Lessons Learned: Geographic Information Systems and Farmworkers in the Lake States

M. S. Vela Acosta, D. J. Reding, S. P. Cooper, P. Gunderson

ABSTRACT. *Agencies serving the estimated 42,000 to 137,000 migrant and seasonal farmworkers in the Lake States (Wisconsin, Michigan, and Minnesota) face distinct challenges, including inadequate access to farmworker data to address their needs. This project developed and evaluated a geographical information system (GIS) database for compiling and displaying existing farmworker data in the Lake States. A three-step study was conducted in the Lake States: (1) a preliminary resource and needs assessment was conducted among agencies serving farmworkers, (2) a GIS product was created using data available from state agencies, and (3) the GIS product was evaluated by an advisory board of qualified occupational health and safety representatives for appropriateness, applications, and ease of use. Agencies participated by sharing their available farmworker data. The GIS product consisted of a CD-ROM with data displayed in a graphic format and downloadable spreadsheet files consolidated by county demographic, crop, housing, and migrant health clinic information. Evaluators of the GIS product found it to be an accessible, unique clearinghouse for farmworker-related data. The GIS product can become a valuable tool for agencies serving farmworkers and those researching farmworker-related issues. Agencies and health professionals require useful and comprehensive databases to track and serve farmworkers, and a multi-agency partnership using GIS technology could provide this capability. Further research is required with improved definitions and resources to apply the GIS product.*

Keywords. *Database, Farmworkers, Migrants, GIS, Hispanic, Occupational Health, Safety.*

Only recently have concerns about agricultural safety and health, particularly for migrant and seasonal farmworkers (hereafter farmworkers), become a public health research focus in the U.S. (Frank et al., 2004). There was estimated to be 2.5 million farmworkers in the U.S. in 1990 (Commission on Agricultural Workers, 1992). Regional, state, and agency data about farmworkers are currently not readily accessible, and there is no system for the dissemination or sharing of such data (Villarejo, 2003). The National Agricultural Worker Survey (NAWS) is the only source for national demographic statistics about farmworkers, and it does not provide any regional data (U.S. DOL, 2000). Barriers to locating and counting farmworkers include distrust of out-

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siders, unconventional housing arrangements, language, literacy, and mobility (U.S. GAO, 2003).

Can researchers address the scarcity of farmworker–related data, in collaboration with the agencies serving farmworkers, to sustain and enhance farmworkers' occupational health outcomes? Answering this question requires an understanding of three challenges that researchers must overcome: first, merging the differing definitions of the eligible population (Code of Federal Regulations 42, 1962); second, determining relevant and measurable outcome parameters; and third, establishing meaningful interagency cooperation and communication (Berman, 2003).

The NAWS defines a migrant as one who travels at least 75 miles to obtain a job in U.S. agriculture (U.S. DOL, 2000). The Federal Migrant Health Program defines a migrant as one who, in the preceding 24 months, had principal employment in agriculture on a seasonal basis and who moved to seek such employment. Migrant education uses a qualifying definition that includes the parents and child/children moving between school districts to obtain agricultural work within the past three years (U.S. Department of Education, 2002). The eligibility criteria for farmworkers to obtain services from federal programs rely on those definitions but lack consistency between agencies (Martin and Martin, 1994), and only 20% of farmworkers have access to health care services (McLaurin, 2000).

The occupational safety and health needs of farmworkers are not limited to states traditionally associated with large Hispanic populations, such as California and Texas (Hansen and Donohoe, 2003; Earle–Richardson et al., 2003). The Lake States is a farm region defined by the USDA National Agricultural Statistics Service that includes the states of Minnesota, Wisconsin, and Michigan (USDA, 1999). These states face challenges different from those of states with high numbers of farmworkers, and the challenges vary according to season, crop, and number of farmworkers (Millard et al., 2001; Slessinger, 1996). Reliable and comprehensive data to formulate appropriate and measurable strategies that are tailored to agricultural seasons are needed (Vela Acosta and Lee, 2001).

Partnerships between researchers and community stakeholders have been demonstrated to improve the outcomes of agricultural health and safety research projects, particularly for populations that are relatively inaccessible (May et al., 2003; Kamel et al., 2001; Arcury et al., 1999; Arcury et al., 2000; McCauley et al., 2001; Thompson et al., 2001; Castorina et al., 2003). Participatory research is essential to determine the extent to which regional needs and the interests of regional agencies can be achieved with systematic methodology (McCullum et al., 2003; Arcury et al., 2001; Quandt et al., 2001a; Quandt et al., 2001b; Sanchez et al., 2003). Ongoing consultation and feedback between universities, agencies, and other community–based partners are essential to assess the content of interventions and to seek consensus in the use of tools to be used in the analysis of farmworker services (Flocks et al., 2001).

Access to regional data and interagency sharing of information is essential for serving this special population, as well as for facilitating and implementing research. Geographic Information Systems (GIS) have been used to communicate public health problems and solutions (Jenks and Malecki, 2004). GIS is a tool for capturing, storing, checking, integrating, manipulating, analyzing, and displaying data (Chorley, 1987; Star and Estes, 1990; Grimshaw, 1999; Ricketts, 2003). GIS provides a system that enables users to visualize, analyze, and display regional information by linking databases to maps to detect patterns for business, environment, and health assessments (Grimshaw, 1999; McLafferty, 2003). The usefulness of GIS and spatial point pattern analysis in public health research has been demonstrated, yet health service professionals have shown an unwillingness to use this unfamiliar technology (Ricketts, 2003; Cockings et al., 2004;

Brody et al., 2004). GIS is already being used in agriculture and has the potential to identify populations at risk, view similar crops in a region, detect health hazards by region, and identify available health care facilities (Eason, 2004; Brody et al., 2004; Aelion and Conte, 2004).

Consolidating regional farmworker information that includes worker numbers, locations, agricultural seasons, and crops can contribute to the promotion of nontraditional research methods. Reports of the estimated size of the farmworker population in the Lake States have varied widely during the years from 1990 to 2001 (table 1). The lack of national reference data and definitive standards for action necessitated an initial exploratory approach. The usefulness of a GIS product as an information management system for agencies and researchers in the Lake States was the goal of this research. The objective of this study was threefold: (1) to gather available information from agencies serving farmworkers in the Lake States, (2) to develop a GIS product using this data and place it onto CD-ROMs for distribution, and (3) to assess the feasibility of that GIS product for agencies in the Lake States to use in planning intervention programs. The long-term goal was to link the available information in a shared format (GIS), providing regional data for agencies to plan interventions and serve farmworkers nationwide.

Materials and Methods

The first phase of the GIS product development required an assessment of the available resources and needs of agencies serving farmworkers in the Lake States, as well as the needs of researchers who might use the data. Contacts with agricultural employers, federal agencies, migrant associations, researchers, and others ($n = 85$) were developed throughout the three states. Formal presentations were conducted to establish initial collaboration for the project, and the resulting discussions reflected the lack of access to information about farmworkers. The objectives of this phase were to determine the level of interest in and the feasibility of developing a graphical model to represent the information available about farmworkers in the Lake States via GIS. The Institutional Review Board at the Marshfield Clinic Research Foundation approved this study's protocol and instruments.

For the second phase, the data collected from agencies serving farmworkers in the three-state region that volunteered to participate in this project and to provide information were used to create the GIS product (table 2). An agreement was reached with the Julian Samora Research Institute at Michigan State University to develop the GIS product (in CD-ROM format) to display the collected information in a user-friendly format for access by state agencies. Two CD-ROMs were developed. The first CD-ROM used ArcView software (ArcView 3.2, ESRI, Inc., Redlands, Cal.), and the second CD-ROM displayed maps and data using Macromedia Flash. The end product displayed

Table 1. Number of farmworker population estimates from 1990 to 2001 in the Lake States.

Minnesota	67,227[a]	161,020[b]	16,463[c]
Wisconsin	13,344[a]	53,145[b]	20,000[d]
Michigan	8,199[a]	24,138[b]	5,541[e]
Lake States	88,770	238,303	~42,004

[a] U.S. DHHS, 1990.
[b] Larson and Plascencia, 1993.
[c] U.S. Census Bureau, 1990.
[d] MCSSA, 1995.
[e] Bureau of Migrant Services, 2001.

demographic and other farm–related data graphically through the use of modern mapping technology and included downloadable databases. Information from the three states, by county, consisted of numbers of farmworkers, housing occupancy, type of crops, migrant health clinic locations, number of migrant children, and agricultural seasons in the Lake States. Data were county–level aggregates and not broken down by age, gender, or ethnic group. The GIS product was distributed to all participating collaborators and advisors within the Lake States and to participants from other states interested in addressing farmworker needs.

Evaluation of the GIS product was the third phase of this project. An advisory board of 26 members, including representatives from both government and non–governmental agencies serving farmworkers in the Lake States and other states, participated in the evaluation of the GIS product (table 3). A copy of the GIS product, which included the operating software, was sent to members of the advisory board two weeks prior to a meeting held for evaluation purposes. The following strategic points of the GIS product were evaluated: type of data, scope of the data, timeliness of the data, technical usability, relevance to agency needs, future trends, and implications for funding agencies (such as NIOSH). The evaluation incorporated an estimation of the long–term potential for

Table 2. Agencies that provided data for the GIS product in the Lake States.

State	Agency and Data Provided
Minnesota	Migrant Education Office: –Number of migrant children, 2000 Minnesota Department of Health: –Number of farmworkers, 1997 –Crops, 1997 (types and length of season) –Crop locations, 1997 Bureau of Primary Health Care: –Locations of migrant health centers, 2000
Wisconsin	Bureau of Migrant Services: –Number of farmworkers, 2000 –Crops, 2000 (types and length of season) –Crop locations, 2000 –Housing occupancy, 2000 (locations and numbers) Bureau of Primary Health Care: –Locations of migrant health centers, 2000
Michigan	Migrant Education: –Number of migrant children, 1992 Bureau of Primary Health Care: –Locations of migrant health centers, 2000 Bureau of Employment Services, Migrant and Seasonal Farmworker Census: –Housing occupancy, 2000 –Housing units, 1999 –Housing maximum capacity, 1999 Michigan Department of Agriculture, Environmental Stewardship Division, Migrant Labor Housing Program: –Hired farm labor, 1992 (numbers and locations) Michigan Migrant Services, Family Independence Agency, in cooperation with Michigan State University Extension Service: –Migrant population, 1985 –Crops, 2000 (types and length of season) –Crop locations, 2000

Table 3. Advisory board list: At least one representative from each agency served.

1.	Aguirre International, Burlingame, California.
2.	Brownsville Community Health Clinic, Brownsville, Texas.
3.	Bureau of Community and Family Development, Wisconsin Department of Health and Family Services.
4.	Chicano Latino Affairs Council, Minnesota Department of Health.
5.	Department of Rural Sociology, University of Wisconsin.
6.	Division of Environmental Health and Disease Prevention and Control, Minnesota Department of Health.
7.	Division of Surveillance, Hazard Evaluations, and Field Studies (DSHEFS), National Institute for Occupational Safety and Health, Cincinnati, Ohio.
8.	Family Health Medical and Dental Center, Wautoma, Wisconsin.
9.	Health Data and Statistics, Minnesota Department of Health.
10.	Institute of Public Health, University of Florida.
11.	Julian Samora Research Institute, Michigan State University.
12.	Michigan Farm Bureau Center.
13.	Migrant Education Office, State of Michigan.
14.	Migrant Health Promotion, Bureau of Primary Health Care, U.S. Department of Health and Human Services, Lansing, Michigan.
15.	Minnesota Department of Economic Security.
16.	Minnesota Department of Health.
17.	Pesticides and Toxics Branch Region 5 and Office of Pesticides Programs, U.S. Environmental Protection Agency, Illinois and Washington, D.C.
18.	School of Public Health, University of Texas.
19.	United Migrant Opportunity Service, Inc. (UMOS), Minnesota and Wisconsin.
20.	U.S. Department of Labor.
21.	Bureau of Migrant Services (now Bureau of Migrant Refugees and Labor Services), Wisconsin Department of Workforce Development.

maintaining updated farmworker data, and an assessment as to whether the information would assist in planning services and interventions that would ultimately be supported by using the GIS product in the Lake States (sample questions given in table 4). The evaluation, conducted by an independent facilitator, led to a written report, which was sent to all participants for further review and comment.

Results and Discussion

Lake States Information and GIS Description

After phase 1 of the research was completed, farmworker–related data were obtained from agencies in the Lake States agricultural region (table 2). All collected data from the

Table 4. Selected questions to the advisory board for evaluation of the GIS product in the Lake States.

1.	Can the GIS product, as it is, be useful for agency proposes?
2.	If it needs to be modified, can that be achieved with additional information that already exists in your agency?
3.	What information would be good to add to the GIS product to reflect the situation of farmworkers within your state or region?
4.	How can this GIS product be used to plan effective interventions, such as in education, health, etc.?
5.	How feasible will it be to update the GIS product every year? Every five years?
6.	Does the GIS product reflect what you or your agency need?

agencies were at the county level. Data were compiled from a variety of formats ranging from spreadsheet and word processor files to paper printouts. In Minnesota, there were 29,560 farmworkers in 1997, but no migrant housing information was available. In Wisconsin, the total number of farmworkers in 2000 was 9,466, and 34 of the 72 counties had migrant housing. The number of farmworkers in Michigan in 1992 was 103,550 divided in two groups: those who worked more than 150 days (n = 20,132) and less than 150 days (n = 83,238). Migrant housing was reported for 46 of the 83 Michigan counties. Numbers of migrant children were available for all counties in Michigan and Minnesota. Information about locations of migrant health care clinics, types of crops, and seasons was available for all counties in the Lake States for the year 2000. Table 2 lists the sources of information included in the GIS product by state, agency, and type of data.

The GIS product, as developed in the second phase of the project, consisted of two CD-ROMs. The first CD-ROM used ArcView software (ArcView 3.2, ESRI, Inc., Redlands, Cal.), and the second CD-ROM displayed maps and data using Macromedia Flash. The numbers of farmworkers, types of crops, crop seasons, number of housing units, maximum number of occupants per unit, number of migrant children, and migrant health clinic locations were displayed in a graphic format by county (figs. 1 and 2).

An example of the crop season GIS display for Minnesota is shown in figure 1. When one of the months in the window on the left is selected, the counties with crops requiring farmworkers are highlighted. The main crops in Minnesota during the months of July and August (peak agricultural season) are beets, pickles, peas, corn, soybeans, green beans, onions, and potatoes (USDA, 2000). In August, 51 of the 85 Minnesota counties host farmworkers, and those counties with farmworker populations from 2,001 to 5,799

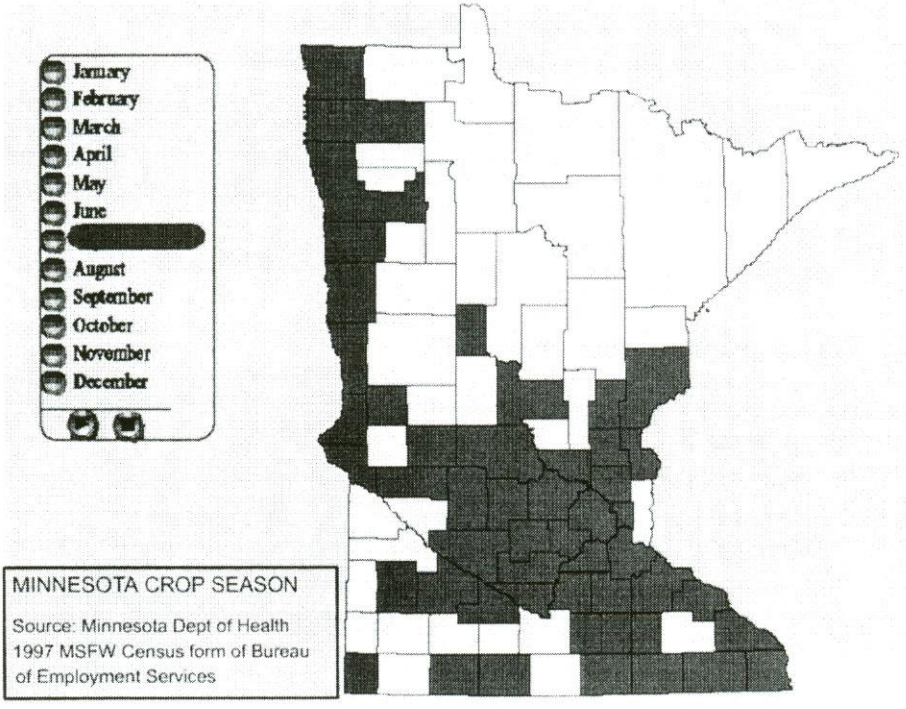

Figure 1. Minnesota GIS product view for the 1997 crop season.

have a migrant health center (there are nine such counties). Farmworkers in the 42 counties with 2,000 or fewer farmworkers are required to travel to access health care. The average distance to be traveled was estimated to be 120 miles.

Figure 2 shows the maximum migrant farmworker housing capacity, in migrant services housing units by county, for Wisconsin in 2000. When a single county is selected, the name of the county is displayed. In August, farmworkers are in 36 of the 72 counties in Wisconsin. The migrant health center is located in Waushara County. Polk County hosts 4,813 farmworkers during its peak influx, and it is approximately 232 miles away from the migrant health center. In Wisconsin during the months of July and August, the main crops are beets, potatoes corn, peppers, cucumbers, celery, peas, beans, canning vegetables, and Christmas trees (USDA, 2000).

An example of a downloadable spreadsheet file that can be accessed through the second CD–ROM is shown in figure 3. In Michigan, three of the 83 counties did not host farmworkers (Keweenaw, Baraga, and Crawford). Twenty–four migrant health centers are located in Michigan, three of which are in Saginaw County. Berrien and Monroe counties each have two migrant health centers. There are no migrant health centers in the eight counties in the northwest portion of the state. The farthest distance traveled form this part of the state to a migrant health center (from Keweenaw County to Emmet County) is approximately 320 miles. The main crop products in Michigan during the months of July and August include apples, asparagus, snap beans, dry beans, bedding plants, carrots, celery, cucumber, grapes, and blueberries (USDA, 2000).

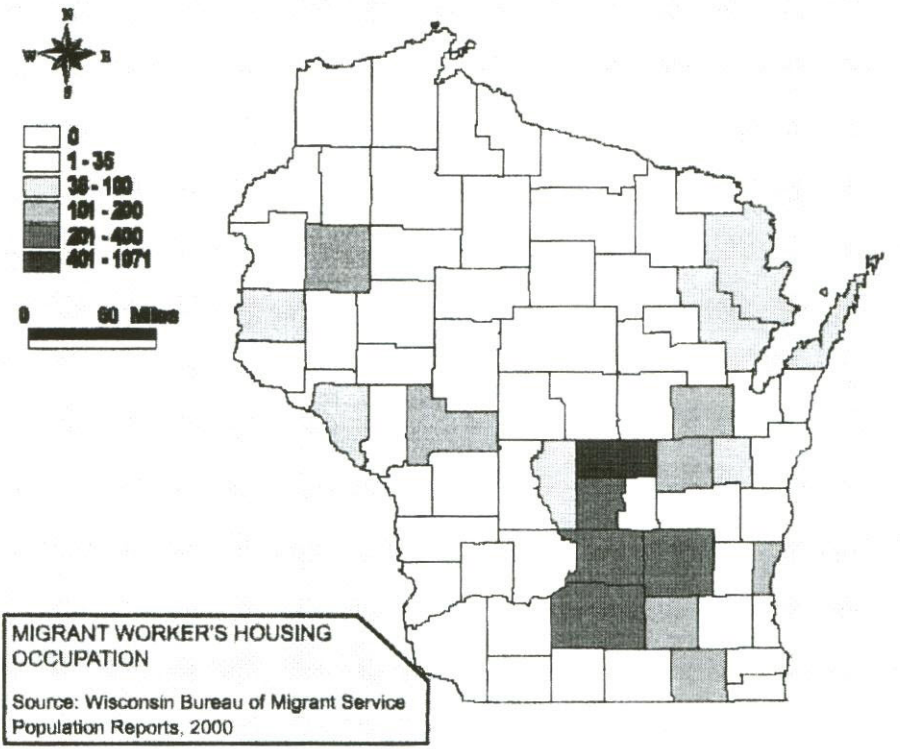

Figure 2. Wisconsin GIS product view showing farmworker housing occupation for the year 2000.

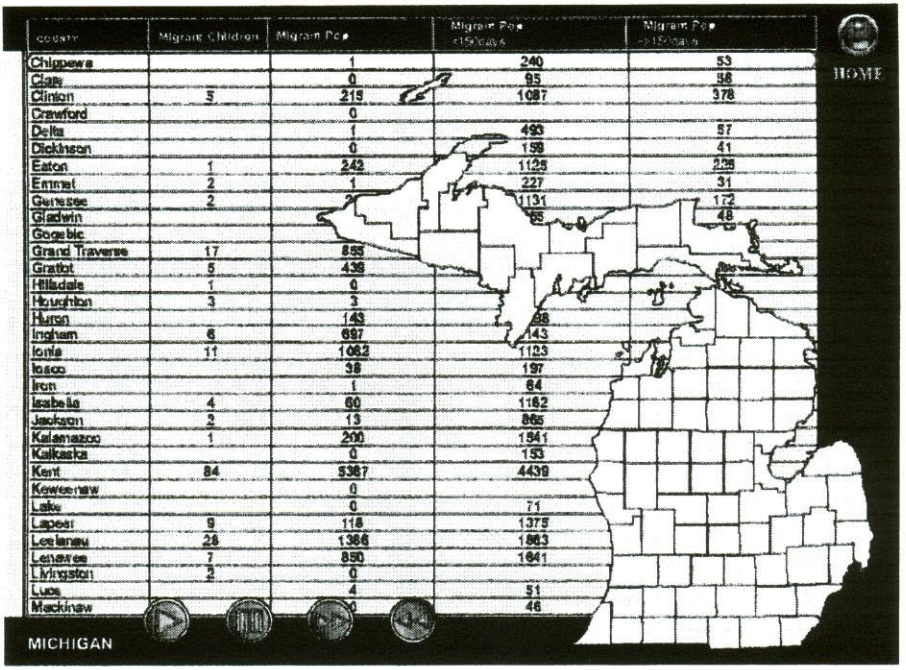

Figure 3. Michigan GIS product view displaying content for downloadable data for the year 2000.

GIS Product Evaluation

The third phase, evaluation of the GIS product by the advisory board, is summarized in table 5. Two potential users of the GIS product were identified: agencies providing services to farmworkers, and researchers developing intervention programs for farmworkers. According to the advisory board, the most important concern about developing a useful GIS product was the acquisition of accurate and current farmworker–related data. The GIS product was praised for its ease of use, and the visual display of the data was said to enhance understanding of the numbers. The reviewers proposed that the GIS product be used as a training tool for non–technical audiences in a variety of governmental, nonprofit, and for–profit organizations, including community health centers. The addition of photos illustrating work tasks and work environments was suggested for those who are not familiar with agriculture. It was also suggested that the GIS product would assist users in decision making, planning interventions, evaluating interventions, planning programs, and evaluating program outcomes.

The advisory board suggested inclusion of data on pesticides and toxic chemical sales and use for those states where such data are available. They also remarked that the GIS product would require maintenance and yearly updates. A purchase price of approximately $100, and a modest annual subscription fee ($10 to $30) for updates was proposed. The GIS product also needs to be accessible for persons with a disability, in compliance with recent federal regulations for accessible technology. The advisory board recommended that the GIS product enhancements be addressed before dissemination via the internet. Ideally, the GIS database would be available free on a web site, such as NIOSH.

Table 5. Summary of advisory board GIS product evaluation.

GIS Product Strengths
–Responds to the scarcity of farmworker data and would be extremely useful, both at state and regional levels.
–Consolidates currently available farmworker data.
–Can become an easily accessible clearinghouse for farmworker data.
–Can be used to assess needs, write grants, plan interventions, perform evaluations, and train staff.
–User friendly.
GIS Product Limitations
–Enhance features and provide more detailed instructions.
–Establish rigorous screening of data for inclusion.
–Require active maintenance (yearly).
–Enhance prior to publication or posting on a website.
GIS Product–Specific Recommended Enhancements
–Include instructions for program use, loading, and printing tools in the CD–ROM case.
–Include database description and list strengths and limitations.
–Provide photos illustrating agricultural tasks and environments involved in production.
–Provide crop descriptions (by clicking on map) to get a list and photo or video of task. This would help in identifying occupational health risks that could be linked to prevention programs, such as North American Guide to Children's Agricultural Tasks.[a]
–Provide data on pesticide and toxic chemical sales and uses.
–Provide main hazards by crop and state from on–site health hazard evaluations, including information from the Occupational Safety and Health Administration regional offices.
–Provide occupational health outcomes data with appropriate links to resources to plan interventions to prevent injury and disease.
–Provide county demographics from the U.S. census.
–Provide housing and community health center information, including addresses and seasonal schedules.
Incorporate
–Links to the National Agricultural Worker Survey to compare regional needs with national data.
–Links for migrant education and health programs, including locations.
–A committee of three or four "data people" to develop criteria for inclusion/exclusion of various databases and describe the strengths and limitations of each data source.
–Worker's compensation data and updated census data.
–The input of agricultural health and safety engineering specialists for tasks associated with specific risks and interventions.

[a] Lee and Marlenga (1999).

Discussion

All agencies in the Lake States were very responsive to collaborate and participate in this study. The GIS product developed in this study demonstrated the usefulness as well as the limitations of this technology. It was shown to be a powerful tool to present data based on the realistic methodologies already used by agencies in the Lake States. The GIS product was shown to be easy to use and readily understood. The largest limitation was the burden of obtaining and merging updated farmworker data. The information contained in the GIS product also reflected that each state has different capacities, regulations, and information to serve this special and seasonal workforce (Forfang and Kramer, 1998; Duran, 2001; Millard, 2001).

At the time of this research, there was no information available regarding housing location or inspections, even though the Minnesota Department of Health has had laws regulating sanitary conditions in migrant labor camps since 1951 (Forfang and Kramer,

1998). The need for an ongoing surveillance system was shown by the contrasts in the information available for each state. For example, the available information for counties in Minnesota linked farmworker locations with the production of sugar beets (Forfang and Kramer, 1998). However, other agencies explained that, due to mechanization, the location of farmworkers is no longer related to sugar beet production, and farmworkers are now located more around the Twin Cities area (Gloria Bostic, Department of Economic Security, St. Paul, Minn., March 2001, personal communication).

In Wisconsin, yearly updated records of housing inspection (location, capacity, etc.) have been kept by the Bureau of Migrant Services since 1995. Therefore, data were available about numbers of housing units and maximum occupancy (Bureau of Migrant Services, 2001). The GIS product as a graphical display allowed visualization of the distance from the working fields (for example, apples and Christmas trees) to the nearest migrant worker health clinic in Wisconsin. Due to confidentiality issues, the exact location for a crop production was not displayed, adding to the ethical issues brought up by other investigators working with farmworker populations (Cooper, 2000; Cooper et al., 2004).

The estimated number of farmworkers in Michigan exceeded the numbers from the other two states in the Lake States, and there were more agencies serving them (table 2). Consolidating the farmworker data into a centralized source would help to identify ways to improve data collection and quality, such as what is missing or inadequate. Although the advisory board's consensus was that the GIS product was not yet ready for broad distribution or for publication on the web, the board was uniformly enthusiastic about the usefulness of this product to their organizations. Three different representatives on the advisory board were interested in pursuing the development of a GIS product for states with higher numbers of farmworkers, i.e., Florida, Texas, and California.

The GIS product includes visual displays of demographic data and agricultural production by season and crop for each county, and it can be particularly useful for anticipating service needs for agencies. Engaging the services of an agricultural futurist would provide information on potential changes and trends in production, labor needs, health care options, and agency services. Overall, the advisory board concluded that the GIS product has the potential to become an easily accessible clearinghouse for farmworker data. With the recommended enhancements, including specific data inclusion criteria, the GIS product would be very useful for addressing the environmental equity needed for this special population by using available information from regional and state agencies (Maantay, 2002).

This GIS product could also be extremely valuable in assessing farmworker health needs, writing grants, planning interventions, performing evaluations, and training staff. This exploratory project has provided important information for the development of a long-term, state-level model for occupational health assessment of farmworkers using the GIS product approach. In spite of all the budget and time limitations for farmworker-related data at the time of this exploratory project, this initial model, developed in the Lake States after a rigorous screening for data inclusion, could be customized and implemented for other regions.

Conclusion

This study documented the discrepancies in farmworker-related data in the Lake States. As other industries benefit by using innovative technological approaches, agriculture can benefit from the ability to visualize resources and services to target work hazards so that the needs of farmworkers and their employers can be integrated in a

comprehensive manner. Regional data collection and quality issues can be better identified through the consolidation of information into a central source. Agencies and health professionals serving farmworkers in the Lake States need readily available and comprehensive databases to track and serve farmworkers. A multi-agency partnership approach that included researchers as part of the team demonstrated the potential of GIS to assess and enhance services for farmworkers.

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