OUTREACH TO INCREASE EFFICIENCY OF AQUACULTURE IN NEPAL

Human Nutrition and Human Health Impacts of Aquaculture/Activity/16HHI03UM

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ABSTRACT

Establishing school ponds and a curriculum for school-age children and women's groups should be an effective approach to create awareness and to educate rural communities about the nutritional value of fish and methods of aquaculture. Two ponds of 75-105 m2 in size were established, one each in two public schools of Chitwan and Nawalparasi districts in Nepal. A school curriculum was also developed to demonstrate methods of aquaculture and educate adolescent students on nutritional value of fish. This technology was also disseminated to women's groups to expand understanding of the value of fish production and consumption for their families.

Carps and Nile tilapia fry were provided to each school from nearby private fish hatcheries and were stocked in each pond at 10,000 carps/ha. In addition to carps, 3,000 Nile tilapia/ha were stocked also. The materials necessary to maintain ponds, including feed and fertilizer, were also provided to each school. Fish were cultured for one production cycle with the participation of high-school-age students. The ponds were maintained in good condition and net yield averaged 4.3 t·ha-1·yr-1, comparable to commercial yields. A course of study was developed for teacher and student education on fish culture. About 40 students of grade 8, 9, and 10 and 3 teachers were selected from each school to receive training on fish culture. Training of teachers and students included fish pond development, managing pond depth, pond preparation, species choice, water color, fertilizing, feeding, grow-out, and harvesting of fish, as well as nutrition education, including fish preparation and eating. Twelve sets of training were conducted in all. Tests indicated that students dramatically improved in knowledge of aquaculture and nutrition after taking this course with median scores increasing from about 60 to 80% in the schools. In addition to training of students, informal education activities were also carried out for women's groups, which included forming two women's fish farming groups in the school community for each district. A training workshop was organized for each women's group on the role of household aquaculture in family nutrition and income. Also, a survey was carried out at four locations to assess the status of fish farmers, their culture practices, and impact of fish farming on economic, nutritional, and social aspects. Results indicated that there was a positive impact of the project on aquaculture practices.

INTRODUCTION

Much of effort to integrate aquaculture and nutrition globally has focused on households. Research is critical in determining best practices and possible variations in aquaculture systems throughout the world and how they might adapt to local culture and conditions (Diana, 2012). However, research alone cannot be effective in changing paradigms in aquaculture communities. Outreach of research results and social interactions to advise local communities are also important in changing aquaculture systems to become more sustainable and more profitable (Diana et al., 2013). Such outreach can target key groups to begin education, with the ultimate goal of local practitioners helping each other improve their aquaculture systems. For aquaculture, direct outreach by government or non-

government organizations is one effective tool, but organic spread of knowledge from practitioner to practitioner is at least equally effective (Tain and Diana, 2007).
Nepal has diverse agro-climatic and socio-economic characteristics, but suffers from limited communication and transportation networks. Most Nepalese live in rural areas at subsistence or near subsistence levels. Most of the protein consumed by the rural population comes from cereal grains. Cereal proteins are generally deficient in one or more essential amino acids and are not complete sources of protein unless taken with other protein sources. An additional concern is that people have a habit of consuming only one cereal grain at a time in Nepal. People in the Terai eat more rice, while those in the hills consume more corn. This tends to make their diets unbalanced in nutritional content. However, this diet may be made nutritionally superior by supplementing it with fish.

Schools remain the center for learning in a community. Having ponds in schools can produce a practical, hands-on message to the local population that fish are an important constituent to boost nutrition, and hence, residents became encouraged to build fish ponds of their own. This also helps build the capacity of teachers who could spread knowledge on the importance of fish in nutrition to parents during teacher-parent interactions, as well as educating students and adults on issues of environmental sustainability and nutrition. We developed a project using school ponds and education on the nutritional value and methods of aquaculture to help young people understand the value of fish production and consumption for their families (Jha et al., 2016). While many Nepalese attend school, most have only a primary school education, and about 68% of women are illiterate. Therefore, training must consider these limitations, while still providing for information exchange (Kloeblen, 2011). The construction and operation of these ponds was a very exciting event for the school communities. Often, a number of adults attended events such as stocking and harvesting, as well as visits during our training exercises.

Women play an integral role in the aquaculture and fisheries sectors all over the world. Although women's roles and responsibilities are changing in some countries, there are constraints that limit female participation in aquaculture (Egna et. al., 2012). A few such constraints women face in aquaculture and fisheries are time availability and allocation, land ownership and access to water, credit, training, and labor. Lack of training opportunities can trap women in vulnerable and poorly paid positions with no prospects of advancement (FAO, 1998).

Since various outreach activities have been a major component of our work in Nepal, we also believe it is time to evaluate the relative success of these activities. For this component, we focused on locations where people have received training or on-farm experiments to improve local fish culture. We conducted a survey to determine how many of our innovations have been included in the common culture practices of local people. We realize farmers may not easily implement changes in practice completely, but may make modifications to their production systems based on how they perceive the practice to improve their yield or profit.

There is a global concern that nutritious food must be supplied to women, as well as their children during the first 1,000 days of life. Fish provides valuable nutrients to the world's population, including high-quality proteins (about 6% of world protein supply in 2002); balanced amino acids; vitamins A, D, and B12; iodine and selenium; and long-chain omega-3 polyunsaturated fatty acids. Fish bones, when eaten, are also an excellent source of calcium, phosphorus, and fluorides. Fishes are acceptable for most of the ethnic groups in Nepal and have formed one of the very important parts of human diet since the time immemorial. The fact that fishes are readily available sources of generous amounts of complete protein and of a great variety of vitamins and minerals make them a valuable food for women during pregnancy and lactation, for children during their periods of growth and maturation and for our growing population of senior citizens (Jha, 2018). At least a three-fold increase in animal protein supply is required for optimum health of many rural people. Nepal should promote small-scale aquaculture by setting immediate and long-term objectives. The immediate need is to increase awareness among rural communities of the potential for backyard fish farming, while in the long term, commercial aquaculture should be encouraged (Bhujel et al., 2008). Also, fish contribution to household food and nutrition security depends upon availability, access, and cultural and personal preferences (Beveridge et. al., 2013).

Fish has been considered “living cash” and a pond a “saving bank” because fish can usually be harvested throughout the year when needs arise (Bhujel et al., 2008, Shrestha et al., 2012). Based on the previous result of our school pond program, educational efforts were focused on to create more awareness on different cultural practices for better fish production and consumption.

OBJECTIVES

The overall goal of this project was to educate rural communities on aquaculture practices and nutritional value of fish through establishing pond in the school and training students, teachers and women. The specific objectives were:

1. To expand outreach on school ponds in villages and methods of aquaculture in general to the communities near our target schools.
2. To conduct surveys to determine recent changes in fish culture practices in rural areas of Nepal and the sources of information that led to these changes.

MATERIALS AND METHODS

Two public schools were selected in Chitwan and Nawalparasi districts of Nepal (Figure 1). Ponds approximately 75-105 m^2 in area were established at each school (Table1). Ponds differed in design due to land available for a pond, location within the school, and soil permeability (Figure 2 and Figure 3).

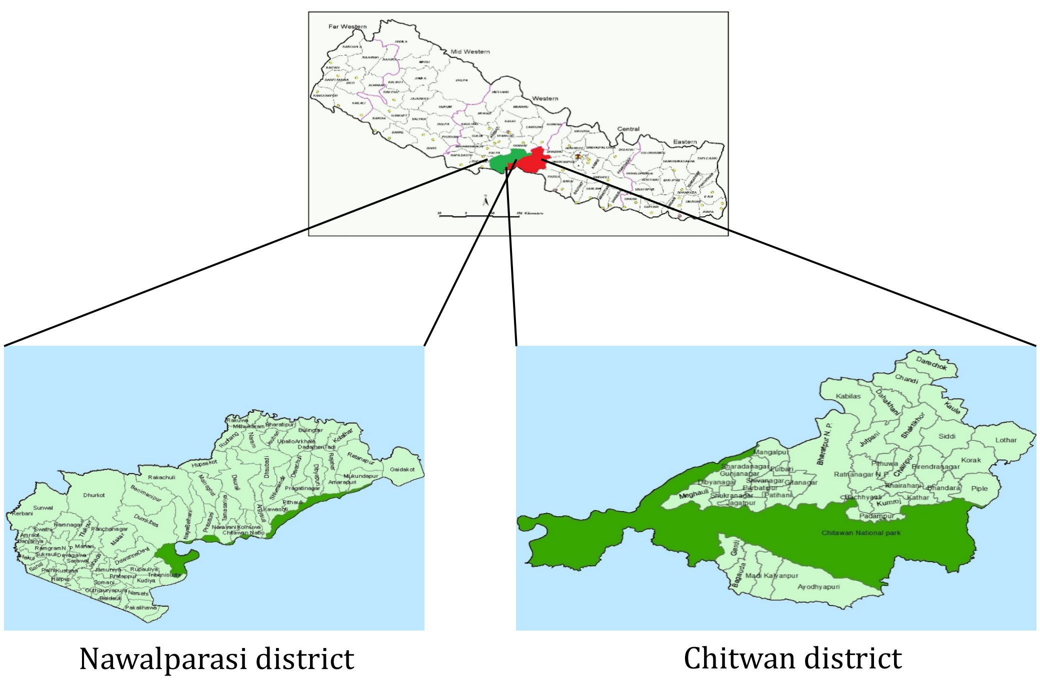

Figure 1. Map of Nepal showing the location of Chitwan and Nawalparasi districts

Table 1. Name of schools, location, size, and type of fish ponds in the present study

School Name	Address	Pond Size	Pond Type
Annapurna Secondary School	Parwatipur, Chitwan	10 m x 7 m	Concrete tank
Chandeswori Secondary School	Godar, Nawalparasi	15 m x 7 m	Earthen pond with plastic lining

Figure 2. Fish pond constructed at Chandeswori Secondary School, Godar, Nawalparasi

Figure 3. Fish pond constructed at Annapurna Secondary School, Parwatipur, Chitwan

Carps and tilapia were provided for each school from nearby private fish hatcheries, and were stocked in each pond at 10,000 and 3,000 fish/ha, respectively. The carp species included silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*), common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*), rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*), stocked at a combined density of 10,000 fish/ha. In addition to carps, monosex tilapia (*Oreochromis niloticus*) were added to each pond at 3,000 fish/ha. Stocking ratio of different carps (%) is given in Table 2. The materials necessary to maintain ponds, including feed and fertilizer, were provided to each school. One cycle of fish culture was demonstrated with the participation of school teachers and students.

Table 2. Stocking ratios of carp at each school

	Carp stocked (% of total)						
School	Silver	Bighead	Common	Rohu	Naini	Grass	Tilapia
Annapurna	14	11	21	11	7	7	21
Chandeswori	21	16	32	16	11	11	31
Species Composition	20%	15%	30%	15%	10%	10%	22%

A course of study was developed to educate teachers and students about fish culture. About 40 students from grades eight, nine, and ten and three teachers were selected from each school to receive regular training on fish culture. School students and teachers received regular training from the principal investigators and other experts about fish nutrition, pond measurement and farming activities, with similar lessons for both groups. Training of teachers and students included fish pond development, managing pond depth, pond preparation, species choice, water color, fertilizing, feeding, grow-out, and harvesting of fish. In addition, we included nutrition education, including fish preparation and eating, in the training. Twelve sets of training were conducted in total. Students and teachers were expected to be responsible for long-term maintenance, sales, and income generated from the school ponds.

We formed two women's fish farming groups in each school community for further training activities. A training workshop was organized by the project team at each school with a women's group. The topic was the role of household aquaculture in family nutrition and income. A linkage was developed so the women's fish farming groups could ultimately work with the teachers and students to ensure long-term sustainability of the school ponds.

Two tests were designed to evaluate the knowledge of students in fish pond production, as well as their knowledge about the benefits of fish nutrition. The tests were administered before and after training given in each school system.

Also, a survey was carried out at four locations in Chitwan and Nawalparasi districts of central Nepal to assess the status of fish farmers, their culture practices, and impact of fish farming on economic, nutritional, and social aspects.

District	Location	Program carried out by AquaFish	Number of farmers surveyed
Chitwan	Khairahani 10	School Pond, CST* polyculture	50
Chitwan	Kharahani 12	Periphyton enhanced aquaculture	50
Nawalparasi	Kawasoti	School pond	50
Nawalparasi	Madhyabindu	Periphyton enhanced aquaculture	50

* CST = Carp, Sahar and Tilapia polyculture

Khairahani 10 in Chitwan district included Kathar and adjacent area and was considered as Chitwan-1 during survey, while Khairahani 12 included Majhui, Kapiya and other adjacent areas and was considered as Chitwan-2. Similarly, Kawasoti in Nawalparasi included several wards of Kawasoti Municipality and was considered as Nawalparasi-1, while Madhyabindu in Nawalparasi included several wards of Madhyabindu and Devchuli Municipality and was considered as Nawalparasi-2 during survey.

RESULTS AND DISCUSSION

Two public schools were selected for establishment of school ponds in Chitwan and Nawalparasi districts of Nepal (Table 1 and Figure 1). Ponds differed in design due to land available for a pond, location within the school, and soil permeability.

Ponds were initially stocked on different dates and harvested after 180 to 210 days (Table 3). Stocking ratios varied among schools due to availability of fry, but all ponds were stocked at 1 carp per m^2 (Table 2), and 0.3 tilapia per m^2. The students proved to be very good at fish culture, with yields in these ponds similar to commercial aquaculture in the region (averaging 4.5 $t \cdot ha^{-1} \cdot yr^{-1}$, compared to 4.9 $t \cdot ha^{-1} \cdot yr^{-1}$ for commercial aquaculture in the country) and overall survival (carps+ tilapia) ranging from 72 to 80%. Due to small sample size (only 2 school ponds), statistics could not be done on these results. However, tilapia showed better survival than carps (Table 4). In addition, feed conversion efficiency was relatively good averaging 1.9 (1.7-2.1). Grow-outs were conducted through both summer and winter months, with water temperatures averaging about 29.2°C and ranging from 18.3 to 32.7°C. Water quality was never an issue during grow out (Table 5).

Table 3. Stocking and harvest data for each school pond

School	Pond Area (m^2)	Total stocked weight (Kg)	Total harvested weight (Kg)	Culture period (Days)
Annapurna	70	0.815	14.01	210
Chandeswori	105	1.240	29.09	180

Table 4. Extrapolated net yield, gross yield, survival, and feed conversion ratio (FCR) for each school pond.

School	Net yield ($T\ ha^{-1}\ yr^{-1}$)	Gross yield ($T\ ha^{-1}\ yr^{-1}$)	Tilapia survival (%)	Carp survival (%)	Overall survival (%)	FCR
Annapurna	3.3	3.5	95.2	77.3	79.8	2.1
Chandeswori	5.4	5.6	87.1	69.8	72.3	1.7

Table 5. Important water quality parameters measured by the students. Mean±SE (range)

Parameters	Annapurna	Chandeswori
Temperature (°C)	29.9±3.4 (18.3-31.8)	28.6±4.8 (22.4-32.7)
Dissolved Oxygen (mg/L)	3.6±1.1 (3.2-6.8)	4.5±1.2 (2.1-5.8)
pH	7.6 (8.1-8.3)	8.2 (7.3-7.9

Two tests were designed, before and after training to test the knowledge of students in fish pond production, as well as their knowledge about the benefits of fish to human nutrition. For each school, median grades for pre-tests were <40%, increasing to post-test medians near 80% (Tables 6). On the general perception of aquaculture and nutrition, the percentage of students obtained score below 40 was 25.6 % before training, while it decreased to 0 after training. Similarly, the percentage of students obtained score between 40- 60 was 48.2 % before training, while it decreased to 11.5% after training (T-test, $p<0.05$, Table 6).

Table 6. The percentage of students receiving different scores for tests related to overall aquaculture and nutrition taken before and after completion of the school pond class. Mean values with different superscript in the same row of same score range are significantly different (T-test, $p<0.05$).

	Before training				After training			
Score	<40	40-60	60-80	>80	<40	40-60	60-80	>80
Annapurna	40.0	52.0	8.0	0.0	0.0	17.5	32.5	50.0
Chandeswori	11.1	44.4	44.4	0.0	0.0	5.4	45.9	48.6
Mean	25.6±20.4^{a}	48.2±5.4^{a}	26.2±25.7^{b}	0.0±0.0^{b}	0.0±0.0^{b}	11.5±8.6^{b}	39.2±9.5^{a}	49.3±1.0^{a}

Tests results also indicated that students' initial knowledge about the nutritive value for fish prior was quite poor, with 51% of the students scoring <40 on the test, while it significantly decreased to 0% after training (T-test, $p<0.05$). Similarly, the percentage of students that scored between 40 and 60 was 32.5% before training, while it decreased to 15.5% after training (Table 7).

Table 7. The percentage of students receiving different percentage scores for nutrition related questions taken before and after completion of the school pond class. Mean values with different superscript in the same row of same score range are significantly different (T-tests, $p<0.05$).

	Before training				After training			
Score	<40	40-60	61-80	>80	<40	40-60	60-80	>80
Annapurna	66.0	26.0	6.0	2.0	0.0	17.5	32.5	50.0
Chandeswori	36.1	38.9	25.0	0.0	0.0	13.5	48.6	37.8
Mean	51.1±21.1[a]	32.5±9.1[a]	15.5±13.4[b]	1.0±1.4[b]	0.0±0.0[b]	15.5±2.8[b]	40.6±11.4[a]	43.9±8.6[a]

Students' initial knowledge about farming practices for fish prior was quite poor, with 18% of the students scoring <40% on the test, while only 5% scored <40% after training (T-tests, $p<0.05$). Similarly, the percentage of students obtained scores between 40% and 60% was 26.9% before training, but only 6.5% after training (Table 8).

Table 8. The percentage of students receiving different scores for aquaculture related questions taken before and after completion of the school pond class. Mean values with different superscript in the same row of same score range are significantly different (T-tests, $p<0.05$).

	Before training				After training			
Score	<40	40-60	61-80	>80	<40	40-60	60-80	>80
Annapurna	28.0	26.0	38.0	8.0	10.0	7.5	32.5	50.0
Chandeswori	8.3	27.8	61.1	2.8	0.0	5.4	43.2	51.4
Mean	18.2±13.9[a]	26.9±1.3[a]	49.6±16.3[a]	5.4±3.7[b]	5.0±7.1[b]	6.5±1.5[b]	37.9±7.6[b]	50.7±1.0[a]

It's difficult to attribute many changes in behavior to this program, due to the short time period for training (one year) and variability in consumption by individual households. There was no significant increase in household fish consumption after completion of the course, though it was 30.8kg per year after training and 23.7kg before training (Table 9). Approximately 17% of students lived in households with fish ponds, and one household built a new pond during the training period (Table 9).

Table 9. Details on students trained, students with household ponds, and fish consumption of students (number of times fish were eaten per year) for program students before and after completion of the school pond class. Mean values with different superscript in the same row are significantly different (T-tests, $p<0.05$).

School	Number of Students		Number with a Fish Pond		Fish Consumption (kg)	
	Before Training	After Training	Before Training	After Training	Before Training	After Training
Annapurna	50	40	6	7	22.3±27.8[a]	23.4±16.9[a]
Chandeswori	36	37	7	7	25.6±44.7[a]	38.9±40.3[a]
Mean	43	39	6.5	7	23.7±35.6[a]	30.8±31.2[a]
Total			13	14		

Establishing school ponds and a curriculum for school-age children and women's groups should be an effective approach to educate rural communities about the nutritional value of fish and methods of aquaculture. To create linkages with the community, this program organized two women's fish farming groups in the school communities. Members learned about the importance of household aquaculture for nutrition and income generation. Connecting the local women's groups to the school pond project spread the value of fish production and consumption among households and ensured long-term school pond sustainability.

Survey results indicated that there was a positive impact of the project on aquaculture practices. All aquaculture development programs, including trainings and experiments, were expected to cause some change in culture practices as well change in economic aspects of farmers. Table 10 shows the changes in aquaculture adopted by farmers on getting trainings.

Table 10. Changes in culture practice after training

	Chitwan-1	Chitwan-2	Nawalparasi- 1	Nawalparasi- 2
Change in culture practice				
Y	21	43	41	35
N	29	7	9	15
Type of change				
Feed	13	37	12	8
Fertilizer	4	6	24	11
Chemical	10	7	16	10
Disease	7	6	5	2
Water Quality	2	6	7	10
Stocking density	1	8	1	6
Production	3	10	0	11
Marketing	0	1	0	4
Area expansion				
Y	22	8	8	24
N	28	42	42	26
Change in pond design				
Y	26	6	21	24
N	24	44	29	26
Change in farming system				
Y	49	8	24	29
N	1	42	26	21
Change in feed type				
Y	32	45	14	7
N	18	5	36	43

Many farmers in Chitwan-2 and Nawalparasi-1 responded that they have adopted some changes in their culture practice after receiving some training while the number of farmers adopting change was lower in Chitwan-1 and Nawalparasi-2. Changes adopted by farmers in culture practice included feed management, feeding practice, fertilization, disease inspection, water quality management, stocking density, production and marketing strategy. Many farmers responded that they adopted changes in feeding (Figure 4), fertilization, and chemical use. Some respondents (10 from Chitwan-2 and 11 from Nawalparasi-2) also reported to have higher production after adopting new management practices. The largest number of farmers expanding farm size after training was in Nawalparasi-2, followed by in Chitwan-1. However, considerably higher number of farmers adopted some changes in their pond design after receiving training except in Chitwan-2. Changes adopted in pond design related to dyke slope, dyke width, water depth, water inlet, and outlet structures. The highest number of farmers adopting change in their culture system was in Chitwan-1, followed by Nawalparasi-2, Nawalparasi-1, and Chitwan-2. (Figure 5). Figure 5 shows the number of respondents adopting change in feed type after trainings and involvement in experiments.

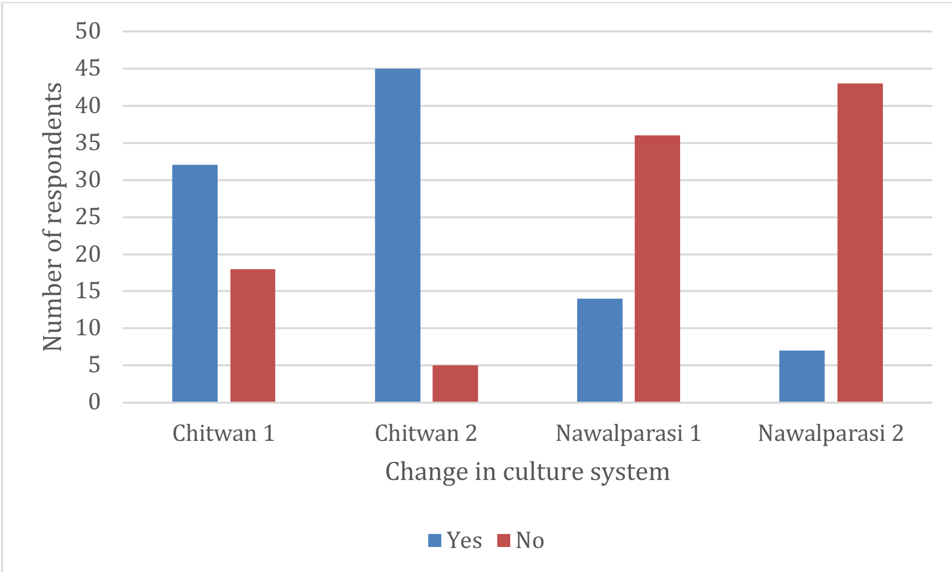

Figure 5. Number of respondents adopting change in feed type after training or involvement in experiments.

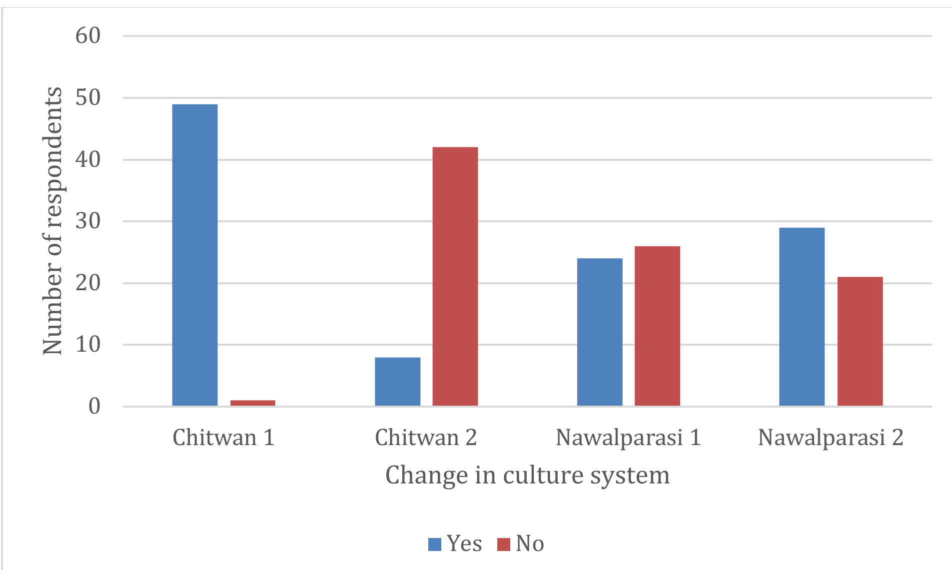

Figure 4. Number of respondents adopting changes in culture system after training and involvement in experiments

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