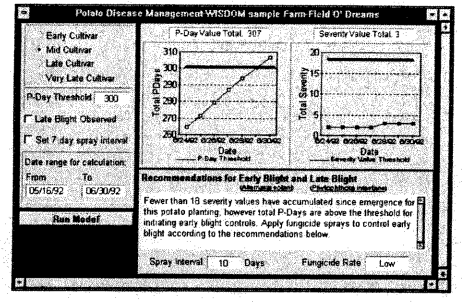
University of Wisconsin
College of Agricultural and Life Sciences

WISDOM is an integrated computer program that helps to organize many of the crop management decisions made by growers on a daily basis. Use of the program may improve profitability and reduce the environmental impact associated with intensive crop production.

WISDOM represents the latest ideas in an integrated systems approach for crop management developed by Wisconsin's Integrated Pest Management project and University of Wisconsin-Extension specialists.

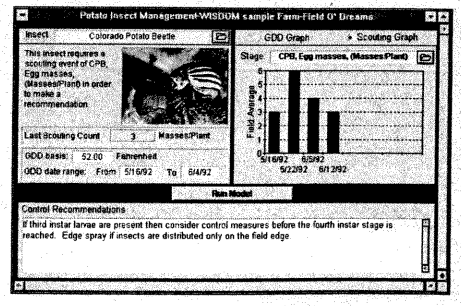
WISDOM version 1.0 consists of several program modules related to potato crop production. Daily data on environmental and crop conditions are input by the grower and analyzed by WISDOM's predictive models. Recommendations are then displayed for optimal pest and crop management. These models are included in the four main program modules: Disease Management, Insect Management, Irrigation Scheduling, and Weed Management. Other modules included in this version of **WISDOM** can be used for record keeping of field events, record keeping of pesticide and applicator information, potato storage ventilation calculation, and graphing of certain field data to spot trends and analyze data. Also included is an extensive database called Plant Pests Profiles detailing pest life cycles and control recommendations. Digitized color photos are displayed to help with pest identification.



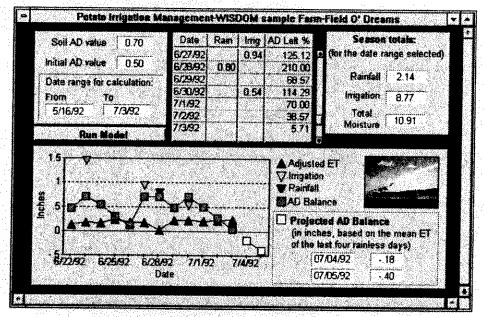


- The Disease Management module warns growers of the potential for early and late blight development and recommends scheduling and rates of fungicide applications. This information helps improve disease control and reduce unnecessary fungicide sprays.

- The Insect Management module records Growing Degree Days on user-defined thresholds for prediction of insect and crop phenology. Scouting records entered into the Field Records database are accessed and graphed when appropriate and are then used as the basis for control recommendations. This assists in the timing of control measures for improved efficiency.

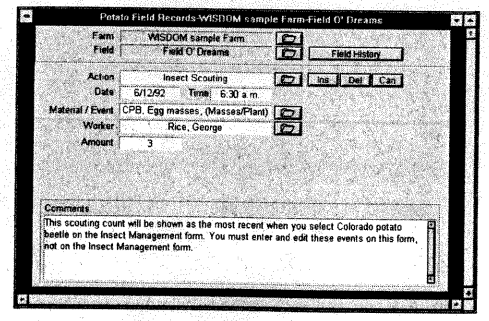


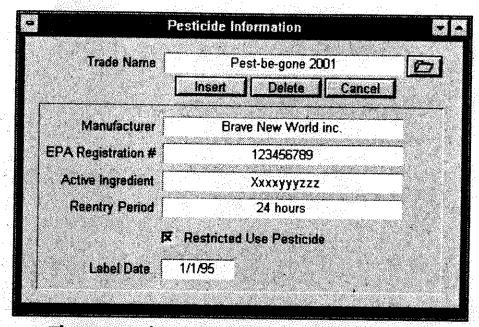
- The Irrigation Scheduling module monitors and projects soil Allowable Depletion to optimize the use of valuable water resources. This lowers irrigation costs as well as reducing the potential for leaching of nitrates and pesticides into the groundwater.



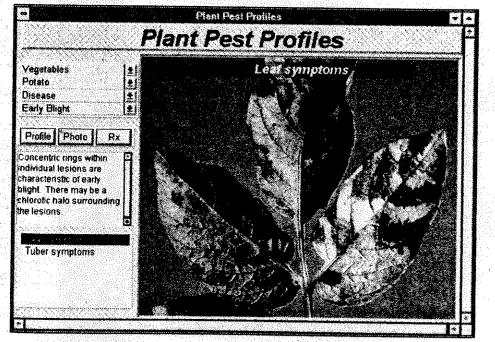
- The Weed Management module, based on potato crop emergence prediction, assists growers in better timing of pre-emergence herbicide applications and aids in management of time and equipment.

- Field Records database is used to enter and record data about pest scouting events and chemical applications actions.





The Pesticides Information database records detailed information on the pesticides you use, and provides ways to print out reports. The Pesticide Applicator database allows you to maintain records on pesticide applicators for regulatory compliance.



- Pest profiles database displays information and pictures of plant pests to help you identify and control them. If you have a CD-ROM drive, you can request the CD version of the database, which includes over 100 digitized color images to aid with pest identification. The CD-ROM version also inludes pest profiles for sweet corn, snap beans, and peas.

IPM software, 1575 Linden Drive, Madison, Wisconsin, 53706, (608)262-8332 or 262-0170

WISDOM version 1.0

Order form / price list

April '95

New users:

Wisconsin Growers	$250
Out-of-state Growers	$500
University / Public schools	$200

Upgrades from PCM software:

Wisconsin Growers	$100
Out-of-state Growers	$250
University / Public schools	$100

Name:

Title:

Company:

Address:

phone:

fax:

quauntity: amount: $

Please make your check payable to:
UW - Horticulture Department

Mail to:
IPM software
UW-Horticulture Department
1575 Linden Drive
Madison, WI 53706

Reprints from HortTech, Vol. 4(4), October/December 1994
A Publication of the American Society for Horticultural Science, Alexandria, VA 22314

Wisconsin's IPM Program for Potato: The Developmental Process

W.R. Stevenson[1], D. Curwen[2], K.A. Kelling[3], J.A. Wyman[4], L.K. Binning[2], and T.R. Connell[2]

Additional index words. *Solanum tuberosum*, computer software, IPM team, systems research

Summary. The Wisconsin potato crop is managed intensively through multiple inputs of pesticide, fertilizer, and irrigation. Beginning in 1979, a multidisciplinary team at the Univ. of Wisconsin developed an effective Integrated Pest Management Program to address key management decisions associated with this crop. The program fostered the development of several private IPM businesses and continues to help increase the acceptance of IPM technology by the potato industry. Results of component and integrative research, funded by industry, state, and federal sources, provided the essential ingredients for development of computer software now used for managing the potato crop on ≈70,000 acres (28,330 ha) of potatoes in a multistate area. The software helps growers determine the need for and timing of critical crop inputs. By reducing or eliminating unneeded pesticide and irrigation applications, the software helps to improve overall production efficiency. Industry adoption of this software is providing the impetus for development of more comprehensive software that includes additional aspects of potato production as well as the production of crops grown in rotation with potato.

Depending on the year, Wisconsin ranks fourth or fifth nationally in the production of potatoes for processing, fresh, and certified seed markets. Potatoes are a key component of the state's diverse agricultural economy, with a value of $120 million produced on 68,000 acres (Pratt, 1993). This importance to Wisconsin's agriculture is reflected in research and extension support by the Univ. of Wisconsin (UW) and its College of Agricultural and Life Sciences (CALS).

A team of faculty with research and extension assignments at the Univ. of Wisconsin has engaged in an intensive pest and crop management project with the potato crop since 1979 (Shields et al., 1984). This team has achieved significant progress toward integrating disciplinary research findings into a cohesive and comprehensive management program for the potato crop and the broader farming enterprise that includes crops commonly grown in rotation with potatoes. Wisconsin growers have responded by adopting some, if not all, of the components of this program.

The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked advertisement *solely to indicate this fact.*

University of Wisconsin, Madison, WI 53706.

[1]*Dept. of Plant Pathology.*

[2]*Dept. of Horticulture.*

[3]*Dept. of Soil Science.*

[4]*Dept. of Entomology.*

Development of Potato IPM in Wisconsin

The Univ. of Wisconsin–Madison College of Agricultural and Life Sciences has a strong tradition of providing solutions to agricultural problems through a blend of basic and applied research. Coupled with the "Wisconsin Idea" philosophy that the boundaries of the university are the boundaries of the state, the results of agricultural research and new ideas quickly find their way to the farms and communities throughout our state. All too often, however, results of focused single-discipline (i.e., component research) projects are provided to rural audiences without a clear understanding of how this information interacts with other parts of the whole farming enterprise. The integration of this information with site-specific production systems then is left to the clientele, often on a trial-and-error basis. Some of the most focused solutions to long-standing problems fail when attempts are made by clientele to integrate this information with existing practices. In some instances, focused remedies that excel in small field plots actually may have a deleterious effect on other parts of the system.

The UW IPM Program was initiated in 1979 with the assistance of USDA 3d Special Program Funds in response to grower requests for in-depth training in pest and crop management strategies. The Wisconsin IPM program built upon the existing breadth and strength of agricultural programs at UW–CALS and delivered this fundamental information to the producers using a hands-on and demonstration approach.

The potato was one of the crops receiving early attention in this statewide program. In some respects, this was an ideal choice because: 1) growers traditionally have been progressive and very interested in IPM tactics; 2) the crop is managed intensively with multiple inputs of pesticide, fertilizer, and irrigation; 3) potato is a high-value/high-risk crop; 4) the crop often is grown in environmentally sensitive areas; and 5) historically there has been a strong potato research base at the UW. Intensive research and extension activities have helped to build a strong interdisciplinary team of faculty as well as foster a spirit of cooperation between growers and university personnel. After 3 years of building a program that involved a system of intensive crop and pest scouting combined with regional and in-field weather monitoring, the field scouting aspects of the program were turned over to private enterprise in 1983. At least six private businesses that specialize in IPM programs dealing with potatoes have evolved and continue to prosper. Recent surveys of the Wisconsin potato growers indicate that 97% of Wisconsin's growers rely on field scouting to make management decisions, and 46% now hire an IPM consultant. The interdisciplinary team has continued to work closely with the consultants and growers to provide program refinements based on practical inputs from the field.

One important aspect of the Wisconsin IPM program has been the development of specialized computer software to assist growers and consultants in crop and pest management decisions. Initial software development included the PDM (Potato Disease Management) and WISP (Wisconsin Irrigation Scheduling) programs. Both of these programs then were incorporated into an expanded Potato Crop Management (PCM) program (Stevenson et al., 1989). This more sophisticated software now includes modules for predicting and controlling disease, scheduling irrigation, predicting crop emergence, predicting development and managing harmful insects, and ventilating stored potatoes. Growers and IPM consultants hired by growers report software use on ≈40,000 (16,188 ha) of Wisconsin's 68,000 acres (27,519 ha) of potatoes. Program use also has expanded to neighboring states, where growers report using the software on an additional 30,000 acres (12,141 ha). The software saves growers about $20 per acre (Connell et al., 1991) by eliminating two to three fungicide sprays for foliar disease control when weather conditions and crop susceptibility do not favor disease development. Estimated savings related to disease control for Midwestern potato growers exceed $1.4 million per year. Additional savings from software use include reducing rates and improving the timing of herbicide applications, reducing insecticide treatment by targeting vulnerable life stages of economically damaging insects, and reducing irrigation inputs by 10% to 15% by matching irrigation inputs to crop demand. Field research has demonstrated that additional savings may be possible when growers use all components of the software fully. Growers and consultants who have used the software for several years appear to achieve the greatest savings.

Grower acceptance of PCM has fostered the ongoing development of additional PCM modules covering areas such as record-keeping, fertility management, seedpiece decay, crop canopy development, storage management, and marketing. These developments are backed by extensive field and laboratory research prior to incorporation into PCM.

A promising area of IPM field research now focuses on how to manage better crops such as sweet corn, snap beans, sorghum sudan, and red clover, which are likely to be

"Grower acceptance of PCM has fostered the ongoing development of additional PCM modules..."

"Use of crop management software has been an effective tool for broadening the adoption of IPM technology."

grown in rotation with potatoes. One goal of this research is to understand better how rotational crops affect management of pest problems associated with the potato crop and vice versa. This research will permit the expansion of the current PCM software to include components for selection and management of rotational crops. We anticipate that this will broaden the adoption and use of integrated crop management software in farming enterprises in Wisconsin. In a state with an extensive potato and processing vegetable industry, expansion of the PCM software to include these additional crops is essential to the long-term sustainability of vegetable production systems. The addition of a rural sociologist to the research and extension team is expected to help identify potential barriers to adoption of new technology. This new information will be especially helpful as focus shifts from a single crop to multicrop systems requiring multiple inputs from growers and field personnel employed by vegetable processors.

The Wisconsin IPM program and focused potato IPM initiatives have attracted state, regional, and national attention. Producers in several potato production areas of the United States now successfully use the PCM software. In addition, cooperative research projects focusing on local adaptation of this software are underway in Oregon and North Dakota. Additional projects to evaluate this IPM software are being discussed with two Canadian provinces.

Use of crop management software has been an effective tool for broadening the adoption of IPM technology. Many of the early goals of the Wisconsin IPM program have been achieved by using computer technology and software on the farm.

Keys to program success

Creating the team. Dave Curwen was hired in 1963 as a regional vegetable crop specialist and focuses his attention on cultivar evaluation, row spacing, irrigation management, and crop storage. Larry Binning was hired in 1969 to provide leadership in chemical and cultural weed control. Keith Kelling was hired in 1977 to serve as soil fertility specialist. Jeff Wyman was hired in 1979 to assume extension/research responsibilities in vegetable crop entomology. He had served in a similar capacity at Univ. of California, Riverside, from 1973 to 1979 with focus on integrated pest management of vegetable insects. Walt Stevenson also arrived in 1979 to assume extension/research responsibilities for diseases affecting vegetable crops. He had served in a similar capacity at Purdue Univ. since 1972, where he gained a working familiarity with computer technology and its promise for rapid delivery of research and extension information. Thus, an experienced team was assembled with a mandate to focus on vegetable crop management at a time when IPM implementation was recognized as essential to continuing agricultural profitability and sustainability. The formation of the team also coincided with a generational change in vegetable farm managers, providing a knowledgeable and progressive grower clientele to assist the team in development and implementation of IPM technology. Each team member came from a sufficiently diverse background that they complemented one another without undue overlap. By 1979, all were recognized authorities in their respective fields and had a general hands-on knowledge of crop production practices. Each member brought specialized expertise to the team, and this expertise was recognized and widely used by the Wisconsin potato and vegetable industry. Appointments were split between extension and research, ensuring that team members were involved in extensive field and laboratory research programs (component research) that were closely tied to their extension programs. Combined research/extension responsibilities enabled the team to spend considerable time together in travel, discussion, planning, and meetings. All members were comfortable working as a team and were willing to share team responsibilities along with any credit or criticism directed to the team. It should also be noted that the team approach to programming and problem-solving is inherent to the Wisconsin Cooperative Extension Service and its subprogram committee structure.

USDA/UW–CALS/UW–Extension funding. Funding for statewide extension programming in integrated pest management first became available to Wisconsin in 1979. These formula funds were critical in focusing programming efforts in IPM and in assembling an effective plan for multidisciplinary programs. While specialists from several disciplines traditionally had participated in grower meetings and field days, the approaches taken generally were not multidisciplinary or integrated. For the first time, funds were available to encourage specialists to begin thinking as an extension team rather than as disciplinary extension specialists. These funds were also critical in developing computer literacy within the IPM team. The need to develop multiple expertise within the framework of a single computer-based system was very beneficial in achieving overall program integration. The USDA–Extension funding arrived at a critical juncture in team development and this funding continues to support IPM efforts.

Extension funding was used to hire program specialists at the Master of Science (MS) level along with computer programmers. The program specialists worked closely with the faculty IPM team and focused their attention on developing specialized IPM programs for targeted commodities, including potatoes. The hiring of computer programmers was an essential early component of the IPM program in developing one of the major delivery mechanisms of IPM information. By permitting the IPM team to make these hires, UW–CALS and UW–Extension administration gave the team a vote of confidence and a chance to develop a coordinated and multidisciplinary IPM program. In retrospect, this helped to gel a group of individuals from several departments into a team willing to commit time and energy to IPM research and extension programming. UW–Extension administration continues to provide programmatic support of IPM activities.

For successful implementation in the commercial production arena, integrated programs such as PCM must be based on a solid and carefully constructed foundation within each of the individual disciplines involved in production. Disciplinary research has generated individual components of PCM, such as disease prediction (Pscheidt and Stevenson, 1986; Stevenson, 1993), insect modeling (Walgenbach and Wyman, 1984a), economic thresholds (Shields and Wyman, 1984; Walgenbach and Wyman, 1984b), weed development (Wiese and Binning, 1987), irrigation scheduling (Curwen and Massie, 1984), nutrient management (Kelling and Wolkowski, 1991; Kelling et al., 1992; Kelling and Wolkowski, 1992), and environmental impacts (Wyman et al., 1985). Without this research base, the integrated PCM software would not meet the essential needs of the production system. This essential phase of component research is long-term and ongoing, involving the efforts of graduate and undergraduate students and specialists. UW–CALS continues to support component and integrative research efforts through Hatch funding. Recent evaluation and planning efforts within UW–CALS have placed emphasis on programs that demonstrate linkages between disciplines and research areas. The potato IPM program has been identified as a effective model program. This recognition will be reflected in continued and potentially increased funding within the college.

USDA regional IPM project funding. Beginning in 1987, a series of research projects were submitted by the UW–Potato IPM Team to the USDA Regional IPM Program for review and funding. Funding for the first of these projects, conducted during 1987–1988, allowed the team to begin integrating the results of successful field research programs (component research) into a comprehensive management program. The product of this research was the development and release of the Potato Crop Management (PCM) software in 1989. The effectiveness of the integrated model was evaluated in large field plots at the Hancock Agricultural Research Station, located in central Wisconsin (integrative research). Somewhat surprisingly, this was the first time this team had worked together on such a large-scale research project. During the integrative research phase, advanced PhD students and postdoctoral trainees were hired to coordinate the large-scale field research trials and facilitate interdisciplinary cooperation. This hiring ensured steady progress of the project and allowed the team to focus on planning and evaluation activities. The team met regularly throughout the year to make management decisions regarding the research and the management of the potato crop. The team recognized the importance of integration and, through results achieved during the first 2-year year block of funding, began to refine a commercially acceptable system for potato crop management (Connell et al., 1991). This system was then evaluated and fine-tuned during a second 2-year cycle of funding (1989–90). Throughout this 4-year period, key growers were helpful in providing advice and direction. In some cases, this feedback led to additional component research, whereas in other cases grower experience helped to fine-tune further integrative research objectives and approaches.

In 1991, Wallendal Farm Supply, Inc., a highly successful potato and processing vegetable farm in central Wisconsin, offered the Potato IPM Team an opportunity to use a 25-acre field with irrigation for long-term field research studies. This was an opportunity to expand the research focus on potato to include several crops commonly grown in rotation with potato (sweet corn, snap beans, red clover, and sorghum–sudan). One of the key research objectives was to observe how rotational crops affected various aspects of potato production, including irrigation, fertility, and pest problems (diseases, plant parasitic nematodes, weeds, and insects). A companion objective was to observe how a potato crop affects management of the rotation crops in 2- and 3-year rotations. It is important to emphasize that funding from the USDA Regional IPM Program was an important catalyst for these expanded integrative studies. This funding came during a critical period and enabled the Potato IPM Team to maintain their focus and to expand their efforts. Funding provided by this program prompted additional support from the Wisconsin potato and vegetable industry and from individual growers.

"For successful implementation in the commercial production arena, integrated programs such as PCM must be based on a solid and carefully constructed foundation within each of the individual disciplines involved in production."

"A strong camaraderie has developed between the potato industry and university researchers/extension specialists... This association has fostered a team concept that includes grower interaction and a general attitude of partnership..."

More-recent funding from USDA CSRS/ES is providing information on the process of adoption of new technology by clientele. Peter Nowak, UW–Rural Sociology, is joining the potato IPM team and conducting a focused study on potential barriers that will affect the adoption of new IPM technology at both the farmer and vegetable processor levels. The information gained in this study hopefully will enhance future adoption of the technology developed by our IPM team.

Industry funding. Beginning in the mid-1970s, the Wisconsin Potato Industry began a checkoff program that contributed about $20,000 for research on production problems experienced by the industry. By the mid-1980s, the level of funding increased to $80,000 and, in 1993, funding reached $180,000. The Wisconsin Potato Industry Board designates a research committee to meet regularly with UW–CALS faculty to review the problems facing their industry and to encourage the preparation of research proposals addressing these problems. The research committee then reviews these proposals and recommends which proposals should be funded. While funding for a specific project rarely exceeds $15,000, this funding often serves as seed money to initiate new projects and to leverage additional funding from a wide array of funding sources. While growers normally fund problem-oriented disciplinary projects, they also have provided funding of critical importance in underpinning the interdisciplinary effort, such as maintenance of a statewide weather network and refinement of integrated software. Researchers report their findings to the industry research committee and to the industry as a whole during winter educational meetings.

A recent development in industry funding of potato research is the planning for a "potato excellence fund" consisting of a $1.25 million endowment provided by growers and allied industry who wish to provide resources in addition to the normal checkoff. This fund will be established in an interest-bearing account at the Univ. of Wisconsin Foundation. The fund will be managed cooperatively by growers, industry representatives, and the university. A portion of the annual interest will be used to address long- and short-term concerns of the industry through funding for graduate students, technical support, and special high-impact projects. The remaining interest will be reinvested into the fund to offset inflation. The "potato excellence fund," developed at the initiative of key growers, is indicative of the mutual respect that has evolved over the past many years of interaction between the college and the potato industry. The level of proposed support and the way in which the support will be distributed will help to maintain team interest and focus.

Grower interaction. A strong camaraderie has developed between the potato industry and university researchers/extension specialists and has been a major key to success. This association has fostered a team concept that includes grower interaction and a general attitude of partnership between the university and the potato industry. The Wisconsin potato industry maintains close contact with the IPM team through a series of winter educational meetings and summer field days. At these meetings, growers hear from research and extension specialists regarding up-to-date reports of current research, reviews of seasonal production problems, and discussions of future industry trends, issues, and needs. Virtually all Wisconsin growers attend at least one of these meetings or field days per year. In addition to Wisconsin attendees, it is common to attract attendees from Michigan, Illinois, Iowa, Minnesota, and Canadian provinces.

Concepts and products tested in small plots on university research farms frequently have been verified through further testing on grower farms. This essential ingredient for both component and integrative research has strengthened the ties between the university and industry. The potato industry cooperates closely with university research and extension faculty by providing land, equipment, and financial resources to ensure success of large field plots.

Because growers contribute financially to research and extension programs, they are keenly aware of the need for visible, definable, and measurable progress from each research project. The industry feels a partnership with the research and extension team as goals are defined, research is conducted, and progress is made. In addition to frequent interaction with growers, the IPM team also interacts frequently with the processing industry, e.g., Frito Lay, Inc., Ore Ida Foods, Inc., Sunspiced, Inc., and others, to answer questions, solve problems, provide education for their production employees, and cooperate in research projects. Extension appointments of team members allow them to spend considerable time with growers on their farms evaluating problems, formulating solutions, and testing ideas and concepts. Dialogue with individual growers maintains a close association with the potato industry. The potato industry is extremely complementary of the IPM programs and research that have been ongoing for the past 14 years. They note that pesticide inputs are declining, yields and quality are increasing, and that they are increasingly competitive with other production areas.

Conclusions

The Potato IPM Team has been successful in obtaining research and extension funding and in achieving its stated objectives during the past 15 years. The team has developed and delivered useful information to a receptive grower audience. By including growers and affiliated industry representatives as participating team members, there is a sense of pride and ownership of IPM programs within the entire Wisconsin potato industry. This, in turn, has helped to establish a high *esprit de corps* among the team and fostered extensive cooperative research and extension efforts. Team efforts have been lauded by administration and noted by other disciplines within UW–CALS. Granting agencies have recognized multidisciplinary team efforts with funding for both research and extension programming.

Growers and the entire potato industry have been quick to adopt new IPM practices that reduce pest problems, reduce crop inputs, reduce adverse environmental impacts, increase crop performance, and increase their competitiveness with other production areas. Their adoption of new computer technology and requests for new, more-comprehensive, crop management software has spurred further software development. Grower use of computer software has brought a unique focus to the overall IPM program in Wisconsin.

The complexity of objectives is increasing as the team moves from a single crop focus to a broader perspective of the farming enterprise. Recent team additions of an agricultural economist and a rural sociologist will help fill current gaps and provide coverage in economics and technology adoption that have been lacking in past efforts.

Acknowledgment

We gratefully acknowledge the support of the many undergraduate and graduate students, postdoctoral trainees, and research specialists who worked with program development; the computer programmers who created the Potato Crop Management software; growers who contributed time and facilities for program testing; staff of the UW Agricultural Research Stations, where much of the component research was conducted; county extension agents in key areas of Wisconsin potato production; and independent crop consultants, who continue to provide input.

Literature Cited

Connell, T.R., J.P. Koenig, W.R. Stevenson, K.A. Kelling, D. Curwen, J.A. Wyman, and L.K. Binning. 1991. An integrated systems approach to potato crop management. J. Prod. Agr. 4(4):453–460.

Curwen, D. and L.R. Massie. 1984. Potato irrigation scheduling in Wisconsin. Amer. Potato J. 61(4):235–241.

Kelling, K.A., C.R. Grau, D.I. Rouse, A.E. MacGuidwin, and D. Hero. 1992. Nitrogen needs of potato following forage legumes. Amer. Potato J. 69(9):590.

Kelling, K.A. and R.P. Wolkowski. 1991. Influence of potato variety on petiole nitrate-N critical levels. Amer. Potato J. 68(9):620–621.

Kelling, K.A. and R.P. Wolkowski. 1992. Interaction of potato variety and N rate on yield, quality and petiole nitrate nitrogen levels. Proc. Wisconsin Annu. Potato Mtgs. 5:23–30.

Pratt, L.H. 1993. Wisconsin agricultural statistics. Wisconsin Dept. of Agr., Trade and Consumer Protection, Madison.

Pscheidt, J.W. and W.R. Stevenson. 1986. Comparison of forecasting methods for control of potato early blight in Wisconsin. Plant Dis. 70(10):915–920.

Shields, E.J., J.R. Hygnstrom, D. Curwen, W.R. Stevenson, J.A. Wyman, and L.K. Binning. 1984. Pest management for potatoes—A pilot program. Amer. Potato J. 61(8):508–516.

Shields, E.J. and J.A. Wyman. 1984. Effect of defoliation at specific growth stages on potato yields. J. Econ. Entomol. 77(5):1194–1199.

Stevenson, W.R., L.K. Binning, J.A. Wyman, D. Curwen, G.J. Rice, J.R. Zajda, J.E. Smidl, B.M. Thorson, and R.W. Schmidt. 1989. PCM—The integrated systems approach to potato crop management. User guide for IBM and IBM-compatible personal computers, Version 1.1. UW–Madison IPM program.

Stevenson, W.R. 1993. IPM for potatoes: A multifaceted approach to disease management and information delivery. Plant Dis. 77(3):309–311.

Walgenbach, J.F. and J.A. Wyman. 1984a. Colorado potato beetle (Coleoptera: Chrysomelidae) development in relation to temperature in Wisconsin. Ann. Entomol. Soc. Amer. 77(5):604–609.

Walgenbach, J.F. and J.A. Wyman. 1984b. Dynamic action threshold levels for the potato leafhopper (Homoptera: Cicadellidae) on potatoes in Wisconsin. J. Econ. Entomol. 77(5):1335–1340.

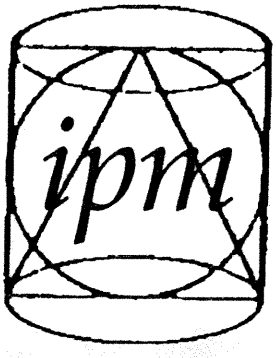
Wiese, A.M. and L.K. Binning. 1987. Calculating the threshold temperature of development of weeds. Weed Sci. 35:177–179.

Wyman, J.A., J.O. Jensen, D. Curwen, R.L. Jones, and T. Marquardt. 1985. Effects of application procedures and irrigation on degradation and movement of aldicarb residues in soil. J. Environ. Toxicol. & Chem. 4:641–651.

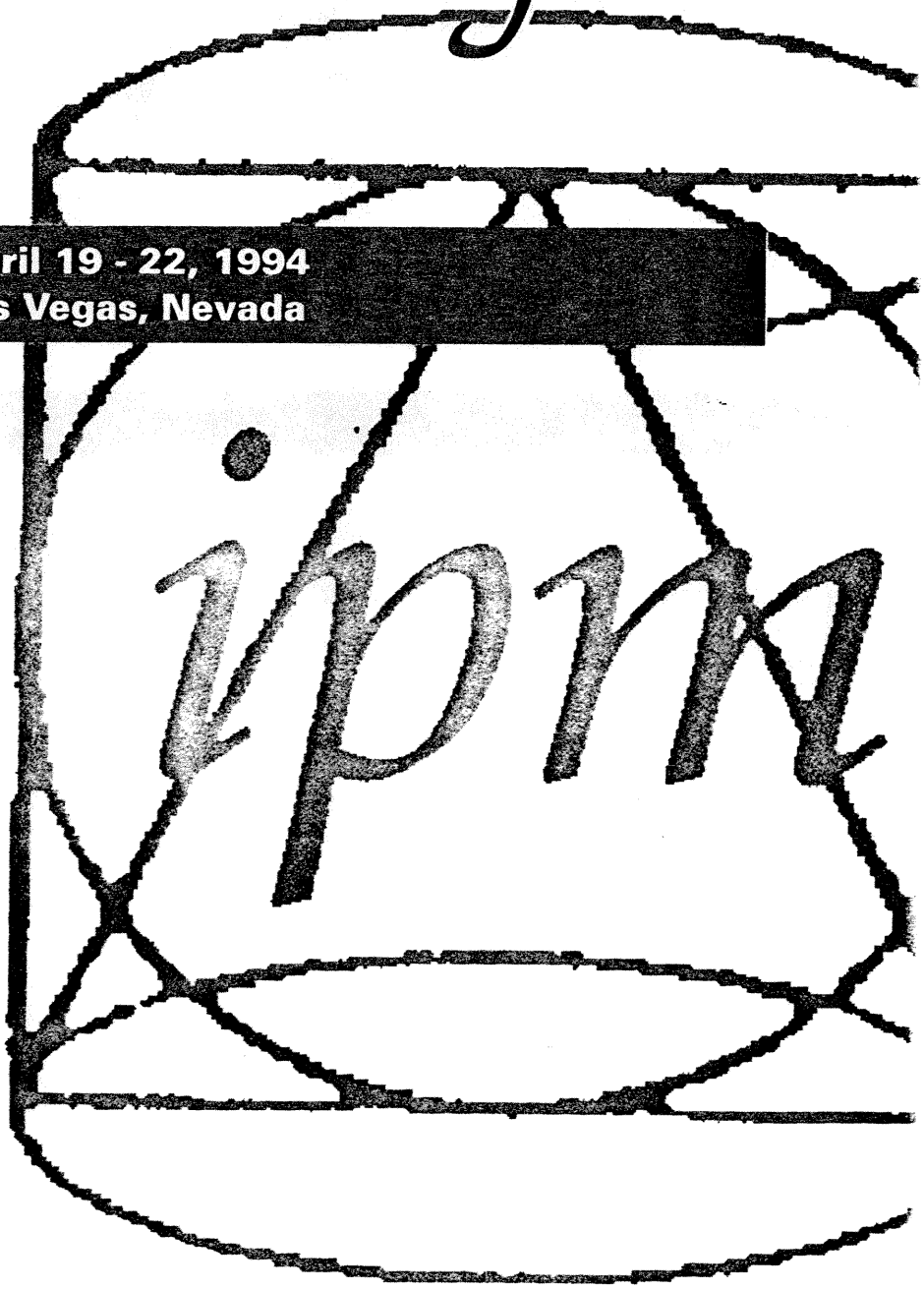
"By including growers and affiliated industry representatives as participating team members, there is a sense of pride and ownership of IPM programs..."

Second National Integrated Pest Management Symposium/Workshop

Proceedings



April 19 - 22, 1994
Las Vegas, Nevada



DEVELOPMENT OF PRESCRIPTIVE CROP AND PEST MANAGEMENT SOFTWARE FOR FARMING SYSTEMS INVOLVING POTATOES

Walter R. Stevenson, Jeffrey A. Wyman, Keith A. Kelling, Larry K. Binning, David Curwen, Timothy R. Connell and Daniel J. Heider. Departments of Plant Pathology, Entomology Soil Science, and Horticulture, College of Agricultural and Life Sciences, University of Wisconsin, Madison, WI 53706

Abstract

Societal concerns related to pesticide and fertilizer use and the intensive management of cropping systems involving potatoes have focused attention on the choice, timing and application rates of agricultural inputs. An integrated pest management (IPM) program was developed for the Wisconsin potato industry because 1) growers have traditionally been progressive and interested in IPM tactics, 2) the crop is intensively managed with multiple inputs of pesticide, fertilizer and irrigation, 3) potato is a high value/high risk crop, 4) the crop is often grown in environmentally sensitive areas and 5) a strong research base existed to support the IPM effort. An important aspect of the Wisconsin IPM program was the development of specialized computer software to assist growers in management decisions. Computer software has provided an effective on-farm tool for analyzing complex environmental and crop information and providing specific management recommendations. The Potato Crop Management (PCM) software was developed at the University of Wisconsin through a multidisciplinary team effort. The program contains modules for predicting crop emergence, scheduling irrigation, managing pests (diseases, insects and weeds) and assessing storage ventilation needs. Since its release to growers and IPM consultants in 1989, use of the PCM software has continued to increase. Growers and consultants now use the software on approximately 70,000 acres of potato production. Savings related to reduced use of pesticides and irrigation are estimated to annually exceed $5,890,000 U.S. when compared with inputs prior to software use. The current software, however, has application to only a few of the many decisions confronting growers. Software enhancements are underway that focus on potato canopy development, crop nutrition, seedpiece decay and farm record-keeping. The PCM program is also being converted from an MS-DOS® environment to a Microsoft Windows™ platform. The new software entitled WISDOM will allow easier data input and exchange, graphical presentation of data and comparison of environmental and crop/pest data between fields and years. The WISDOM software will expand opportunities for managing the farming enterprise including crops often grown in rotation with potato. Modules are being developed for management of snap beans (irrigation scheduling, insect management, and white mold risk assessment) and sweet corn (irrigation scheduling and insect management). Program modularity will facilitate the future addition of new potato and rotational crop modules as new information becomes available from field and laboratory research.

Introduction

Potato production for processing, fresh market and seed is an important asset to Wisconsin's economy. Grown on approximately 68,000 acres, the crop is valued at $120,000,000. Wisconsin is ranked fourth in the United States in total potato production (Pratt, 1993). The overall value

to Wisconsin in jobs, processing and allied agribusiness approaches $350,000,000 per year. Production costs for irrigated potatoes are typical of national costs and currently average $1,700 per acre for long season russet potatoes while gross returns often exceed $2,000 per acre.

Midwestern U.S. weather conditions not only favor the production of cool weather crops such as potato, but they also contribute to the development of a broad range of important pest problems. Production of potatoes in Wisconsin and throughout the North Central region typically includes the intensive use of pesticides to manage diseases, insects and weeds; relatively high rates of fertilizer, particularly on irrigated sandy soils; and irrigation water for optimal production. Fifteen years ago, a typical Wisconsin Russet Burbank field on a loamy sand soil was treated with fungicide dust on the seedpieces, up to 12 applications of foliar fungicides for control of early and late blight, a systemic insecticide at planting and up to four sprays of foliar insecticides, one to three herbicide sprays for grass and broadleaf control, one to two applications of vine desiccant, irrigation consisting of three applications per week totaling 2 inches per week and fertilizer treatments totaling 250-350, 120-160 and 300-400 lb/acre of N, P_2O_5 and K_2O, respectively.

During the early 80's, these intensive inputs began to elicit concerns from both citizens and growers. Their concerns focused on environmental risks, grower and consumer safety and the potential for developing pest resistance to commonly used pesticides. The reliance on intensive use of pesticides and other inputs as well as environmental concerns associated with potato production were the driving forces behind the development of a comprehensive integrated crop and pest management program for Wisconsin growers. This integrated program was designed in partnership with growers, processors and allied industry to maintain a competitive potato industry that optimizes inputs and attempts to minimize or eliminate adverse environmental inputs associated with potato production.

The foundation of this crop and pest management program was a long history of disciplinary research in areas such as disease management (judicious use of fungicides in conjunction with disease forecasting), insect management (targeting vulnerable stages of pest development and economic thresholds), weed management (prediction of crop emergence, plant canopy development and the timing of herbicide applications), fertility practices (rates, placement, source and timing of required nutrients) and irrigation management (matching applied irrigation with crop needs). Research in these and other critical areas created an extensive database that proved useful in making recommendations for solving specific production problems. During the mid-1980's, however, it became apparent to both the potato industry and University of Wisconsin researchers that to be most useful, this information must take on a more integrated and accessible format. The computer, in its early evolution for on-farm use, turned out to be a convenient vehicle for this integration and improved accessibility.

Initial Development Of Computer Applications

Initial development of computer software included the Potato Disease Management (PDM) and Wisconsin Irrigation Scheduling (WISP) programs as stand-alone software. The PDM program targeted the prediction and control of early blight (an annual problem in Wisconsin; Pscheidt and Stevenson, 1986) and late blight (a sporadic problem occurring as a function of inoculum and weather) using a modified BLITECAST approach (Krause, et al., 1975; Stevenson, 1983). Growers experiencing losses to these diseases in the early 80's were receptive to computerized information processing that enabled them to predict the appearance of these diseases and then to improve disease control through optimized fungicide application scheduling

and fungicide rate selection. The PDM program provided growers with prescriptive pest management software using weather and crop information collected in individual fields. Because of the success achieved in disease control, PDM served as a successful cornerstone for future development of more comprehensive computer software. Subsequent to the introduction and adoption of the PDM program, improved computer technology enabled our IPM computer programmers to combine the PDM and WISP programs into a more comprehensive Potato Crop Management (PCM) program. This software included modules for predicting and controlling disease, scheduling irrigation (Curwen and Massie, 1984), predicting crop emergence, predicting development and managing harmful insects through improved targeting of insecticides and use of economic thresholds (Walgenbach and Wyman, 1984a;1984b) and calculating the ventilation needs for storing potatoes. Each of these focus areas was requested by growers and represented areas of intensive disciplinary research. The PCM program facilitated integration between modules and allowed growers to use data collected in their fields for multiple management decisions.

Value Related To Software Use

Growers and IPM consultants report use of the PCM software on approximately 40,000 of Wisconsin's 68,000 acres of potatoes. The program is also used in neighboring states where growers are using the software on an additional 30,000 acres (Fig. 1). Use of the software saves growers an estimated $20 per acre (Connell et al., 1991) by eliminating 2-3 fungicide sprays early in the growing season before the threshold accumulation of 18 severity values (Krause, et al., 1975) and 300 P-Days (Sands et al., 1979; Pscheidt and Stevenson, 1986) (Fig. 2). The estimated savings related to the delayed initiation of early and late blight controls for Midwestern potato growers exceed $1.4 million per year (Fig. 3). Further reductions (15-20%) in the amount of fungicide applied during the growing season are possible when growers adjust fungicide rates according to environmental conditions and the accumulation of P-Days. Additional benefits from using PCM and associated technology include: reducing herbicide rates (up to 50%) and improving the timing of herbicide applications; reducing insecticide treatment(40-50% reduction) by utilizing economic thresholds and targeting vulnerable life stages of economically damaging insects; reducing irrigation inputs 10-15% by matching irrigation inputs to crop demand and reducing nitrogen inputs by 20% (Table 1 and Figure 4). Potential total savings from using the PCM software and associated technology are approximately $84/acre. Growers and consultants who have used the software for several years appear to achieve the greatest benefits. It should be noted, however, these savings are partially offset by the costs of soil and plant tissue analysis, scouting services and environmental monitoring. These costs appear to range from $15-$20/acre in Wisconsin, but can be higher in other regions of the U.S. Wisconsin growers and allied industry are currently being surveyed to determine the full extent, value and costs of using integrated pest and crop management technology. The survey will also assist in identifying barriers to further adoption of management technology.

Opportunities For Enhanced Use Of Prescriptive Pest Management Software

Disease Management

Early and Late Blight Control. Foliar application of fungicides is directed at the control of both early (*Alternaria solani*) and late (*Phytophthora infestans*) blights. The appearance of a

second mating type of *P. infestans* (A2) in many states in the U.S. and the appearance of several strains insensitive to metalaxyl fungicide has placed added emphasis on multiple applications of protectant fungicide when weather conditions favor disease development. Potato cultivars currently grown in Wisconsin and other potato production areas of the U.S. and Canada are susceptible to both early blight and late blight. Field evaluation of a broad spectrum of potato cultivars and breeding lines indicate potential for reducing fungicide inputs for early blight control on some cultivars and breeding lines, but cultivar resistance to late blight clearly needs plant breeder attention. Field trials in Wisconsin have demonstrated the benefits of cultivar resistance to early blight for reducing disease progress in both sprayed and unsprayed blocks (Fig. 5). Combining disease forecasting technology with information on cultivar susceptibility to foliar diseases would enable the grower to make informed decisions on the timing and rate of fungicide application.

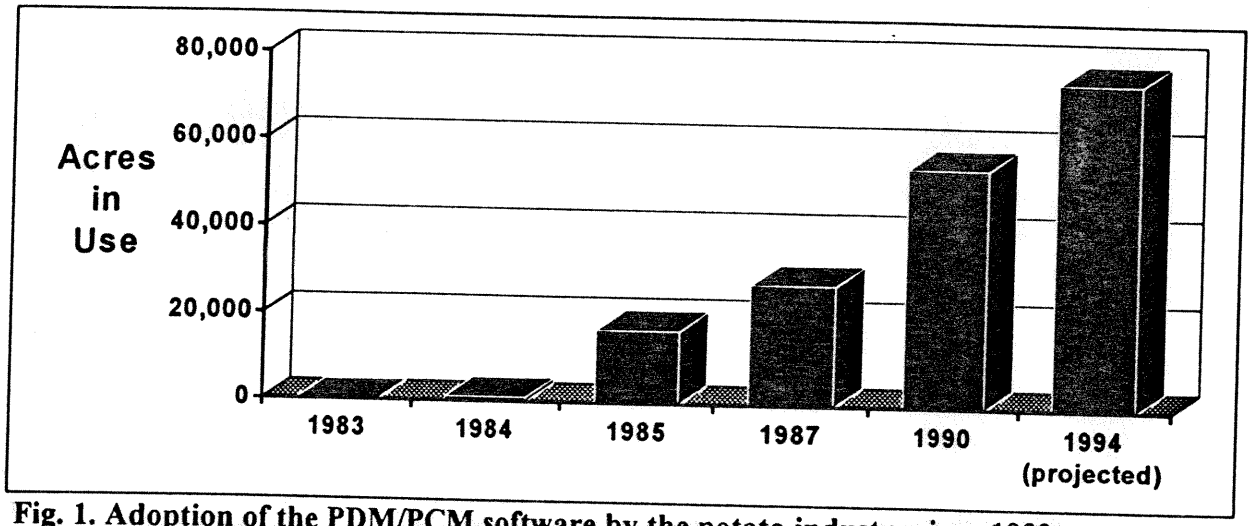


Fig. 1. Adoption of the PDM/PCM software by the potato industry since 1983.

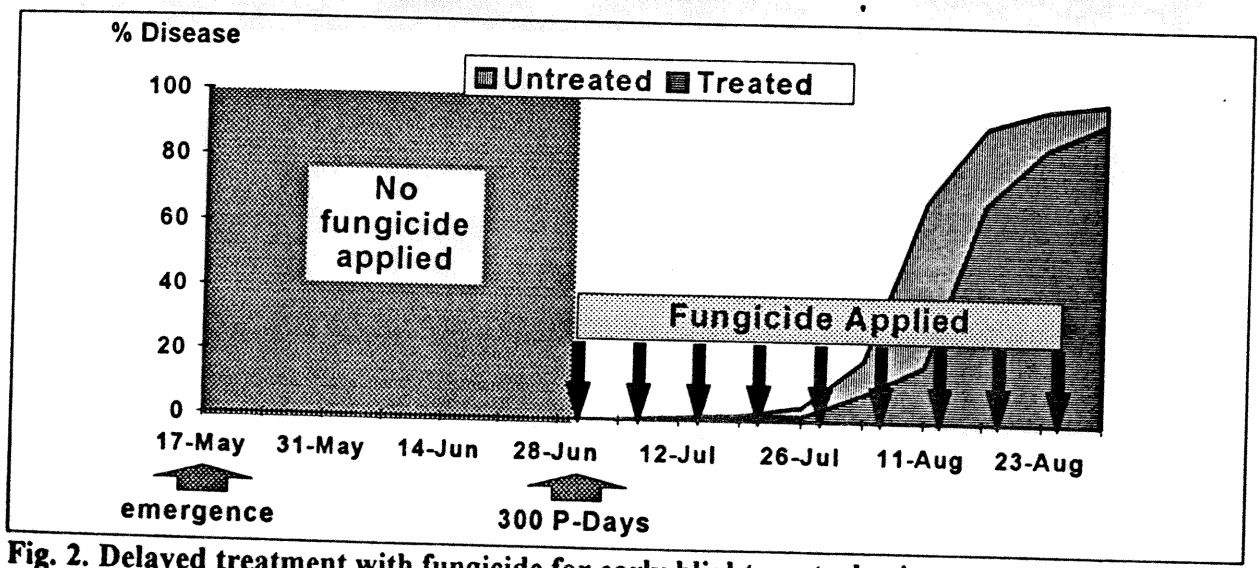


Fig. 2. Delayed treatment with fungicide for early blight control using a treatment threshold of 300 P-Days.

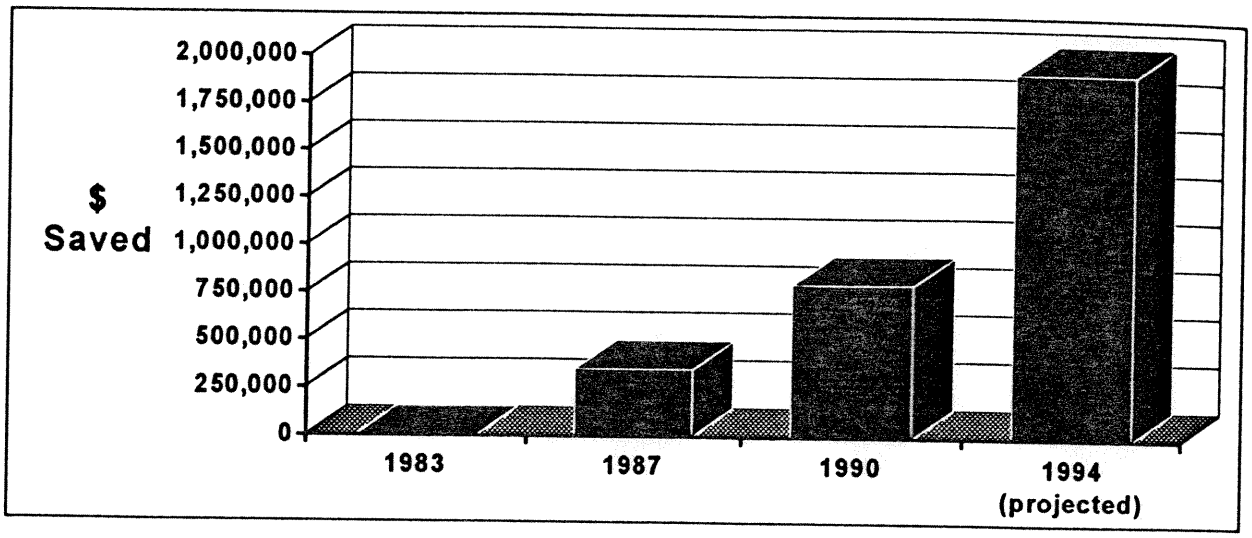


Fig. 3. Estimated savings from reduced fungicide inputs related to use of the PDM/PCM software.

Table 1. Sources of reduced inputs for production of long season 'Russet Burbank' potatoes using the Potato Crop Management software and associated technology.

Description of Inputs	Input Reduction/Acre	Input Value/Acre
Elimination of two sprays using EBDC fungicide each @1.5 lb ai/acre plus application costs ($5.00/acre)	3.0 lb ai	$20.00
Reduction in fungicide rate for remaining sprays - e.g. EBDC - 18% reduction from historical use pattern of 12.0 lb ai/acre	2.25 lb ai	$7.50
Herbicide use reduction (50%) - Eliminate one spray post emergence Reduce rates of preemergence spray	metolachlor- 1.5 lb ai metribuzin- 0.5 lb ai	$23.00
Insecticide use reduction (40%) - Eliminate systemic at planting and 1-2 foliar sprays	2.5 lb ai	$20.00
Reduction in irrigation and energy costs - application of water to match crop needs	2.1 inches	$4.50
Nitrogen fertilizer reduction (20%)	50 lb N	$9.20
Total Input Reduction	9.75 lb ai pesticide, 50 lb N, 2.1 inch water	$84.20

Seedpiece Handling. Seedpiece decay, stand loss, and loss of plant vigor pose major production risks to Wisconsin growers. The seed handling and planting aspects of potato production are among the most critical decisions faced by growers. Failure to recognize potential problems related to seedpiece decay and failure to take corrective action can result in reduced or

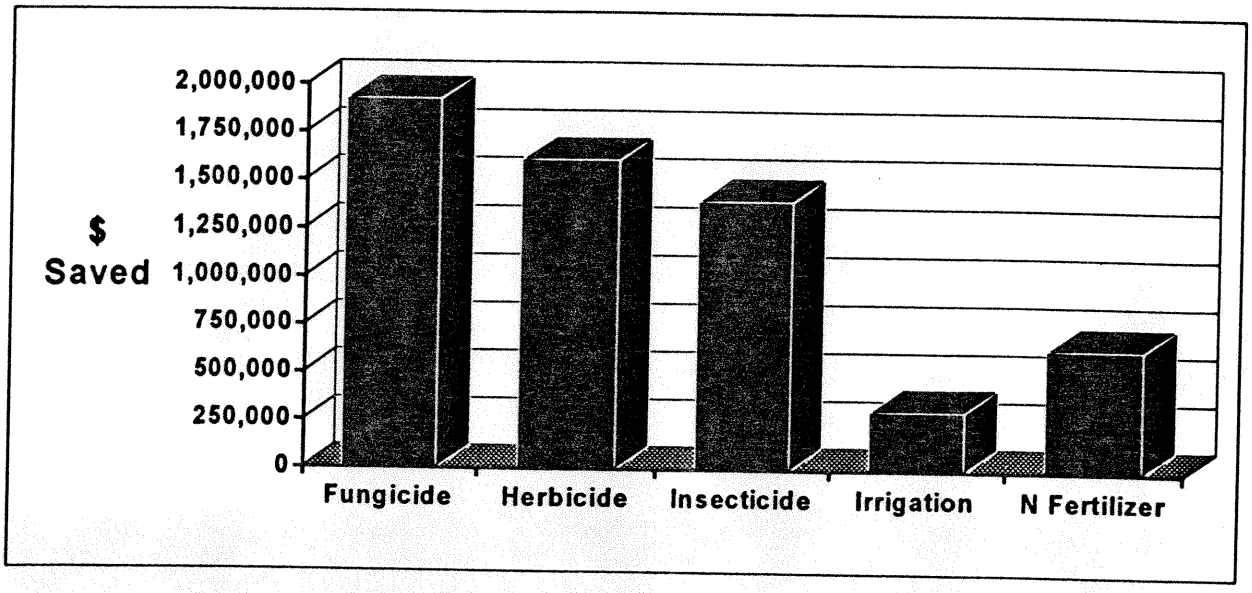


Fig. 4. Projected savings from reduced inputs related to use of PCM software and associated technology on 70,000 acres in 1994.

delayed emergence. This in turn may lead to replanting or retarded growth which then affects harvest scheduling, yield, marketability and crop profitability. To offset the risk of seedpiece decay, growers have traditionally coated cut seedpieces with a fungicide dust before planting. Planting 18 cwt seedtubers/acre and applying a dust treatment at the rate of 1 lb/cwt of seed, each planted acre receives 18 lb of fungicide dust. Research at the University of Wisconsin has shown that seedpiece decay in Wisconsin is generally caused by bacteria such as *Erwinia carotovora atroseptica* and a fungicide dust treatment does little to protect the seedpiece from decay. Research has also shown that seedpiece decay is directly related to 1) how the seedpiece is handled before and during planting and 2) the temperature and moisture at the time of planting and during the week after planting. Seedpiece decay is, therefore, not a random event, but rather a situation that is under the grower's control. Field and laboratory data provide the basis for development of an expert system designed to analyze information related to seed handling and weather conditions and to provide site specific recommendations for reducing the potential for seedpiece decay with minimized fungicide inputs. The addition of this expert system to the PCM program will provide an additional avenue for adoption of IPM technology and for growers to further reduce fungicide inputs.

Insect Management. The increased interactive capacity provided by the new PCM software presents opportunities for growers to improve insect management decisions by using real time scouting data cross referenced with other fields and historical data. Differences in cultivar tolerance to key insect pests could be accounted for in control decisions by adjusting existing treatment thresholds to reflect increased or decreased tolerance. Temporal changes in susceptibility which occur through the growth cycle could also be addressed in a similar fashion. The refinement of treatment thresholds to reflect known cultivar differences would reduce pesticide use on resistant varieties. As insecticidal inputs are decreased, the potential for integration of biological control into the overall insect management program will be enhanced.

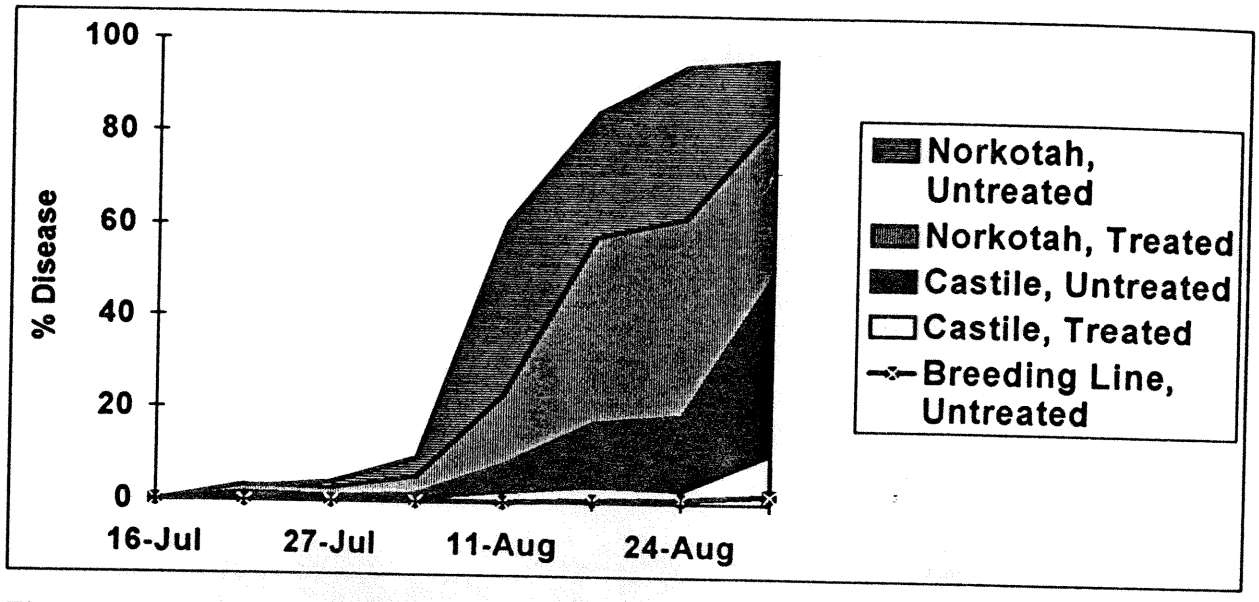


Fig. 5. Changing the progress of early blight over time with combinations of field resistance and fungicide.

Graphical presentation of real time pest and beneficial insect populations generated by field scouts would allow growers to assess the potential for biological regulation in individual fields and significantly increase the possibility of success. Insecticide resistance continues to be a major threat to the effective management of insect pests such as the Colorado potato beetle and the green peach aphid. On-line availability of historical pesticide use data will allow growers to follow resistance management strategies more effectively for individual species while insuring that control decisions for other pests do not compromise such strategies.

Weed Management. Weed control efforts in most years consist of preemergence herbicide sprays, cultivation and occasionally, post emergence sprays. The reliance on chemical controls for weed management in potatoes has directed research efforts to methods that reduce the potential environmental impacts from these applications. Recent research has focused on modeling the growth of the potato crop and evaluating the effect of crop shading on weed growth (Connell and Binning, 1991; Raby and Binning, 1986). A potato cultivar such as 'Russet Burbank' forms a dense canopy and provides approximately 95% shading of the soil surface seven to nine weeks after emergence. Using this knowledge, we have been able to adjust the timing and reduce the rate of herbicide applications such that only the required seven to nine weeks of control are provided from a single herbicide application. Other experiments have determined that at these reduced rates the potential for herbicide movement through the soil and into the groundwater is greatly reduced or eliminated. To make this information useful for a wide range of geographical areas and different cultivars (which vary in the amount of competition they provide), we are focusing on modeling the weed growth under a variety of shading conditions. By evaluating the growth of different weed species under varying light conditions, we will be able to predict weed problems before they occur based on historical weed geographics and the amount of shading that different cultivars provide. This information can then be combined into a total weed management program to guide the grower in making environmentally and economically sound decisions.

Irrigation Management. Improved management of irrigation has the potential to reduce the impact of some plant diseases, improve tuber quality and reduce the potential for pesticide and nitrogen leaching. Overirrigation from emergence to tuberization appears to increase root infection by *Verticillium dahliae* and avoiding water stress during tuber bulking may decrease disease severity (Powelson et al., 1993). Since the activity of the common scab pathogen (*Streptomyces scabies)* is inhibited in moist soil, maintaining 80-90% of available soil moisture during tuber initiation and bulking limits disease severity (Powelson et al., 1993). Soil moisture levels that deviate from the optimum during plant and tuber growth also affect the development of hollow heart, sugar ends and tuber malformation. The fine-tuning of irrigation by carefully adjusting water inputs during important phases of crop growth offers opportunities for further reducing water inputs, but perhaps more importantly, opportunities for improving the quality and marketability of the harvested tubers.

Nitrogen Fertilizer Management. Historically nitrogen fertilizer has been applied at rates totaling 250-350 lb N/acre. In most cases, yield and quality have been optimized with rates closer to 200 lb N/acre (Fixen and Kelling, 1981). Recent research has shown that through the use of a calibrated petiole nitrate-N test, the amount of early-season applied N can be reduced and later-season applications made only where the need exists. This approach results in fewer instances of excessive N being applied that can potentially leach to groundwater. These calibrations have been completed for several potato cultivars (Kelling and Wolkowski, 1992). Subsequent research has also shown that these tests help growers accurately account for on-farm N sources when potatoes are preceded by a forage legume (Kelling et al., 1993). This information is being incorporated into a nitrogen fertilizer management module which will help the grower select the best rate and timing of N application for the cultivar being grown and the management options available for a given field. It will also help growers interpret in-season petiole tests for selected cultivars and, where appropriate, will recommend rates of N to apply.

Pest and Crop Interactions. There are often complex interactions between the crop, pests and cropping inputs which require integrated solutions. For example, plants deficient in nitrogen are more susceptible to early blight than well nourished plants. Early blight progresses rapidly on nitrogen deficient plants and prematurely defoliates infected plants even with intensive treatment with multiple fungicide sprays. Excessive irrigation promotes the leaching of nitrogen below the root zone of the potato and leads to nitrogen deficiency in the plant. Frequent and excessive irrigation also keeps the foliage wet for extended time intervals and thus favors disease spread. As the nitrogen deficient plants begin to prematurely senesce, foliage is lost to early blight infection and the canopy density and shading is reduced. Light penetration stimulates weed growth which leads to weed competition for light, water and nutrients and may cause harvesting difficulties. Insects may also be attracted to stressed potato plants leading to additional defoliation. The use of prescriptive software provides opportunities to improve the management of complex problems with timely and effective remedies.

Enhancement Of Computer Applications

The Wisconsin potato industry has requested additional program functions such as modules for soil fertility and farm record keeping that require expanded software capabilities not possible within the current PCM program in a MS-DOS® environment. Currently, the PCM program is

being converted to a Microsoft Windows™ application entitled WISDOM. This conversion allows greater flexibility in programming, but it also provides many new features to the program user including:

1) An improved spreadsheet format for easier data entry and exchange of data between files: Environmental and crop data are manually entered into a spreadsheet format on the screen. Moving between days, weeks and months of the growing season is achieved by touching left or right arrows. Some growers report that they use data collected at a single monitoring station for management decisions in several nearby fields planted with different cultivars, planting dates, growth rates, etc. With the new program, data can be easily copied from one file into other files. The copy routine can be set to automatically copy newly entered data into several designated files, thus reducing data entry time for the user.
2) Presentation of data summaries in a graphical format: Information needed for grower decisions is presented as line graphs to show how various parameters (e.g. P-Days, Severity Values, Degree Days, Rainfall/Irrigation, days after emergence) change over time. Program users can be alerted when these units exceed specific thresholds so that key management decisions can proceed in a timely manner.
3) Graphical comparison of data between years: Historical data for a specific field or region can be stored in a separate file and used for comparison of production parameters with the current growing season. By using multiple comparisons per graph, program users will be able to further refine their crop and pest management activities.
4) Crop and pest record keeping: Records of field activities such as pesticide and fertilizer applications and pest scouting information can be stored for future reference. These records will play a greater significance in the future as they are linked to various program modules for tailoring specific recommendations to the occurrence of specific pests and implementation of specific management decisions. Records of pesticide application will also play useful roles in implementing strategies for managing or preventing pest resistance problems.
5) A pictorial database of pest and crop problems: Scanned slides of insects, diseases, weeds, deficiencies, toxicities and physiological problems, stored on disk or CD-ROM, are being linked with existing software. The stored photographs, complete with descriptive information and recommendations for control can then be selected by the software user for review. This feature will help in the diagnosis of problems and in applying the correct cultural, biological or chemical remedies.

Expanding The Horizons Of PCM To Include The Entire Farming Enterprise

The PCM program is comprehensive, but by design, is targeted at only a portion of the total farming enterprise, the potato crop. A need still exists to incorporate IPM information for the crops commonly used in rotation with potatoes so that growers have a guide for the entire farming system. Potato production in Wisconsin usually includes two to three year rotational sequences involving marketable commodities (snap beans, sweet corn, field corn, peas) and non-harvested cover crops (alfalfa, red clover, sorghum-sudan, rye). Both types of rotational crops have advantages to the overall farming enterprise. Cover crops may serve to hold the soil and nutrients in place, act as trap crops for insect pests or reservoirs for natural enemies, and have allelopathic effects on weeds and diseases. Many cover crops do not provide short term

economic returns to growers, but may promote long term benefits to the overall enterprise which may be of equal or greater value. In contrast, marketable rotational crops provide short term income to the grower and may also provide some additional long term benefits. Some rotational crops, however, may contribute to the survival and increase of important pest problems and thus would represent risks to the potato component of the farming enterprise.

An integrated research project was initiated in 1991 to investigate the short and long term benefits and risks of six specific rotational sequences involving marketed and non-marketed crops grown in rotation with potatoes. The project was designed as a long-term (six-year) experiment to investigate six specific two and three year rotations involving potatoes (Table 2). Factors are being identified that contribute to or interfere with the preventative management of pests in the potato crop. Information developed from this research will be integrated with existing preventative and therapeutic strategies currently utilized in the PCM software. Expansion of the PCM software which will include modules for the management of both snap beans and sweet corn is underway. Management modules for snap beans include irrigation scheduling, a degree day calculator for predicting insect development and crop maturity and assessment of the potential for white mold development, a disease affecting both potatoes and snap beans. Modules for sweet corn include irrigation scheduling and insect management. All of these modules will be included in an enterprise management program that addresses the improved management of potato and the crops grown in rotation with potato.

Table 2. Six specific two and three year rotations involving potatoes as the crop of primary focus.

Rotation No.	Year of Rotation					
	1	2	3	4	5	6
1	Potatoes	Snap Beans	Potatoes	Snap Beans	Potatoes	Snap Beans
2	Potatoes	Sorghum-Sudan	Potatoes	Sorghum-Sudan	Potatoes	Sorghum-Sudan
3	Potatoes	Sweet Corn	Potatoes	Sweet Corn	Potatoes	Sweet Corn
4	Potatoes	Snap Beans	Sorghum-Sudan	Potatoes	Snap Beans	Sorghum-Sudan
5	Potatoes	Snap Beans	Sweet Corn	Potatoes	Snap Beans	Sweet Corn
6	Potatoes	Snap Beans	Red Clover	Potatoes	Snap Beans	Red Clover

Summary

Growers and associated industry have been quick to adopt new IPM practices that enhance productivity, reduce crop inputs, and maintain their competitiveness with other major production areas. Computer technology has provided a convenient vehicle for delivering new IPM technology to the farm for implementation. Feedback from growers indicates many needs and opportunities for further adoption of IPM technology. This feedback has spawned many component and integrated research projects that will lead to additional solutions to current problems. The complexity of the PCM program has increased greatly since its first release in 1989. As we move from a single crop focus to the broader perspective of an entire farming enterprise, we are keenly aware of the risks and opportunities of this endeavor.

Literature Cited

Connell, T.R. and L.K. Binning. 1991. Canopy development model for weed management in potatoes. Am. Pot. J. 68:602 (Abstr.).

Connell, T.R., J.P. Koenig, W.R. Stevenson, K.A. Kelling, D. Curwen, J.A. Wyman and L.K. Binning. 1991. An integrated systems approach to potato crop management. J. Prod. Agric 4:453-460.

Curwen, D. and L.R. Massie. 1984. Potato irrigation scheduling in Wisconsin. Am. Pot. J. 61:235-241.

Fixen, P.E. and K.A. Kelling. 1981. Potato fertility requirements and recommendations: nitrogen. Wisconsin Potato Production. 81-DF-B, UWEX.

Kelling, K.A. and R.P. Wolkowski. 1992. Interaction of potato variety and N rate on yield, quality and petiole nitrate-nitrogen levels. Proc. of Wisconsin's Annual Potato Meetings 5:23-29.

Kelling, K.A., D. Hero, C.R. Grau, D.I. Rouse and A. MacGuidwin. 1993. Potato responses to nitrogen following various legumes. Proc. of Wisconsin's Annual Potato Meetings 6:93-104.

Krause, R.A. , Massie, L.B. and Hyre, R.A. 1975. BLITECAST: A computerized forecast of potato late blight. Plant Dis. Rep. 59:95-98.

Powelson, M.L., K.B. Johnson, R.C. Rowe. 1993. Management of diseases caused by soilborne pathogens. Pages 149-158 in: Potato Health Management. R.C. Rowe, ed. APS Press, St. Paul, Minnesota.

Pratt, L.H. 1993. Wisconsin Agricultural Statistics. Wisconsin Department of Agriculture, Trade and Consumer Protection, Madison, WI. 98pp.

Pscheidt, J.W. and W.R. Stevenson. 1986. Comparison of forecasting methods for control of potato early blight in Wisconsin. Plant Dis. 70:915-920.

Raby, B.J. and L.K. Binning. 1986. Weed competition study in 'Russet Burbank' and 'Superior' potato (*Solanum tuberosum*) varieties with different management practices. Proceedings of the North Central Weed Control Conference 41:28-29.

Sands, P.J., Hackett, C., and Nix, H.A. 1979. A model of the development and bulking of potatoes (Solanum tuberosum L.). I. Derivation from well-managed field crops. Field Crops Res. 2:309-331.

Stevenson, W.R. 1983. An integrated program for managing potato late blight. Plant Dis. 67:1047-1048.

Walgenbach, J.F. and J.A. Wyman. 1984a. Colorado potato beetle (Coleoptera: Chrysomelidae) development in relation to temperature in Wisconsin. Ann. Ent. Soc. Am. 77:604-609.

Walgenbach, J.F. and J.A. Wyman. 1984b. Dynamic action threshold levels for the potato leafhopper (Homoptera: Cicadellidae) on potatoes in Wisconsin. J. Econ. Entomol. 77:1335-1340.

Acknowledgement

The authors gratefully acknowledge the support of the many undergraduate and graduate students, postdoctoral trainees and research specialists who worked with program development, growers who contributed time and facilities for program testing, staff of the UW Agricultural Research Stations where much of the component research was conducted, County Extension agents in key areas of Wisconsin potato production and independent crop consultants who continue to provide input. The authors are especially grateful to George Rice, Paul Kaarakka and Roger Schmidt, computer programming specialists, who have been instrumental in expanding the capabilities of the PCM software and who are rewriting this software in a Windows™ format.

environmental risks. (The presentation should be 3-5 minutes, with remaining time devoted to questions and answers.)

8:25 - 8:35 --Mike Pariza, Department of Food Microbiology and Toxicology chair, will describe new food safety challenges facing Wisconsin food producers and processors, and efforts now underway to strengthen College response. (Q and A)

8:35 - 8:45 --George Shook, Department of Dairy Science chair, will describe efforts to strengthen responsiveness and coordination of College research and outreach efforts directed at state's dairy industry. (Q and A)

(continued)

8:45 - 8:55 -- Hector DeLuca, Department of Biochemistry chair, will describe relations between fundamental and applied research and their benefits to state's economy, using examples from his vitamin D research. (Q and A)

8:55 - 9:00 --Concluding remarks. Chairs adjourn briefing.

Please give me a call if you have questions or need more information. The city ramps around the capital square are your best bet for nearby parking. If you need an overhead or slide projector and screen please let me know. Keep in mind that we are on a tight schedule here and need to respect the time blocks allocated to each part of the program.

Mike Farrar
Larry Benning
George Shook
Hector Deluka

Notice 4/25

Wed. 6/7 7:30-9am
417 North

Dean Wyse 2-4930

breakfast briefing 7:30-9:00

- Ag Comm.
- Rural Affairs
- Natural Resources
- Senate Ag

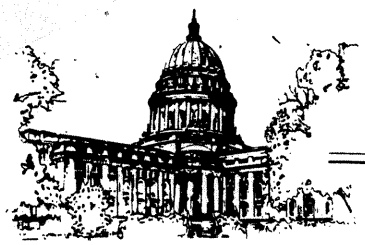
(who else)

1 hearing notice
- list all committees
- al's signature

? Is this considered a public hearing
if majority of members are present - quorom
- topics generally w/in jurisdiction of committee

? Briefing on what

possible dates: ~~May 18th~~
~~23rd no~~
~~* 30th~~
1st week in June
Friday 9th
Wed. 7th
Tues. 6th



ALVIN R. OTT

State Representative
3rd Assembly District

Ainsworth - yes Lasee - no
Johnsrud - yes

Bank Inn on Park } room charge

May 12, 1995

To: Representative John Ainsworth, Rural Affairs Chairman
Representative DuWayne Johnsrud, Natural Resources Chairman
Senator Alan Lasee, Senate Agriculture Committee Chairman

From: Representative Al Ott, Agriculture Committee Chairman

Re: Breakfast briefing with Dean Roger Wyse, UW-Madison College of Agriculture and Life Sciences

* Call Dean Wyse 1st thing Thurs

Roger Wyse, Dean of the UW-Madison College of Agriculture and Life Sciences (CALS), has asked me to coordinate a time when he can brief members of our committees on certain issues related to CALS. He would like to do this over a dutch-treat breakfast.

I am willing to coordinate the time and place for the briefing. I have been advised by David Stute of the Legislative Council that I should publish a hearing notice because there will likely be a quorum of one or more committees present and the topics to be discussed will generally be within the jurisdiction of at least one of the committees which will be present. Mr. Stute indicated that a hearing notice signed by me which lists the committees to be present and the purpose of the meeting will be sufficient.

I am hoping to schedule the meeting for Wednesday, June 7th from approximately 7:30am to 9:00am. Please contact Kim in my office by Wednesday, May 17th to let us know whether or not you are interested in having your committee participate in the meeting and if June 7th fits into your schedule.

417 N = coffee

Dr. Neal Jorgenson
Exec. Asso. Dean
Len Maurer
asst. Dean
Dr. Richard Barrows } assoc. Dean
Dr. Robt. Steel

Notice by 5/25 or 26

June 7 E-Mail
- Progress in downsizing CALS
- Major issues facing agriculture in WI + its resource base + role of CALS

talk to Wyse for more specific issues
- ag + urban interface
- waste

Office:
318 North
P.O. Box 8953, State Capitol
(608) 266-5831

Toll-free Legislative Hotline:
1 (800) 362-9472

1123

Ranking Member: Agriculture, Forestry and Rural Affairs / **Member:** Envir...

cc:Mail for: len maurer

Subject: June 7 CALS Briefing agenda
From: Len MAURER 6/5/95 11:44 AM
To: uswlskjr@ibmmail.com at IPNET at IPNET
bcc: Roger WYSE
bcc: Neal JORGENSEN
bcc: Sheila EARL

Kim: Here is the agenda I've e-mailed to faculty. Let me know if there is a problem with any part of this.

In addition, Dean Wyse said that Rep. Sheila Harsdorf and Sen. Kevin Shibilski both indicated to him that they would be interested in attending the briefing. Sen. Dale Schultz may also have an interest in the briefing. We realize, of course, that it is the chairs' decision as to whom they wish to have attend.

Thanks for your help on this.

June 2, 1995

TO: Larry Binning, Horticulture
Hector DeLuca, Biochemistry
Mike Pariza, Food Microbiology and Toxicology
George Shook, Dairy Science

FROM: Len Maurer

Re: Briefing for Assembly Committees on Wednesday (June 7) from 7:30 to 9:00 AM, Room 417 North, State Capitol.

Three committees are involved in our Wednesday morning briefing. Note that the three Assembly committees are Agriculture, chaired by Al Ott; Natural Resources, chaired by DuWayne Johnsrud, and Rural Affairs, chaired by John Ainsworth. Also enclosed is the complete membership list for each committee. We don't have an indication at this time of attenadnace, but my guess is that if we get half of the members (about 15) during this hectic week of Assembly caucuses on the state budget we will be doing well. If you bring handouts, however, you should bring enough for the total committee membership (30 copies).

The agenda is as follows:

The chairs will call the briefing to order and the clerk will call roll.

7:40 - 7:55 -- Dean Wyse will present information about College attempts to resolve budget problems, and describe new organizational features and efforts to focus College efforts on priority areas.

7:55 - 8:15 --Question and Answers

8:15 - 8:25 --Larry Binning, Department of Horticulture chair, will describe integrated pest management programs that reduce production costs and

environmental risks. (The presentation should be 3-5 minutes, with remaining time devoted to questions and answers.)

8:25 - 8:35 --Mike Pariza, Department of Food Microbiology and Toxicology chair, will describe new food safety challenges facing Wisconsin food producers and processors, and efforts now underway to strengthen College response. (Q and A)

8:35 - 8:45 --George Shook, Department of Dairy Science chair, will describe efforts to strengthen responsiveness and coordination of College research and outreach efforts directed at state's dairy industry. (Q and A)

(continued)

8:45 - 8:55 -- Hector DeLuca, Department of Biochemistry chair, will describe relations between fundamental and applied research and their benefits to state's economy, using examples from his vitamin D research. (Q and A)

8:55 - 9:00 --Concluding remarks. Chairs adjourn briefing.

Please give me a call if you have questions or need more information. The city ramps around the capital square are your best bet for nearby parking. If you need an overhead or slide projector and screen please let me know. Keep in mind that we are on a tight schedule here and need to respect the time blocks allocated to each part of the program.