INFORMATION SOURCES, TECHNOLOGIES, TEACHERS' ATTITUDES, AND COMMUNITY IMPACT FROM TEACHING AQUACULTURE IN THE NORTHEASTERN REGION

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Abstract

The purpose was to establish baseline data for all Northeastern secondary agricultural education programs that incorporated aquaculture in the total curriculum during 1996-1997. Perceptions of aquaculture information and training, technologies used, community linkages, and teachers' attitudes towards aquaculture programs were sought from agriculture teachers in 12 states. Respondents (N=70) indicated the source of their aquaculture information as other agriculture education teachers, conferences, workshops, or courses. A majority of teachers had attended formal training programs such as technical aquaculture courses and aquaculture curriculum workshops. Respondents rated indoor tanks, water quality kit, recirculatory system, aerator, and feeding pellets as very important technologies to an aquaculture program. Agriculture teachers perceived that teaching aquaculture motivated students, but they did not believe an aquaculture program would encourage students to seek a postsecondary education. Northeastern agricultural education programs had very limited crossover between school districts when describing linkages, arrangements, and/or agreements to teach aquaculture. The primary benefits of a collaborative linkage included increased student participation and peer tutoring. The community impacts from teaching aquaculture were described as awareness level activities such as aquaculture facility tours, open houses, and field days. Agriculture teachers rated colleges and universities as important external contributors to aquaculture programs.

Introduction

Molnar et al. (1987) reported that the world catch of fish was approximately 4 million metric tons in 1900. The total world supply of fish caught increased to over 97 million metric tons during the year 1991 (MSU Aquaculture Center, 1994). It is estimated that future world demand and consumption of fish will necessitate a supply of approximately 115 million metric tons by the year 2000 (Stickney, 1994).

At the most basic level of successful aquaculture production is the scientific and mathematical knowledge, as well as technological skills, needed to produce repeated crops of aquatic products. A preliminary review of related research and literature produced a noticeable void of studies that had investigated the agriculture teachers' aquaculture information sources, training programs, technologies used, attitudes towards aquaculture, or community impact from teaching aquaculture in a secondary agricultural education program. What information sources and technologies are used to teach aquaculture in the Northeastern region? What are teachers' attitudes towards an aquaculture program?

Review of Literature

Current and future demands of aquatic animals and plants have been determined to exceed the supplies available through traditional harvesting techniques employed by the world's fishing

industry. Due to expected supply shortages, aquaculture is considered to be one of the fastest growing industries in the US agricultural sector (Stickney, 1994). The potential for increased job opportunities, rural development, and economic growth in the aquaculture industry has increased the awareness and teaching of aquaculture in secondary schools.

El-Ghamrini (1996) stated that aquaculture education in US high schools has a very short history. A lack of documented research substantiates this claim as no studies were found that described the current status of aquaculture education programs. Conroy and Peasley (1997) encountered a similar situation in their report on the "National Aquaculture Curriculum" to the Council for Agricultural Education. Historical accounts suggest more effort has been exerted in establishing research and education at the postsecondary level than has been evident at the secondary school level (Conroy & Peasley, 1997).

Conroy & Peasley (1997) reported that aquaculture programs can be costly, but less-expensive alternatives have been explored and developed by agriscience teachers. Because of the potential demand for aquaculture industry personnel and scientists, the aquaculture industry has supported many secondary schools with the initial costs of building new facilities and providing technical information needed for implementing an aquaculture education program.

The purpose of El-Ghamrini's (1996) North central region study was to determine the adoption of innovative aquaculture education technologies by high school agriculture teachers. Respondents (N=141) indicated the reasons for adopting an aquaculture curricula included motivation of students, added prestige to the agriculture program, added science dimension to the program, addressed community expectations, and the curriculum related well to the environment, outdoor recreation, and natural resources. Their programs were described as having adequate school resources and an active aquacultural linkage with the local community. Would similar results occur in the Northeastern region?

Purpose and Objectives

The purpose was to establish baseline data for all Northeastern secondary agricultural education programs that incorporated aquaculture in the total curriculum during 1996-1997. Perceptions of aquaculture information and training, technologies used, community linkages, and teachers' attitudes towards aquaculture programs were sought from selected agriculture teachers in Connecticut, Delaware, Maryland, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and West Virginia. The following research objectives were part of this study.

1. Identify the sources of aquaculture information used by agriculture teachers.
2. Identify the sources of aquaculture training programs for agriculture teachers.
3. Assess the types of aquaculture systems and technologies used for teaching aquaculture.
4. Determine agriculture teachers' attitudes towards an aquaculture education program.
5. Determine the community impact from teaching aquaculture.
6. Ascertain the importance of external contributors to aquaculture programs.
7. Determine if significant differences existed in mean scores between respondent groups.

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Methods and Procedures

As part of a larger study, data were collected using descriptive survey methodology. The primary advantage in using this methodology was the accumulation of large amounts of data (Borg & Gall, 1989). The target population consisted of all Northeastern agriculture teachers who taught an aquaculture component during 1996-1997. Respondents' names were obtained from letters, electronic mail, and telephone conversations with state supervisors of agricultural education, teacher educators, and state aquaculture specialists. From these communiqués, the population was 115. The nature of this study required the entire population of interest be included in the sample. A limitation exists in that the sample may not represent the larger population of Northeastern teachers who were teaching aquaculture, but were not identified in the population. Caution is warranted in generalizing the results beyond the accessible sample.

The instrument used was entitled "Assessing the Educational Benefits of Teaching Aquaculture in Secondary Agricultural Education Programs." Portions of the original instrument (El-Ghamrini, 1996) were modified to meet regional specifications and included assessment of teachers' aquaculture information sources, technical training, aquacultural technologies used, attitudes towards aquaculture, and linkages between the aquaculture industry and secondary school programs.

To establish content and face validity, researchers used a panel of experts including aquaculture specialists and faculty from Agricultural and Environmental Education at West Virginia University. The research instrument was pilot tested with the final version resulting in a Cronbach's alpha of 0.91. Data collection began in May and was concluded in July 1997. Reminders and replacement instruments were sent to nonrespondents during May and June. A total of 80 questionnaires (70%) was received, however no research instruments were returned from Massachusetts.

To control nonresponse error and maintain validity, early and late respondents were compared statistically (Ary, Jacobs, & Razavieh, 1996). Research shows that nonrespondents are often similar to late respondents (Goldhor, 1974). A late respondent was classified as one who returned his or her questionnaire during July. Respondents were compared by scores on aquaculture technologies used, teacher's attitudes towards aquaculture, and external contributors. Statistical tests revealed no differences between respondents. Respondents' data were compiled, yielding a total response rate of 61% ($\underline{N}$=70). Descriptive statistics and oneway analysis of variance were performed on the data. The significance level of .05 was set *a priori*.

Findings

Northeastern agriculture teachers rated the importance of different aquaculture information sources, using a four-point scale ranging from 1 (Not Important) to 4 (Very Important). A combination of training programs, courses, conferences, symposiums, other agriculture teachers, workshops, field days, and tours were all rated as very important aquaculture information sources (Table 1).

To increase understanding of these sources, oneway analysis of variance (ANOVA) tests were conducted to determine significant differences between groups. Analyses of the sources by age groups revealed a significant difference for the source "workshops, field days, or tours." Post hoc tests showed that respondents in the age group 30 to 39 rated this source higher (3.76) than did those in the age group 50 to 59 (3.00). Analyses of the sources by gender revealed significant differences for "workshops, field days, or tours" and "training programs, courses, conferences, or symposiums." Female agriculture teachers rated both information sources higher (3.89, 3.95 respectively) than did

male agriculture teachers (3.47, 3.52 respectively).

Analyses of the sources by educational level showed respondents significantly differed in "visits to aquaculture centers, extension service, professionals, or researchers," "workshops, field days, or tours" and "other secondary education teachers." Respondents with a Doctorate rated the first two sources lower (2.33, 2.33 respectively) than did all other respondents. For the variable "other secondary education teachers," teachers with a Bachelor's degree rated it higher (3.00) than did teachers with a Master's degree (2.29).

A majority of respondents indicated that they had attended formal aquaculture training programs in the past. The majority recorded training in technical aquaculture workshop(s) and/or workshop(s) or training programs concerning the aquaculture curriculum (Table 2).

Table 1 Importance of Aquaculture Information Sources

Information Source	N	M	SD
Training programs, courses, conferences or symposiums	67	3.64	.60
Other agriculture education teachers	67	3.61	.52
Workshops, field days, or tours	66	3.59	.72
Visit to aquaculture centers, extension, professionals, or researchers	67	3.49	.68
Talking with friends or producers or neighbors	67	3.31	.76
Posters, pamphlets, bulletins, or any other printed materials	67	2.79	.83
Aquaculture equipment sales personnel	67	2.52	.94
Other secondary education teachers (chemistry, biology, etc.)	67	2.49	1.04
Electronic mail (e-mail), or Internet or any other computer means	66	2.47	.96
Mass media (Newspapers, Magazines, TV, Radio)	67	2.36	1.05

Note. Scale values: 1=Not important; 2=Somewhat important; 3=Important; 4=Very important.

Table 2 Frequencies of Aquaculture Training Programs Attended by Agriculture Teachers

Training Program	f	%
Technical aquaculture workshop(s) or training program(s)	43	61.4
Workshop(s) or training program(s) in aquaculture curriculum	42	60.0
University course(s) in aquaculture	13	18.6
Symposium(s) about aquaculture teaching	11	15.7
Training program(s) in aquaculture management	7	10.0
Training program(s) in aquaculture teaching methodology	3	4.3

Northeastern agriculture teachers rated the importance of aquaculture technologies, using a four-point scale ranging from 1 (Not Important) to 4 (Very Important). Respondents were given explicit instructions to rate only those technologies they had used to teach aquaculture. The highest rated technologies "indoor tanks" (3.98), "water quality kit" (3.94), "recirculatory system" (3.92), "aerator" (3.82), and "feeding pellets" (3.71) were each considered to be very important to an aquaculture program (Table 3).

Table 3 Importance of Aquaculture Technologies to an Aquaculture Program

Technology	N	M	SD
Indoor tanks	64	3.98	.13
Water quality kit	66	3.94	.30
Recirculatory system	59	3.92	.43
Aerator	61	3.82	.39
Feeding pellets	51	3.71	.58
Aquarium/aquaria	53	3.42	.93
National Council for Agricultural Education Manuals	47	3.28	.95
Green houses	40	3.00	1.13
Monoculture	33	2.88	.99
Fish hatcheries	31	2.77	.92
Polyculture	25	2.48	1.05
Exotic fish	29	2.38	1.12
Automatic feeder	41	2.37	1.18
Integrated fish farms	23	2.30	1.11
Equipped transporting tanks	26	2.12	1.07
Cages	28	2.11	1.07
Bioengineering fish species	24	2.04	.95
Raceways	26	2.00	1.17
Fish pens	23	1.87	.97
Fish ponds	24	1.83	1.09

Note. Scale values: 1=Not important; 2=Somewhat important; 3=Important; 4=Very important.

ANOVA tests on the aquaculture technologies by age groups revealed a significant difference for "automatic feeder." Respondents in the age group 40 to 49 rated this technology higher (3.00) than did teachers in the age group <30 (1.50). Analyses of the technologies by gender revealed significant differences for "automatic feeder," "cages," and "fish hatcheries." Male agriculture teachers rated all three technologies higher (2.67, 2.38, and 3.00 respectively) than did female teachers (1.79, 1.29, and 2.30 respectively). Analyses by educational level showed respondents significantly differed in the technologies "cages" and "fish ponds." Respondents with a Bachelor's degree rated both technologies higher (2.78, 2.71 respectively) than did respondents with a Master's degree (1.71, 1.53 respectively).

Researchers were interested in determining agriculture teachers' attitudes towards the aquaculture program. Using a Likert-type scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), respondents strongly agreed with five statements (Table 4). Agriculture teachers were undecided about environmental restrictions limiting the aquaculture industry.

Table 4 Descriptive Statistics for Teachers' Attitudes Towards Aquaculture

Variable	M	SD
Aquaculture is a form of agriculture	4.78	.62
The world's aquaculture industry will continue to grow	4.75	.50
Training for aquaculture teachers is important	4.60	.60
There will be more job opportunities in aquaculture in the future	4.55	.61
Supportive administration is important for aquaculture high school teaching	4.51	.66
Availability of aquaculture teaching facilities is important	4.50	.63
The world's waters are being over-fished	4.29	.85
High interest among students is important for aquaculture high school teaching	4.28	.75
Aquaculture courses should emphasize applications more than theories	4.26	.84
Aquaculture courses should be taught in high school	4.18	.76
Availability of highly qualified aquaculture high school teachers is important	4.12	.98
Overall the high school aquaculture teaching program is effective	3.87	.82
Environmental restrictions will not limit the aquaculture industry	2.97	1.18

Note. Scale: 1=Strongly disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree.

No significant differences were found when comparing teachers' attitudes by age groups or gender. Analyses of teachers' attitudes by educational levels revealed a significant difference for the statement "overall, the high school aquaculture teaching program is effective" and "aquaculture courses should be taught in high school." Respondents with a Doctorate rated the statement "overall the high school aquaculture teaching program is effective" higher (4.33) than did teachers with a Master's degree (3.70). The converse was true for "aquaculture courses should be taught in high school" in that respondents with a Master's degree rated that statement higher (4.36) than did teachers with a Doctorate (3.00).

In addition to measuring agriculture teachers' attitudes towards aquaculture, respondents were asked what changes would occur in the number of aquaculture classes and students over the next five years. Agriculture teachers indicated the overall number aquaculture classes will remain the same (56%), but the number of students enrolled in an aquaculture class will increase (59%). Additional teachers' comments included a need for agriculture teachers to adapt their existing programs, secure relevant curriculum and materials, increase their motivation and enthusiasm for teaching aquaculture, and time for developing an effective aquaculture program. Northeastern agriculture teachers commented that an increase in student interest, enrollment, and involvement were also contributing factors for future aquaculture program growth. Lesser importance was noted for "hands-on" experience and/or integration of scientific concepts.

To assess community impact, teachers recorded the activities they had observed as a result of teaching aquaculture. The responses revealed a decisive split in the level of activities, which were described as "awareness level" activities only (Table 5).

Table 5 Community Impact as a Result of Teaching Aquaculture

Variable	Frequencies	
	Yes	No
There is increasing awareness among school district students about aquaculture	63	3
Tours of school aquaculture facilities have been given to young school children	56	10
One or more open houses/field days have been held for residents	46	20
There is increasing awareness among school district residents about aquaculture	44	22
One or more residents has inquired about establishing an aquaculture enterprise	41	25
The aquaculture program has worked cooperatively with commercial producers	25	41
One or more aquaculture producers has sought advice from the school's instructor	24	42
Aquaculture products from the school have been used in the community	20	46
Aquaculture students have competed for aquaculture-related awards through FFA	20	46
One or more residents has started an aquaculture enterprise	20	44

Northeastern agriculture teachers were asked if their schools had any linkages, arrangements, or agreements with other school districts to teach aquaculture. Only 15 respondents indicated that linkages existed between school districts. Of those 15, nine shared facilities with other school districts, while six shared teachers across districts. Agriculture teachers were asked how those linkages were beneficial to their particular program. The primary benefits were a combination of increased student participation, peer tutoring, and using the aquaculture program to recruit middle school students.

Respondents used a four-point scale ranging from 1 (Not Important) to 4 (Very Important) to rate the importance of external contributors in assisting schools with starting and maintaining an aquaculture program. No contributor was rated as very important ($\underline{M} > 3.50$). Seven of the nine contributors were identified as important contributors (Table 6).No significant differences existed when comparing contributors by age groups or gender. Analyses of the contributors by education levels revealed significant differences for "State Department of Natural Resources," "State Department of Education," and "National Council for Agriculture Education." Respondents with a Bachelor's degree rated both State Department variables (Natural Resources and Education) higher (3.39, 3.00 respectively) than did teachers with a Doctoral degree (2.00, 1.33 respectively). Bachelor's degree holding respondents also rated the "National Council for Agriculture Education" higher (3.65) than did their peers holding a Master's degree (2.93).

Conclusions

Northeastern agriculture teachers consider practical information sources such as training programs, courses, conferences, symposiums, other agriculture education teachers, workshops,

Table 6 Importance of external contributors to secondary aquaculture programs

Contributor	N	M	SD
Colleges and Universities	66	3.35	.85
Private Aquaculture Industry	63	3.29	.79
National Council for Agricultural Education	63	3.11	1.05
State Department of Agriculture	62	2.89	1.07
State Department of Natural Resources	62	2.77	1.05
State Cooperative Extension	62	2.69	1.03
State Department of Education	63	2.60	1.16
US Department of Agriculture	60	2.35	1.04
US Department of Education	60	2.27	1.12

Note. Scale values: 1=Not important; 2=Somewhat important; 3=Important; 4=Very important.

field days, and tours as very important to their aquaculture programs. In contrast, mass media, computerized communication, and other secondary education teachers are less important sources. Northeastern agriculture teachers prefer to gather their aquaculture information from sources that are reliable and/or from situations that provide experiential learning.

A large majority of teachers had attended formal training programs such as technical aquaculture workshops and/or workshops concerning the aquaculture curriculum. Of lesser indication were programs in teaching methodology, management, and aquaculture teaching symposiums. These findings may indicate that agriculture teachers value training programs embodying practical, rather than theoretical aspects of teaching aquaculture.

Northeastern agriculture teachers consider indoor tanks, water quality kits, recirculatory systems, aerators, and feeding pellets as very important technologies to an aquaculture program. The National Council Aquaculture Manuals, green houses, and automatic feeder are less important. Northeastern agriculture teachers place superior importance on technologies that are essential for keeping their fish alive.

An essential component of this research involved the determination of selected Northeastern agricultural education teachers' attitudes towards the aquaculture program. Agriculture teachers strongly agree with five statements; most notably are the statements that aquaculture is a form of agriculture, the aquaculture industry will continue to grow, and aquaculture training is important for teachers. These findings illustrate that Northeastern agriculture teachers are optimistic about the future of aquaculture, however they realize that adequate training is essential to the future success of aquaculture programs.

Agriculture teachers believe the future number of aquaculture classes will remain the same as now, but the number of students enrolled in aquaculture will increase. If these predictions are at best, a moderately accurate picture of the future, then school districts must prepare for what might be overcrowded facilities and overworked teachers.

The community impacts from teaching aquaculture in the Northeastern region are described as awareness level activities such as aquaculture facility tours, open houses, and field days. Agriculture teachers reported that aquaculture awareness among school district students and residents was evident in their local community, however activities involving action and/or collaboration between the aquaculture program and community members had occurred minimally. The results illustrated that most Northeastern agriculture programs have very limited crossover between school districts when describing linkages, arrangements, and/or agreements to teach aquaculture. This result contradicts what El-Ghamrini (1996) found. Although limited, teachers believe the benefits of having a linkage include increased student participation, peer tutoring, and using the aquaculture program to recruit middle school students.

Northeastern agriculture teachers relied on external contributors to assist them in starting and maintaining an aquaculture program. Colleges and universities are considered as the best external contributors to an aquaculture program. The US Departments of Agriculture and Education are less important and no external contributor to an aquaculture program is very important ($\underline{M} > 3.50$). These findings illustrate that collaborative efforts are needed between external contributors and Northeastern agriculture programs.

Implications and Recommendations

With the advent of the Internet and other electronic communication methods, it would be reasonable to expect that agriculture/aquaculture teachers could fully utilize these information

sources for gathering high quality technical information. Does such information exist on the Internet? Do agriculture teachers have a reliable source that could transfer such information electronically? What is the role of distance education in transferring technical aquaculture information? In a similar manner, what can be stated about the content and nature of formal training programs in aquaculture? Why do agriculture teachers prefer technical aquaculture workshops more often than aquaculture teaching methodology workshops?

Northeastern agriculture teachers perceived that teaching aquaculture motivated students, yet they did not believe an aquaculture program would encourage students to seek a postsecondary education. In another part of this project, Northeastern agriculture students stated that the "aquaculture program was one of the best educational experiences they had acquired in high school," yet they did not have aspirations of working in the aquaculture industry. Why is there a discrepancy between the present and long-term benefits of an aquaculture program? A longitudinal study of agriculture students and teachers involved with an aquaculture program will provide a better understanding of the long-term benefits gained from such a program.

The future of aquaculture education in the Northeastern region will depend upon the attitudes and actions of the present. Agricultural educators must think futuristically about the students, pedagogy, and content of agriculture/aquaculture education beyond the year 2000. These sentiments were best summed up by one respondent who wrote, "If we are going to reinvent AgEd for 2020, Aquaculture should be part of it."

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