Journal of Agricultural Education
Volume 41, Number 2, pp. 2-10
DOI: 10.5032/jae.2000.02002

ASSESSING THE AQUACULTURE CURRICULA 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 the educational enrichment, barriers, and aquaculture curricula were sought from agriculture teachers in 12 states. Respondents (N = 70) averaged 16 years of experience in agricultural education, but only 4.5 years experience teaching aquaculture. Aquaculture awareness occurred in 1990, but was not taught until 1993. Teachers rated three instructional units (water quality, tank systems, and fish nutrition) as very important sources of educational enrichment in an aquaculture program. Limitedfacilities to house the program, need to care for fish on weekends and holidays, high cost of equipment to teach aquaculture, low teacher knowledge about aquaculture, and high costs of remodeling facilities for aquaculture were rated as important barriers to implementing an aquaculture program. Northeastern agriculture teachers rated the National Council's aquaculture publications, tilapia and model aquaculture recirculation system, as very useful. Only 8 respondents had used all 22 aquaculture curriculum materials produced by the National Council for Agricultural Education. Increased efforts are needed in sharing what is known about aquaculture with younger and female northeastern agriculture teachers, especially those with limited experience in teaching aquaculture.

Introduction

Aquaculture can be considered the aquatic complement to agriculture. It is the production of fish and/or other aquatic species in a controlled environment (Bardach et al., 1972; Lovell, 1979; Shell, 1983; Molnar et al., 1987). The total world supply of fish caught increased to over 97 million metric tons during the year 1991 (MSU Aquaculture Center, 1994). Future world demand and consumption of fish will necessitate a supply of approximately 115 million metric tons by the year 2000 (Stickney, 1994). Based on the annual global per capita consumption, population increases, and wild fish caught, a considerable shortfall will be evident in the total world supply of fishery products.

It is expected that aquaculture, the practice of producing aquatic animals and plants, will become a major global industry in the 21st century (McCraren, 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. The National Council for Agricultural Education (1994) reported that after one year of testing an aquaculture curriculum at six high schools, there was a 400% increase in student enrollment for aquaculture classes during 1992-1993. Also, it was found that aquaculture courses attracted nontraditional students of agriculture, women, and minorities.

Theoretical Framework

Aquaculture programs in secondary schools integrate math and science concepts and

provide hands-on practical experiences that complement theory (Conroy & Peasley, 1997). Mooring and Hoyle (1994; quoted in Conroy & Peasley, 1997) reported that one aquaculture program in North Carolina used chemistry, biology, and math in an integrated manner with their closed recirculation system, pond, and caged pond production methods. On a larger scale, methods of integrating aquaculture into an agricultural education program have included workshops, conferences, field trips, and demonstrations to pique the interest of students, teachers, and school administrators (El-Ghamrini, 1996).

Conroy and Peasley (1997) reported that although aquaculture programs can be costly, 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. The aquaculture industry has provided technical information needed for implementing an aquaculture education program. In addition, the aquaculture industry may provide some incentives, training, and job opportunities for students who have some educational preparation in aquaculture (El-Ghamrini, 1996). Despite these limited examples, further research is needed to determine the current status of secondary aquaculture education programs at the regional and/or national level.

In a North central region study by El-Ghamrini (1996), agriculture teachers were characterized as those who taught in small schools, came from a single-teacher department, liked to try new curricula, liked science, and found aquaculture interesting to teach. Reasons for adopting an aquaculture curriculum 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. Potential barriers to an aquaculture program included taking care of fish on weekends and holidays, facility limitations, low teacher knowledge, high equipment costs, limited administrative support, and the possibility of failure. Respondents rated the instructional units water quality, aquaculture management, fish nutrition, fish marketing, fish biology, fish diseases, and fish ecology as important for teaching aquaculture.

El-Ghamrini (1996) sought to determine the effectiveness of aquaculture publications produced by the National Council for Agricultural Education. Respondents rated each publication used in teaching aquaculture; the highest ratings were for Tilapia (87%), Catfish (76%), and Model Aquaculture Recirculation System (74%). The Council's aquaculture materials were used partly by 106 respondents with over one-half (n = 77) rating the materials as important or very important to their aquaculture program. The majority did not use or were not aware of the Council's aquaculture materials. Results of El-Ghamrini's (1996) study showed low usage of the Council's materials for shellfish and saltwater shrimp in the North Central region. Would similar results occur in a study conducted in the northeastern region that includes several Atlantic coastal states?

Regional concerns about the rapid expansion of aquaculture education programs in the northeastern region, despite documented evidence of educational enrichment, barriers, or the curricula used to teach aquaculture, became the driving force behind this study. Scant evidence, previous research studies in particular, was found to assist the researchers in determining why agricultural education teachers decided to establish aquaculture programs, given the relatively high costs of initial program start-up. Furthermore, inadequate literature was found in determining the educational enrichment and/or barriers, if any, that have been associated with aquaculture programs in other parts of the country. Finally, the researchers

did not find other studies that had examined the usefulness, as perceived by northeastern region agricultural education teachers, of the aquaculture curricula produced by the National Council for Agricultural Education.

Purpose and Objectives

The purpose of this study was to establish baseline data for all northeastern secondary agricultural education programs that incorporated aquaculture in the total curriculum during 1996-1997. Perceptions of the educational enrichment, program constraints, and aquaculture curricula 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. Assess demographic information of northeastern aquaculture education programs.
2. Determine the factors associated with the decision to teach aquaculture.
3. Ascertain the sources of educational enrichment from teaching aquaculture.
4. Identify the barriers associated with teaching aquaculture.
5. Evaluate the usefulness of the aquaculture curricula produced by the National Council.

Methods and Procedures

Data were collected using descriptive survey methodology. The 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 communiques, the population was found to be 115.

The nature of this study required the entire population of interest be included in the sample. The researchers treated the respondents in the study as a sample of all possible teachers who may have been teaching aquaculture education in the northeastern region (Allen, Abaye, McKenna, & Camp, 1995). 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 sample.

The instrument used was entitled "Assessing the Educational Benefits of Teaching Aquaculture in Secondary Agricultural Education Programs." Portions of the original instrument, developed by El-Ghamrini (1996), included factors affecting the decision to teach aquaculture, importance of instructional units in the Council's aquaculture publications, barriers to implementing an aquaculture program, and demographics.

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. Six agriculture teachers, who taught aquaculture but were not part of the research sample, pilot tested the research instrument resulting in a Cronbach's alpha of .91 for the final version.

Data collection began in May and was concluded in July 1997. Reminders and replacement instruments were sent to nonrespondents during May and June. Seventy usable questionnaires (6 1%) were received, however no research instruments were returned from Massachusetts. Results cannot be generalized to Massachusetts.

To control nonresponse error and maintain

validity, early and late respondents were compared statistically (Ary, Jacobs, & Razavieh, 1996). . Research has shown 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. Scores on factors affecting the decision to teach aquaculture, barriers to implementing aquaculture and demographics were used to compare respondent groups. Statistical tests revealed no differences between respondents. Early and late respondents' data were compiled, yielding a total response rate of 61% (N = 70). Descriptive statistics were performed on the data.

Results

Selected Northeastern agriculture teachers identified their state of residence, age, gender, and highest level of education completed. Over 50% of the instruments were returned from Pennsylvania (n = 16), New York (n = 12), and West Virginia (n = 10). The majority of teachers (36%) were 40 to 49 years old (M = 41.13, SD = 3.60). About three-fourths (71%) of the teachers were male. Two-thirds (67%) had acquired a Master's degree at the time of this study. Agriculture teachers had an average of 16 years in total teaching experience. In contrast, the total years teaching aquaculture averaged 4.40 years. Northeastern agriculture teachers' awareness of aquaculture programs began in 1990, but they did not start teaching it in their schools until 1993.

Teachers reported total enrollments in their schools and aquaculture courses taught as lessons or units, full semester courses, or annual courses. Also recorded was the total number of agriculture teachers as well as female and male students (Table 1).

A majority of total school enrollments ranged from 75 1 to 1000 students. Agricultural education enrollment was reported most often (n = 17) as 101 to 150 students. Nearly half (48%) of the aquaculture course enrollments ranged from 0 to 25 students. The total number of agriculture teachers reported was 128, averaging almost two teachers per program, however many of the agriculture programs were characterized as single-teacher programs. The total number of female students in northeastern aquaculture programs was 1,037 (M = 17.58); male students numbered 1,723 (M = 29.20). Agriculture teachers estimated that approximately $1,088 per program was needed to start and maintain an aquaculture program, with totals ranging from $50 to $20,000.

Northeastern teachers rated the factors that affected their decision to teach. Using a four-point scale (1 = Not Important, 4 = Very Important), the highest rated factor was "it relates to natural resources/conservation (M = 3.52)" while the lowest was "it will result in more students going to college/post-secondary education (M = 2.34)." Results for all 17 factors affecting the decision to teach aquaculture are shown in Table 2.

To determine the sources of educational enrichment from teaching aquaculture, teachers rated instructional units used to provide a high quality aquaculture program (Table 3).

Using a four-point scale that ranged from 1 (Not Important) to 4 (Very Important), three units (Water quality, Tank systems, and Fish nutrition) were rated as very important (M > 3. 50).Northeastern agriculture teachers rated potential barriers to implementing an aquaculture program, using a four-point scale ranging from 1 (Not Important) to 4 (Very Important). Teachers rated the barriers: limited facilities to house the program, need to care for fish on weekends and holidays, high cost of equipment to teach aquaculture, low teacher knowledge about aquaculture, and high cost of remodeling facilities for aquaculture as important barriers to implementing an aquaculture program (Table 4).

Table 1. Descriptive Statistics for Students and Teachers in Aquaculture Programs

	M	SD	Min	Max	Sum
Total high school enrollment	856.52	543.97	65	3000	56,530
High school agriculture education enrollment	137.45	122.52	15	870	9,484
Total enrollment in aquaculture courses	25.09	28.55	0	158	2,760
Course enrollment offered as "lessons or units"	43.61	43.72	0	175	2,137
Course enrollment offered as a "full semester"	16.39	27.40	0	158	623
Numbers of teachers	1.88	0.95	1	5	128
Female students in the aquaculture program	17.58	26.92	0	150	1,037
Male students in the aquaculture program	29.20	30.70	0	135	1,723

Table 2. Importance of Factors Affecting: the Decision to Teach Aquaculture

Factor	M	SD
It relates to natural resources/conservation	3.52	0.61
Aquaculture education motivates students	3.34	0.75
Fits easily into the high school agricultural education curriculum	3.29	0.78
It relates to outdoor recreation/sport fishing	3.27	0.83
It is interesting to teachers	3.25	0.70
It meets the need to teach more science in agricultural education	3.16	0.93
School administrators support teaching aquaculture	3.09	0.84
Aquaculture education is needed in your state	3.08	0.95
It is possible to try out teaching aquaculture on a small scale	3.07	0.88
It has a positive effect on the environment	3.03	0.88
Helps students learn more science concepts than other agriculture activities	2.96	0.91
There are teaching materials easily available	2.77	0.78
Aquaculture provides more prestige/status for the agriculture program	2.74	0.90
Aquaculture education addresses community expectations	2.47	0.83
It is easy to start teaching aquaculture in high school agriculture programs	2.37	0.85
It will result in economic development in the surrounding community	2.35	0.94
It will result in more students going to college/post-secondary education	2.34	0.86

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

Northeastern agriculture teachers evaluated the usefulness of the National Council's aquaculture curricula. A list of 22 publications was provided with a four-point scale that ranged from 1 (Not Useful) to 4 (Very Useful). Respondents were given explicit instructions to rate only those publications they had used to teach aquaculture. The highest rated (very useful) publications were "tilapia" (3.58) and "model aquaculture recirculation system" (3.55). Only eight respondents had used all 22 of the aquaculture materials produced by the Council. About 25 teachers wrote messages on the instrument indicating that they had never heard of and/or had never used any of these materials (Table 5).

Conclusions

Northeastern agriculture teachers were approximately 41 years old, male, and over

Table 3. Importance of Aquaculture Instructional Units

Instructional Unit	M	SD
Water quality	3.88	0.33
Tank (recirculating) systems	3.64	0.62
Fish nutrition	3.51	0.64
Fish biology	3.48	0.66
Fish diseases	3.31	0.80
Fish ecology	3.21	0.79
Marketing aquaculture products	3.18	0.84
Aquaculture economics	3.14	0.76
Fish hatcheries	3.13	0.71
Fish processing	2.97	0.94
Aquaculture as an SAE	2.97	0.93
Ornamental fish production	2.61	0.97
Ichthyology	2.60	0.79
Fish genetics	2.55	0.94
Baitfish production	2.37	0.89
Aquatic weeds	2.29	0.94
Pond construction	2.20	1.00
Nonfish aquaculture enterprises	2.14	0.84

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

Table 4. Descriptive Statistics for Barriers to Implementing an Aquaculture Program

Barrier	M	SD
Limited facilities to house the program	3.13	0.98
Need to take care of fish on weekends and holidays	2.97	1.03
High cost of equipment to teach aquaculture	2.83	1.00
Low teacher knowledge about aquaculture	2.78	1.06
High cost of remodeling facilities for aquaculture	2.66	1.05
Limited administrative support	2.49	1.10
Limited high quality teaching materials	2.49	1.02
Limited technical assistance to help teacher	2.49	1.08
Limited job opportunities in aquaculture	2.46	0.90
Possibility of fish die off	2.46	1.08
Limited local aquaculture industry	2.39	1.07
Limited student interest in aquaculture	2.33	0.97
State laws and regulations	2.28	0.95
Possibility of fish odors in school	2.26	1.11
Federal laws and regulations	2.25	0.97
Restrictive environmental regulations	2.10	1.01
Inflexible state curriculum requirements	2.07	1.08
High cost of utilities (water, electricity)	1.96	0.99

Table 5. Usefulness of the National Council's Aquaculture Curriculum

Curriculum	n	M	SD
Tilapia	40	3.58	0.59
Model aquaculture recirculation system	29	3.55	0.69
Using water (Module III)	35	3.34	0.80
Farming in water (Module IV)	35	3.31	0.76
Trout	20	3.30	0.66
Striped Bass	17	3.29	0.69
Discovering plants and animals in aquaculture (Module II)	33	3.09	0.80
Discovering the origins and opportunities in aquaculture (Module I)	32	3.06	0.80
Planning and managing an aquabusiness (Module V)	29	2.93	0.96
Ornamental/tropical aquaculture	15	2.93	1.16
Plant aquaculture	12	2.83	0.94
Baitfish	14	2.71	0.91
Producing Catfish	16	2.63	1.26
Salmon	11	2.45	1.21
Crawfish farming	13	2.38	0.96
Yellow Perch	12	2.08	1.16
Shellfish culture	10	2.00	1.25
Saltwater Shrimp	9	2.00	1.22
Walleye	9	1.89	1.05
Carp	9	1.67	1.00
Sturgeon	9	1.67	1.00
Red Drum	9	1.67	1.00

Note. Scale values: 1=Not useful; 2=Somewhat useful; 3=Useful; 4=Very useful.

two-thirds held a Master's degree. As a group, these teachers had extensive experience as agricultural educators, but limited experience in teaching aquaculture. Although agriculture teachers' awareness of aquaculture education occurred in 1990, the majority did not start teaching it until 1993. The majority of northeastern secondary agricultural education programs are single-teacher programs. This finding supports the earlier study by El-Ghamrini (1996). Teachers noted that more than $1000 was expended annually from their agriculture programs to teach aquaculture. Aquaculture programs continue to be costly and may be cost prohibitive for some schools.

Northeastern aquaculture education programs occur in fairly large high schools and vocational-technical centers. While most enrollments for agricultural education programs could be considered large, aquaculture program enrollments were considered small. Apparently, the lag from teachers' aquaculture awareness to their actual teaching affects program enrollment. Northeastern agriculture teachers considered the factors most influential in their decision to teach aquaculture were 1) it relates to natural resources/conservation; 2) aquaculture education motivates students; and 3) fits easily into the high school agricultural education curriculum. El-Ghamrini (1996) found similar results in the North central region. The two lowest factors were: 1) it will result in more students going to college/post-secondary education; and 2) it will result in

economic development in the surrounding community. These results indicate agriculture teachers believed that teaching aquaculture might be rooted in a present rather than futuristic sense. Even more interesting was the teachers' dismal perception that aquaculture programs would not produce economic development nor motivate students to go onto college. This critical gap in reasoning may contribute to the stakeholders' and agriculture teachers' misunderstanding about the importance of aquaculture programs throughout the northeastern region.

In determining the educational enrichment from teaching aquaculture, agriculture teachers considered three units (Water quality, Tank systems, and Fish nutrition) as very important instructional units. The water quality unit was considered similarly in the El-Ghamrini (1996) study. Northeastern agriculture teachers perceived the primary educational enrichment from teaching aquaculture was based on the fundamentals of maintaining an aquaculture system.

Respondents believed the potential barriers to implementing an aquaculture program were limited facilities to house the program, need to care for fish on weekends and holidays, high cost of equipment to teach aquaculture, low teacher knowledge about aquaculture, and high cost of remodeling facilities. El-Ghamrini (1996) found similar results in the North central region. In effect, aquaculture programs may require more resources than are available to agricultural education programs and/or teachers.

Northeastern agriculture teachers believed the National Council's aquaculture materials, tilapia and model aquaculture recirculation system, are very useful publications for teaching aquaculture, but only eight respondents had used all 22 aquaculture curriculum materials produced by the National Council. Similar results occurred in the study by El-Ghamrini (1996). These findings may be due to the newness of aquaculture education and/or to a lack of awareness about the aquaculture curricula available to secondary school teachers.

Implications and Recommendations

An important implication to agricultural education exists in the need for increased efforts in sharing what is known about aquaculture with younger and female northeastern agriculture teachers. According to the results, aquaculture programs are expensive and resources are limited. Younger, inexperienced agriculture teachers need assistance in locating resources (financial, technical, and educational) if they are to be successful in establishing and maintaining an aquaculture program. Female agriculture teachers perceived that limited high quality teaching materials posed a barrier to establishing an aquaculture program. A determined effort from the aquaculture industry and state/federal educational entities should be forthcoming to alleviate any barrier to establishing an aquaculture program. Also, increased networking with experienced aquaculture teachers and industry representatives would facilitate the formation of an aquaculture program for young agriculture teachers and female agriculture teachers alike.

The results of this project showed that nearly twice as many males were enrolled in an agriculture/aquaculture program, as were female students. Northeastern agriculture teachers and students both agreed that the educational enrichment from an aquaculture program increased students' knowledge and skills in areas outside the aquaculture curricula. If we accept this as true, then agricultural educators at all levels need to encourage more female students to enroll in an agriculture/aquaculture education program. One method of accomplishing this goal could be realized by inviting high school principals, superintendents, guidance counselors, and parents to participate in the aquaculture education program.

Additional research is needed to determine the current status of secondary aquaculture education programs at the national level. Specifically, what are agriculture teachers' perceptions of the aquaculture program? Research studies are needed to ascertain the community impact from teaching aquaculture and to examine linkages between education and the aquaculture industry. Also, a method for strengthening the network between experienced and inexperienced aquaculture education teachers needs further exploration. A longitudinal study of agriculture students and teachers in an aquaculture program will provide better understanding of the long-term benefits gained from an aquaculture program.

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