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Innovation for Agricultural Training and Education

Capacity Building for Agricultural Technical Vocational Educational and Training (ATVET) Programs in Developing Countries: A Case Study in Nicaragua

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1. INTRODUCTION

Technical and Vocational Education and Training, also known as TVET is defined in many different ways. The United Nations UNEVOC program defines it as a "program integrating education, training and skills development relating to a wide range of occupational fields, production, services and livelihoods" (UNEVOC, 2016).

A common thread in developing countries specifically in Central America, is the presence of ATVET programs that are outdated, under resourced and not very relevant to the economic and environmental challenges of these countries. This lack of training becomes a problem because people are practicing agriculture and forestry techniques in ways that are not productive or sustainable, which means agricultural resources are being used up, destroyed, and not saved (IICBA 2011). TVET programs in developing countries might need assistance to keep running, or even to get started up, in order for people to learn the best farming practices in a sustainable, safe, and productive manner. One of the main goals for many of these developing countries is to have TVET programs that are more accessible and useful to people so they can learn sustainable ways to practice agriculture. Meaningful TVET programs might have the potential to provide better opportunities for children and young in rural settings (Okoye and Okwelle 2014) and better agricultural TVET programs would have a positive impact on forestry, land management, agriculture, and livelihoods.

The motivation behind this case of study is to provide more knowledge on how to enhance the quality of agricultural TVET programs in developing countries with focus on capacity building for TVET teachers. As UNESCO (2012) has indicated, the quality of TVET teachers is fundamental in developing the skills of future TVET trainees. Qualified, trained and motivated TVET teachers are the corner stone for effective learning.

Although there are thousands of TVET establishments in Latin America, there are striking similarities in terms of structure, curriculum, and governance between the countries. Part of the task for this study is to better understand how each country manages their TVET programs. Therefore, the first part of this report will focus on describing in general terms how TVET programs are managed in each Latin American country. This analysis also includes a mapping of formal TVET programs at secondary (basic and upper) and post-secondary non-tertiary TVET programs. This mapping is important to geographically locate TVET centers and programs for further analysis.

The second part of this report includes an analysis of a high school TVET program in Nicaragua with the goal of identifying best TVET practices including the management, pedagogy, entrepreneurship, funding, and community involvement. The study and analysis of this particular TVET center in Nicaragua was recommended as part of a scoping missing conducted in 2014 by the USAID-funded InnovATE project. The case study also includes a survey of the TVET school's alumni with the goal to measure the impact of the TVET program in their personal and professional lives.

1.1. Background

This particular project is one of many TVET capacity developing initiatives under a larger USAID project called Innovation for Agricultural Training and Education (InnovATE). The project is under the leadership of Virginia Tech and includes partnerships with the University of Florida, Penn State University, and Tuskegee University. During 2014, a group of researchers working in the InnovATE project conducted a scoping mission in Nicaragua. Two specific recommendations of the scoping mission are critical to continued capacity development in agricultural education and training: 1) a case study on successful vocational programs for entrepreneurship, and 2) development of a train-the-trainer (T^3) program for agricultural vocational teachers in tropical countries to produce home-grown entrepreneurs.

On addressing the first recommendation, in-depth case studies that reflect successful vocational training programs are recognized as a key output for the improvement of other similar programs in the region Investigators visited the vocational training program FADCANIC in Wawashang, Nicaragua to document educational efforts in entrepreneurship through interviews with administrators, teachers, students, and alumni. Visits and surveys to alumni are critical to verify and quantify of the impact the training program in developing successful entrepreneurs. The visit to the FADCANIC TVET school and survey of alumni of the same school were also fundamental to understand best TVET practices. Results of the work conducted at FADCANIC were as a base to propose a larger capacity building initiative that can support similar efforts in other countries in Latin America among other countries included in the InnovATE project.

Regarding the second recommendation, it was necessary to find an international partner with outstanding recognition on agricultural teaching and wide knowledge of issues impacting TVET education in developing countries. The research team was able to make contact with EARTH University, a higher education teaching institution with a strong reputation for producing high performing entrepreneurs for the agricultural sector in developing countries. EARTH University accepted the opportunity to participate in the design of a train-the-trainer (T3) program for capacity development of TVET's teachers.

2. LITERATURE REVIEW

2.1. A definition of TVET

According to UNEVOC (2016), technical vocational education and training (TVET) is used as an equivalent to vocational education and training (VET) in some countries. The same organization defines TVET as all forms and levels of the educational process involving the study of technologies and related sciences and the acquisition of practical skills. Recently, it has been indicated that TVET programs provide students with the skills needed to achieve a middle-class lifestyle (Harbour 2015). TVET is also defined as any kind of education which has the main purpose of preparing one for employment in a recognized occupation (Kennedy, 2012). Kilbrink and Bjurulf (2013) mentioned that one of the most important issues in TVET is the interaction between school and the workplace. According to Ohimre and Nwosu (2013) nations cannot develop without vocational and technical education and the solution to economic development is total commitment to accepting vocational and technical education. The foundation of TVET is based

on providing skills and abilities that promote establishing self- employment and self-reliance for its students.

Existing TVET programs must adapt to a demand-led training system to provide beneficiaries with skills such as entrepreneurship and middle-level management to be able to gain access to economic opportunities. A well designed TVET program should be of the highest quality and relevance to be able to accept all citizens. In addition, TVET programs need to be flexible and adaptive to current market needs. A modern TVET program would recognize that training provision comes from a variety of sources including entrepreneurship and community leadership (IICBA 2011).

2.2. Capacity building for TVET teachers

Teachers greatly influence the effectiveness of TVET (UNEVOC 2012). One problem of TVET is the modernization of teachers' training programs and bringing them into line with the requirements of the professional standards is not being met (Margolis 2014). Teacher learning takes place in official sessions and through everyday action in the workplace (Bound 2011). Teacher training can be done by identification of the learning needs of the teachers themselves, examination of the constraints in the activity of the teachers along with social, political, and economic contextual circumstances that impact TVET teachers (Bound 2011). One study on TVET teacher training programs examined teams of teachers designing or re-designing their study programs to be more competence-based (Wesselink, et al. 2010). In this program, teachers reported an increase in understanding the state of affairs of their study programs, and empowered them to make decisions about the extent to which they want to make these programs more competence-based.

Recent research in TVET programs indicates that there are challenges in understanding why there is not enough TVET education (Llorente 2012). Some specific challenges are the attitude toward TVET programs and the problem of not having enough manpower and money to support the programs (IICBA 2011). New skills need to be taught through TVET, to advance new challenges such as globalization and sustainability, information technologies, emergence of knowledge society and rapid knowledge obsolesces (IICBA 2011). Therefore, training of the teachers must be updated as well in order to keep up with these new challenges.

The International Project on Technical and Vocational Education (UNEVOC) is endorsing teacher training in vocational education to help people transition from school to work (UNEVOC 2012). The needs of the TVET teachers were examined and results indicated that teacher qualifications could be increased and/or improved by giving the teachers training and updating their skills (IICBA 2011 and Piñero and Storni 2011). This conference report also points out that teacher transformation for TVET is different than for primary and general secondary schools. One of the main differences between TVET teachers and academic teachers is that TVET mandates that the teacher should have knowledge in their field of teaching, where academic teachers need a degree.

Teacher factories are another way for TVET students to have more opportunities. Teacher factories are where TVET teachers have industries come have their production in the TVET School, this is a way that the students can learn many new skills (UNEVOC 2012). It is important to motivate TVET teachers to

bring in these industries and learn these new skills and transfer those to their students. However, TVET teachers feel that the most important aspect about training is to master the technical subjects, with pedagogic knowledge and skills treated as an insignificant addition to the vocational subjects (Mohamad, Saud, and Ahmad, 2009).

3. OBJECTIVES AND METHODOLOGY

The goal of this project is develop a TVET capacity building framework to support the improvement of agricultural and agroforestry education in developing countries. The specific objectives include:

1. To develop a database of formal TVET establishments in Latin America
2. To conduct a case study on the TVET FADCANIC School in Wawashang, Nicaragua to identify best TVET practices
3. To develop a train-the-trainer proposal for capacity development of TVET teachers in selected developing countries

The first objective involves the development of a database of formal agricultural TVET establishments in Latin America. There is little published on the location of TVET establishments. Mapping the location of TVET centers is important because it creates opportunities for developing research on relationships with economic, social, and environmental variables. Location can be used to gain access to the TVET centers for marketing and policy development purposes related to capacity building programs. Data was sought from secondary sources using internet searches, peer-reviewed papers, and reports from global organizations such as UNESCO. The data was organized into a spreadsheet in MS Excel following a standard template. Fields included in the template are: address, city, province/state, country, type of funding, location (longitude and latitude), enrollment, contact information, market, source of data, and focus of the program. When all the available data was included in the spreadsheet, the data was exported to Google Maps for easier visualization.

As indicated in the background section, one of the most significant outputs of the scoping mission in Nicaragua conducted by InnovATE researchers was to return to the FADCANIC TVET school in Wawashang to conduct a case study on best TVET practices. Areas of focus included curriculum, infrastructure, teaching methodology, student life, funding, and alumni, community and industry relations. In-depth case studies that reflect successful vocational training programs are recognized as a key output for the improvement of other similar programs in developing countries. To follow through with this work, various documentation techniques were used including interviews with administrators, leadership, students, and technicians. Additionally, direct observation, document gathering and a survey of alumni were employed. The main outputs of this visit were a strength, opportunities, weaknesses, and threat (SWOT) analysis and a list of best TVET practices.

The survey of FADCANIC alumni was implemented to gain knowledge on the long-term impacts of the FADCANIC TVET school. The survey consisted of multiple choice, open essay, and questions based on Likert scales. The first part of the survey included questions regarding demographic aspects such as gender, ethnic group, socio-economic status, family data, and graduation data. The second part included a series of Likert type questions group in four constructs or latent variables. A copy of the survey is

included in the Appendix section. The survey was implemented in hard copy as many of the alumni did not have access to internet. The implementation was conducted by the sub-director of the FADCANIC TVET school between November 15, 2015 to December 31, 2015. A total of 80 alumni were contacted and 69 responded to the survey. Several statistical analyses were used to analyze the data including frequency distributions, contingency tables, multiple linear regression, and multivariable analysis of variance.

The third objective of this work consisted of investigators conducting a site visit and series of interviews in late-February 2016 at the Escuela de Agricultura de la Región Tropical Húmeda (EARTH) University in Guácimo, Costa Rica. EARTH was established in 1986 with the support of the Costa Rican government, USAID, and the Kellogg Foundation. The goal of this visit was to collect data to develop a train-the-trainer (T3) proposal for TVET teachers with the support of EARTH University. In addition to interviews to the administrators of the continuous education program (PEP in Spanish) at EARTH University, a tour of campus and visits to sustainable communities were conducted. The campus tour was appropriate to gain a first-hand understanding of the teaching model at EARTH, inspect fields, laboratories, classrooms and other infrastructure. The visits to sustainable communities were important in order to understand how knowledge at EARTH University is transferred to the communities and industries.

4. RESULTS

4.1. Database of TVET centers in Latin America

4.1.1 TVET systems in Latin America

The definition of TVET education in Latin America varies for almost each country. However, formal TVET education in Latin America is similar between the countries in the region. Formal TVET in Latin America is available in high school, post-high school professional institutes (non tertiary), and higher education (tertiary). Formal or non-formal education is managed and offered by diverse institutions in each country such as ministries, national agencies, training centers, and private organizations (UNESCO 2013).

The differences in TVET enrollment of each country in Latin America varies depending on many factors. Table 1 shows that Guatemala has the highest enrollment in TVET as a percentage of enrollment in secondary education. Second is Ecuador with a 73.54% and third is El Salvador with a 55.3%. On the contrary, Nicaragua has the lowest enrollment in TVET with a 4.59% and Dominican Republic is the second lowest with a 7.32%. Other interesting statistics show that Cuba is the Latin American country that spends the most per student in secondary education with $9,434/student. The country that spends the least is Nicaragua with only $289/student.

Gender distribution in TVET in Latin American countries is very similar overall, see Table 1. Countries such as Guatemala, El Salvador, Nicaragua, Costa Rica, Colombia, Brazil, Paraguay, and Dominican Republic have more females enrolled in TVET programs than males. The biggest disparity on gender differences is seen in the case of Uruguay where the male enrollment is 10 percentage points higher than the female enrollment.

Table 1. Statistics on secondary and TVET education in Latin America (UNESCO 2014)

Country	Enrollment in secondary education (millions)	GDP per capita (US$)	Expenses per student in secondary education (US$)	Year	TVET enrollment as % of secondary enrollment (male)	TVET enrollment as % of secondary enrollment (female)	TVET enrollment as % of secondary enrollment (total)
Argentina	4.20	12,012	4,674.7	2013	21.11	9.07	14.64
Mexico	14.40	16,734	2,527.0	2011	9.49	8.22	8.85
Guatemala	1.80	5,019	395.8	2013	79.69	83.59	81.64
Belize	0.05	7,937	1,767.5	2013	15.79	11.92	13.74
Honduras	0.91	4,174	803.5	2013	47.99	44.20	45.84
El Salvador	0.77	6,991	801.7	2010	53.82	56.76	55.30
Nicaragua	0.61	4,006	289.1	2010	4.06	5.03	4.59
Costa Rica	0.38	12,733	NA	2013	29.23	31.61	28.53
Panama	0.41	16,346	1,570.9	2011	48.65	41.49	44.84
Colombia	5.00	10,436	2,110.9	2013	25.52	25.72	25.63
Venezuela	2.80	13,267	2,741.7	2009	18.19	16.12	17.10
Ecuador	1.80	9,637	1,972.6	2013	75.56	71.61	73.54
Peru	2.80	10,765	1,221.9	2013	NA	NA	NA
Bolivia	1.30	5,196	1,169.2	2011	NA	NA	NA
Brazil	20.00	11,716	3,514.0	2012	15.13	16.46	15.85
Uruguay	0.31	15,776	1,322.8	2006	26.32	16.58	20.98
Paraguay	0.82	6,038	1,232.2	2012	21.83	21.87	21.85
Cuba	0.83	6,051	9,434.5	2010	58.01	39.12	48.79
Dominican Republic	1.20	10,038	1,769.9	2013	5.95	8.53	7.32

4.1.2 TVET structure and Agricultural TVET in Latin America

Before presenting the database of TVET centers, it is important to summarize the basic structure of TVET and agriculture TVET in Latin America. This summary provides a better understanding of how TVET is managed, led and delivered in each country across Latin America.

Mexico: (INEE 2010): The educational system in Mexico includes these levels: basic, medium superior and superior. The basic type includes initial, special, and adult education. The medium superior consists of high school, terminal studies, and other equivalents. The superior type includes bachelor's, licenciate, master's and doctoral degrees. The superior medium subsystem has three modalities: general, technological, and professional and technical education. Technological education is a group of institutions that were created to provide research, technological development, outreach, and cultural dissemination and they are under the SNET (Sistema Nacional de Education Tecnologica). The formal TVET system is offered at the secondary (high school) level where students have the option of pursuing a

general secondary school program with the goal to prepare students for higher education or to pursue a vocational and technical program (five years) to prepare students for the job market or higher education (UNEVOC 2016).

Guatemala: The national educational system in Guatemala is formed of initial education, pre-elementary, elementary, medium level, and higher education. The medium-level subsystem is divided in two cycles: basic and diversified. The diversified cycle focuses on two areas: science and technical. Alumni of the technical track in the diversified cycle can specialize in agriculture, commercial, industrial, business management, financial, marketing, communications and art. Alumni from the diversified cycle can continue to enroll in higher education institutions or find jobs. INTECAP (Instituto Técnico de Capacitación y Productividad) is the Guatemalan authority that oversees TVET programs, and it has autonomy from the Government.

Belize: The formal TVET system is part of the high school system which is divided into general and vocational and trade education. At the end of the high school education, students in Belize could opt for three different degrees: Caribbean Examinations Council Certificate (CXC), GCE Ordinary-Level Examination and (after additional two years) the GCE Advanced-Level Examinations (UNEVOC 2016). The Institutes for Technical and Vocational Education and Training (ITVETs) are the organizations responsible for providing formal TVET.

Honduras: The educational system includes two subsystems: schooled and non-schooled. The schooled system includes the following levels: pre-school, elementary, basic, medium, and superior. Medium education includes two cycles: common and diversified. The diversified cycle has as a goal to prepare the student to become employed into the economic sector or to continue pursuing a higher education degree. INFOP (Instituto Nacional de Formacion Profesional) is a public organization that regulates and deliver TVET education in Honduras.

Nicaragua: In Nicaragua the educational system includes general education, professional formation, and higher education. The general education subsystem includes pre-school, elementary, adult, special, and high school education. The Ministry of Education is the entity in charge of the general education system. The professional formation subsystem is under the leadership of INATEC (Instituto Tecnologico Nacional), created in 1991, which is public and has government autonomy. The focus of the professional formation subsystem is on agronomy, industry, and business management. The higher education subsystem includes Technical Superior Centers and private and public universities and is under the control of the National University Council (OEA).

Costa Rica: The structure of the Costa Rican educational system includes: pre-school, basic general education, diversified education, and higher education. The diversified education subsystem offers the possibility to choose among academic technical or arts-based programs. If a student chose the technical or art pathway the student will obtain a high school degree and a Medium Level Technical degree.

Technical and Professional education is a subsystem of the general educational system in Costa Rica and it is part of the Costa Rican Technical High Schools. There is an integrated system for technical education under the direction of the National Learning Institute (INA), the Ministry of Education, community

colleges, and universities. In this database, only INA TVET centers are included. In Costa Rica there are 135 Professional and Technical High Schools (Colegios Tecnicos Profesionales) with an enrollment of about 85,000 students (MEP 2014).

Panama: The formal TVET system is composed of high schools or institutes. INADEH (Instituto Nacional de Formacion Profesional y Capacitacion para el Desarrollo Humano) is a public institution in Panama that helps to support the TVET system.

El Salvador: There are two modalities: formal and non-formal. The formal system includes the levels initial, kindergarten, basic, medium and superior. The medium education modality offers two options: a general and a vocational and technical track. Both tracks allow students to continue to enroll in higher education institutions or to search for jobs. The national institution that oversees technical education in El Salvador is INSAFORP (Instituto Salvadoreno de Formacion Profesional), which is a public organization with autonomy from the government.

Colombia: The formal TVET system in Colombia includes secondary education establishments, institutions of higher education and training centers run by SENA (Servicio Nacional de Aprendizaje), which is a public institution. Secondary education in Colombia is divided into the academic and technical tracks. The technical track is further divided in the following tracks: industrial, commercial, pedagogical, agricultural, and social promotion. Higher education in the field of TVET is provided by technical professional institutions. There are 54 technological institutes and 39 professional technical institutes that provide higher education in field of TVET (UNEVOC 2016).

Bolivia: Formal technical education in Bolivia is concentrated in high school education. There are 13 technological high school institutes (8 in urban areas and 5 in rural settings) that are regulated by the government organization called Sistema de Educacion Tecnica y Tecnologica (SINETEC). There are also 26 establishments that offer technical education post-high school (OEI 1997). Other alternative TVET systems are composed of the following institutions: Servicio Nacional de Alfabetización y Educación Popular (SENALEP), Instituto Bolivariano de Aprendizaje (IBA) and INFOCAL.

Dominican Republic: The educational system is divided into initial, basic, medium, and superior. The medium subsystem includes three modalities: general, arts, and professional technical. The professional technical modality offers students the chance to obtain general and professional education. This modality offers a basic technician degree to quickly integrate to the job market. The institution that oversees the professional technical modality is INFOTEP (Instituto Nacional de Formacion Tecnico Profesional), a public entity with autonomy from the government.

Cuba: There are 447 TVET centers with an enrollment of over 189 thousand students distributed in 52 tracks in 2014 (UNEVOC 2016(a); ONE 2014). On the agriculture track, there are 164 TVET centers. TVET programs are led by the Directorate of Technical and Vocational Education under the Ministry of Education. In 2014, the enrollment in TVET center in agroindustry was 16,737 (it was 45,605 in 2009)

Venezuela: According to the current legislation TVET in Venezuela is organized in general high school (five years) and technical high school education (6 years) (Ramirez Angulo and Leon Salazar 2012),.

There are 277 TVET high school establishments in Venezuela; 134 are Agricultural Technical Schools. Some of the TVET schools are called Robinsonian Technical Schools in Venezuela (a political term coined to honor a Venezuelan national hero).

Paraguay: Formal TVET is offered though secondary education with 24 technical tracks in industrial, agricultural, and service sectors. About 60,000 students are enrolled in 600 technical high schools in the country (UNEVOC 2016). Post-secondary TVET is offered through "Tecnicos Superiores" with an enrollment of 10,000 students in 287 institutions (87% are private institutions).

Uruguay: According to Hernandez, Rey and Travieso (2013) there were about 75,000 students registered in TVET in 2010 in Uruguay. TVET is offered in Uruguay by a consortium, Consejo de Educación Técnico Profesional-Universidad del Trabajo (CETP-UTU) that also offers specific courses. CETP-UTU includes 134 establishments across the nation including technical schools (67.1%), basic technical centers (CBT with 15.7%) and agricultural schools (17.2%). Only 2,322 students were registered in the Agricultural and Fisheries TVET track in 2009 according to MEC (2009).

Chile: TVET is under the Ministry of Education. TVET is delivered through two systems: high school education (EMPT) and professional technical education (ESTP). TVET in EMPT is organized in 14 economic sectors and 46 tracks. There are 600 TVET centers (EMPT) with over 200 thousand students registered. Out of this total population, only 7,440 are in the agroindustry track (MEP 2012).

Ecuador: TVET in Ecuador is under the responsibility of the Ministry of Education and Culture and the Ministry of Labor and Human Resources. The total offering from technical high schools covers 20 industries which include over 400 thousand students enrolled in TVET with 13 thousand in agribusiness (Velasco 2005). In the past, Ecuador has had important international collaborations to develop TVET mainly from Spain. SECAP (Servicio Ecuatoriano de Capacitacion Profesional Publica), a public organization, provides capacity building for TVET programs in Ecuador.

Peru: In 2012, there were over 2.4 million students enrolled in high school education in Peru. About 9% of the graduates from high school prepare for a technological career with only 6% in technical education. The TVET student population in Peru is approximately 350,000 with only 20% of these in the agricultural production sector. There are 720 TVET institutes in Peru with 401 of these being private (ASISTE 2016).

Brazil: The government has separated high school education from technical and vocational education as high school education is the last stage of formal education. Those interested in pursuing a TVET program enter a post-secondary program (Herran and Rodriguez 1999). UNEVOC (2016) however says that formal TVET is offered in parallel and in conjunction with secondary education. The Ministry of Education supports a network of vocational education schools aimed at the service, industry, and agriculture sectors. There is also the option to enter an apprenticeship program and pursue TVET in higher education which has duration of three years. There are 31 Federal Institutions, 75 decentralized teaching units, 39 agro-technical schools, seven federal technical schools, and eight schools linked to universities and a federal university of technology.

4.1.3 A database of TVET centers in Latin America

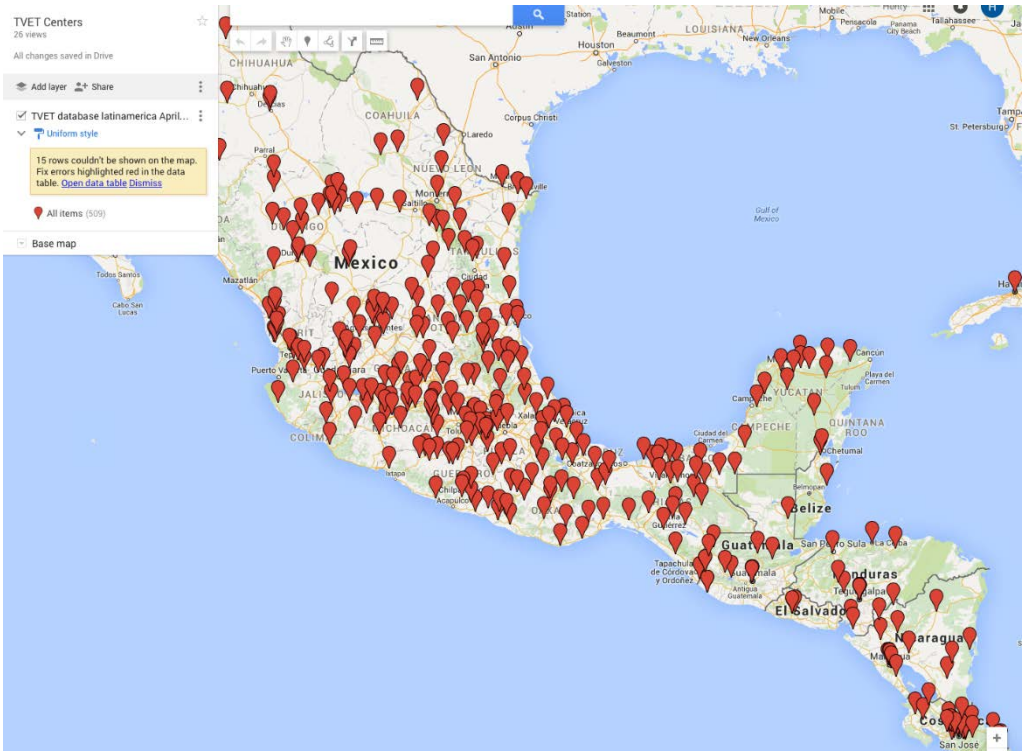

Figure 1. Partial visualization of TVET centers located in Latin America.

A search based on secondary sources was conducted to identify TVET centers in Latin America. The sources included free-access internet documents and other databases, peer-reviewed articles, and reports from international organizations related to TVET. All data was input into a MS Excel spreadsheet following a predefined format. The fields in the format included address, city, province/state, country, type of funding, location (longitude and latitude), enrollment, contact information, market, source of data, and focus of the program. Latitude and longitude coordinates were used to visualize the data into an interactive mapping tool.

TVET centers in the database are a mix of high schools (basic and upper secondary level), post high school non-tertiary, and tertiary TVET centers with a focus on agricultural, agroindustry or agroforestry education. The database is not comprehensive and does not include TVET centers under ISCED 5 (tertiary TVET centers or higher education) as it is limited to secondary (basic and upper) and post secondary non tertiary data. The database includes only formal private, public and non-profit managed TVET centers. Formal TVET is supervised and regulated by the government with credits and course work officially approved for students to continue to higher education or obtain a government-validated certification.

Once the data was collected and validated, Google maps was used to visualize the list of TVET centers, see Figure 1. The tool can be accessed in the web site http://sim.sbio.vt.edu/?page_id=2315, managed by Virginia Tech.

4.2 FADCANIC TVET program case of study

The goal of the case study was to determine and understand the features that make the Center for Agroforestry and Environmental Education (CEAA) school successful. Specific objectives of the case study were:

- Interview funding organizations, administrative personnel, faculty, students, and alumni in order to find out strengths and weaknesses of the CEAA's model

- Understand the regional, social, and political context where CEAA and the Center for Agroforestry (CAF) are embedded and the role of external and internal support organizations such as Norwegian Students' and Academics' International Assistance Fund (SAIH), USAID, and the National Institute of Technology of Nicaragua (INATEC).

- Develop specific strategies that similar organizations in other developing InnovATE-targeted countries could follow to replicate CEAA's model.

Interviews, on-site tours and document analyses were conducted to meet the objectives. A total of 22 people were interviewed (face-to-face and by phone) to collect the data. The position and organization of each person is described as follows:

- Co-Director, CEAA
- Director of Education Programs, FADCANIC,
- Director, CEAA
- Director, CAF
- Director, FADCANIC
- USAID Mission personal at the US Embassy in Nicaragua
- Bureau Environmental Officer, LAC – USAID/DC
- Senior Infrastructure Engineer, Office of Energy and Infrastructure – USAID/DC
- Director of the General Development Office, USAID Mission
- SAIH Program Manager in Norway
- Marketing Director, CAF
- Four teachers, CEAA
- Four students, CEAA
- Tree alumni, CEAA

The visit to the CEAA school and the CAF took place between October 18-23, 2015. The trip itinerary can be found in the Appendix section.

Figure 2. A CEAA's student speaks during the research team visit

4.2.1 The Center for Agroforestry and Environmental Education (CEAA)

Since its inception in 1990, the Foundation for the Autonomy and Development of the Atlantic Coast of Nicaragua (FADCANIC) has worked to improve the quality of social, economic, and political relations of the indigenous and ethnic communities of the Atlantic Coast of Nicaragua. The Center for Agroforestry and Environmental Education (CEAA) is a key educational program of FADCANIC. The CEAA started in 2004 funded mainly through the Norwegian Students' and Academics' International Assistance Fund (SAIH) with more recent funding received from the United States International Agency for Development (USAID). CEAA offers a basic rural technical degree (TBR) and a medium rural technical degree (TMR) which is equivalent to a high school degree. The emphasis areas for each degree are either agroforestry or carpentry.

CEAA has a current population of 202 students from seven different ethnic groups from the Atlantic Coast of Nicaragua. Approximately 43% of the current student population is from the ethnic group Mestizo, 17% Miskito, 15% Mayagna, 15% Creol, 5% Garifuna, 5% Ulwa and 2% Rama. Currently the school employs 20 teachers and 23 technicians. Teachers have degrees in Agroforestry and Agronomy (Licenciate and Engineering) and technicians have degrees from the same CEAA school. In addition to technical skills in agroforestry and carpentry, students also receive training in leadership, communication, and entrepreneurial skills (see Figure 2).

The CEAA school manages three farms that encompass 105 hectares (ha). About 79 ha are considered as farming land and the rest is labeled as forest (15 ha), swamp (2 ha), and other uses (9 ha). The farming

lands are used for different cultivars as shown in Table 2. In addition, there is a 450 hectare wildlife refuge in a nearby location managed by FADCANIC.

The CEAA school infrastructure includes 20 buildings that are used as dormitories, classrooms, a restaurant, production facilities (for CAF), offices and kitchen. Most of the buildings are made of concrete about 10 feet tall except for a two-story building made of wood and concrete that is used as a dormitory for guests or interns coming from universities or other countries. In all cases, bathrooms are shared. The buildings lack proper use of sunlight and openings for ventilation. There is no air conditioning in any of the buildings. Recently, a large open building was added to the campus that is used for large meetings or cultural presentations. The school also has a large roofed gymnasium and an open field to practice outdoor sports such as baseball or soccer. The carpentry program is housed in a rectangular building that lacks proper natural lightning and ventilation. There is a side building where wood finishing processes are performed that is also used for lumber storage.

Table 2. Land uses for the CEAA school property (CEAA 2016)

Land use	Area (ha)
Pineapple and citrus lot	1.50
Grafted citric lot	0.93
Hearth palm and pejivalle fruit	2.50
Cocoa production	16.03
Musaceas production	5.50
Sugarcane	1.77
Malanga root	1.50
Cassava root	2.50
Coconuts	25.00
Birds grazing	1.38
Pigs grazing	1.00
Sheep grazing	1.03
Other grazing	0.50
Ceiba mall	0.70
Nitrogen bank	0.40
Bovine grazing	3.00
Pigs grazing lot 2	3.30
Forest enrichment	7.00
Reforestation project	3.22

The CEAA school does not have access to electricity from the grid due to its remote location. Therefore, solar panels and fossil fuels are used to generate electricity. A total of 60 batteries are used with the solar system to power most of the buildings. There is a fossil fuel power plant capable of generating 18,000 watts per hour that is used only for the operation of the carpentry program. This generator consumes about 110 gallons of diesel each week. Meals for students and teachers are cooked using firewood that is locally produced at the school or donated by local farms. About 2500 rajas (splits) are used every week for cooking, all transported and split by the students. Some of the firewood is also used in by the CAF program to support its dehydration process. Internet access is acquired through a satellite linkage and it is only available in one of the administrative buildings but not available to students or

visitors unless requested. Cell phone reception with local carriers is acceptable and many of the students and teachers have cell phones (including smart phones) to communicate.

In conjunction, the school and CAF operate a water treatment plant to purify water needed for human consumption, academic activities and for the CAF value-added processes. About 1500 liters are purified every day. Recently, the school inaugurated a rain collector system to collect water from the buildings' roofs but also collects water from a nearby creek during the dry months.

Since its inception in 2005, 213 students (167 males and 46 females) have graduated from the CEAA school. Out of this total, 156 are currently pursuing an advanced degree and 56 went directly to employment or entrepreneurial enterprises. During the same period, the CEAA provided education and training to an additional 922 youth in short-term education.

With the support of SAIH and USAID, CEAA has excelled in providing educational, entrepreneurial, and professional opportunities to the at-risk youth population in the region. Students who graduate from the program develop entrepreneurial skills to return to their farms and set up their own business activities. Many continue to pursue higher education degrees in local universities. A third career pathway could be to seek employment in one of the local agricultural or agroforestry industries in the region.

4.2.2 The Center for Agroforestry (CAF)

Figure 3. Coconut oil ready to be packed and distributed to local markets in Nicaragua

The Center for Agroforestry (CAF) is a value-added generation program attached to CEAA also under the leadership of FADCANIC. The Center for Agroforestry transforms agroforestry products into value-added products that are then sold in the local market in the Atlantic Region. In addition, CAF acts as a research center focused on improvement of tropical crops through various mechanisms and transferring results to at least 2,000 families in the region. CAF employs 60 people (in addition to CEAA employment) as field workers, processing, administrative, and marketing positions. The main products produced at CAF are coconut oil (see Figure 3), palm heart, fruit and vegetable flours, and cocoa powder marketed under the Wawashang brand and currently sold on site at FADCANIC's locations under a special permit. However,

CAF is very close to finally obtaining government permits to be able to expand CAF's distribution channels to supermarkets and similar venues.

Even though CAF is making good progress in the path of becoming self-sustaining, the majority of operational funds still come from the program Agenda for Innovation (Agenda para la Innovación), a separately funded FADCANIC program. CAF needs to continue to promote their brand not only in regional markets but also in national and export markets. If CAF is to become self-sustained, it would need to improve their current production capacity and considerably strengthen their marketing efforts (pricing, promotion, distribution channels and product offering).

4.2.3 SWOT analysis and best practices of CEAA and CAF

Table 3. Strengths, weaknesses, opportunities and threats of the CEAA and CAF programs at FADCANIC

Strengths	Weaknesses
• Value-added generation • Entrepreneurship orientation • Land availability • Excellent teachers • Integration with local communities and universities (UNA,UCA, BICU, URACAAN)	• Diversity issues: gender and ethnical • Social conflicts: isolation for students • Poor marketing of own products • Very little support from the Nicaraguan Government • Lack of funding • Poor integration with industry • No planned training for teachers • Access to electricity, internet, and water
Opportunities	**Threats**
• Unique TVET model in Atlantic Coast • Focus on sustainability • Growing population and demand for other TVET programs • Excellent reputation • Extensive alumni network	• Funding sources • Transportation issues • Political landscape • No clear succession line of FADCANIC leadership

CAF and CEAA are two of the most important programs of FADCANIC in the Atlantic Region of Nicaragua. Both programs are located on a 105-hectare farm in Wawashang, Nicaragua. FADCANIC does not receive support from the Nicaraguan government in terms of funding. The link of CEAA with the government is mainly through the Instituto Nacional Tecnologico (INATEC) as CEAA's curriculum and degrees must be certified and approved by INATEC. For some stakeholders, the success of FADCANIC programs could be attributed to several reasons, including: little intervention from the government, strong and passionate leadership, the cultural diversity of the Atlantic region coupled with the school's ability to embrace this diversity within its programs, strong support from local communities, and the geographical location of FADCANIC's programs. A critical success factor is FADCANIC's leadership in the region. Since its foundation, FADCANIC's leadership has been able to develop great relationships with external organizations such as SAIH and USAID and also with local communities in the Atlantic Region to support FADCANIC`s programs. However; there is internal and external concern as the senior leadership of

FADCANIC might retire soon and there is not a clear succession plan. A complete list of strengths, opportunities, weaknesses, and threats (SWOT) for the CEAA school and the CAF is shown in Table 3.

The case of CAEE is similar to CAF in terms of funding and support. CEAA activities depend heavily on contributions from SAIH to support its 43 employees (faculty and technicians) and current 210 students (USAID provides support to 30 students out of the total enrollment). CEAA generates income by selling some of the products produced in the farm to the local market and to CAF for further processing.

There are also have been opportunities to generate revenue at CEAA by contracting furniture and other forest products that can be manufactured by students under the carpentry emphasis. However, the strategy of becoming self-sustained by selling CEAA's farm and wood products is still in its early stages. For CEAA, increased volume, higher value-added production strategies, and stronger marketing skills are much needed if CEAA is to become self-sustained. An intriguing strategy could be to unify efforts between CAF and CAEE instead of just having two financially independent organizations as it appears to be set up currently. There is strong collaboration between CAF and CEAA in terms of teaching, research, and extension activities but it seems that both centers operate under a different financial structure and the profits from CAF are not transferred to CAEE.

The best practices for the CEAA school and the CAF program at FADCANIC are summarized by stakeholders and actors based on the interviews and analysis of related documents in Table 4.

Table 4. Best practices for the CEAA School in Nicaragua according to various sources.

USAID mission:	• FADCANIC leadership • Support from international organizations • Integration with communities • Nicaraguans' land ownership
Administrators:	• Provide scholarships and free tuition to students • Little government intervention • Quality, motivation, and dedication of teachers • Focus on hands-on teaching • Leadership of FADCANIC to find funding for school
Teachers:	• Nicaraguans' land ownership • Focus on hands-on teaching • Student internships in communities during school breaks • Support of communities in selecting the new students
Students:	• Providing leaderships skills to the students • Learning from the specific programs • Interacting with other ethnic groups • Student internships in communities during school breaks
Alumni:	• The strategy for self-sustainability of the CEAA school • Quality and the motivation of teachers • Interacting with other ethnic groups • Focus on hands-on teaching • Environmental aspect of the CEAA school

4.3 FADCANIC alumni survey

The survey of alumni was jointly conducted with CEAA's administrators with the goal to measure the long-term impact of the FADCANIC school in the personal and professional lives of the school alumni.

4.3.1 Questionnaire description

A copy of the questionnaire used for the survey can be found located in the Appendix section. The questionnaire was implemented in Spanish. For a copy of the questionnaire in English, please contact the researchers. The questionnaire used in the survey was revised and approved by the Institutional Review Board (IRB) at Virginia Tech in order to protect the rights of and ensuring the safety of human subjects participating in research.

The first section of the questionnaire is an introductory statement explaining the goal, potential risks, time, and a general description of the survey. In addition, contact information of the school sub-Director and the lead researcher at Virginia Tech was provided to send questions or comments.

The second section of the survey included nine demographic questions, including: gender, ethnic group, socio-economic status, degree obtained at the school, age, graduation year, community of residency, and number of children. The third section included a list of questions in Likert format (rating agreement) grouped in four different constructs: professional development, community impact, school support, and diversity and culture. The final section included open-ended questions asking for strengths, weaknesses and specific aspects that the school could improve. The alumni were also provided with one last field to provide any comments they wish.

4.3.2 Survey management

A total of 80 FADCANIC school alumni were contacted and asked to respond the survey. To distribute the survey, the sub-Director of the FADCANIC school was contacted and asked to help in the distribution and management of the alumni survey. The school has an updated database with basic information including name, year of graduation, contact information, and current location of most of the alumni. Initially, the survey was implemented in an online format using Virginia Tech Qualtrics systems but most of the alumni indicated they had issues accessing the online survey. Therefore, the survey was implemented in paper format beginning in December 11, 2015. Once the survey was sent to the sample population, the subdirector sent reminders to the alumni for responding to the survey. It was not possible to separate the first wave of respondents from the following waves, therefore a non-respondent analysis was not conducted. By January 19, 2016 the survey was considered close after a duration of about 5 weeks.

All data was typed directly from the questionnaires into MS Excel format by the subdirector of the school and final datasheet was sent by email to the research team at Virginia Tech. The CEAA subdirector indicated that the typed data was carefully reviewed to ensure validity.

4.3.3 About the sample

The respondents ranged in age from 16-32 years-old, with the majority (48 out of 69) between the ages of 19 and 23 years-old. Out of the sample, 19% (13) were female and 81% (56) were male. Forty-two alumni (61%) declared that they did not have children, while 16 had one child, six had two children, and one had three children. In terms of ethnic origin, most of the students indicated belonging to the Mestizo ethnic group (57%). The second largest ethnic group was Mayagna with 19%, followed by Miskitu with 16%. Garifuna, Creol, and Rama only reported two students per ethnic group. See Table 5.

Table 5. Ethnic origin of the school alumni.

	Count	Percent
Mestizo	39	57%
Mayagna	13	19%
Miskitu	11	16%
Creol	2	3%
Garifuna	2	3%
Rama	2	3%

Alumni were also asked their graduation year from the school (Table 6**Error! Reference source not found.**). About 52% of the sample indicated completion at CEAA in 2014. There were 4 students who did not indicate a graduation year. The second largest group of respondents represent 2012 with 17 or 25% of the sample. Table 6 shows the year of graduation of the sample.

Table 6. Graduation year from the school

	Frequency	Percent
2009	2	3%
2010	2	3%
2011	3	4%
2012	17	25%
2013	4	6%
2014	36	52%
2015	1	1%

Table 7. Socio-economic status of the sample

	Frequency	Percent
College student	25	36%
Employed	15	22%
Unemployed	14	20%
Entrepreneur	6	9%
Other	6	9%
Employed and studying	3	4%

The socio-economic status of the sample is shown in Table 7. In regards to the type of degree, 57% graduated with the Medium Diploma (Agroforestry) degree, 38% with the Carpentry degree and 4%

indicated an Other degree. In terms of current occupation, most of the alumni indicated they are currently enrolled at a university (36%). The second largest group are employed (22%) and the third largest group is unemployed (20%). Nine percent of respondents called themselves entrepreneurs, the same amount indicated their status as Other. Finally, three alumni (4%) indicated that they are working and studying at the same time.

4.3.4 Descriptive statistics

Central tendency data (median and mode) and variability (range) were calculated for the 18 statements in the questionnaire (see Table 8**Error! Reference source not found.**). The statements had the following Likert scale for response options:

1: Strongly disagree, 2: Disagree, 3: Not sure, 4: Agree and 5: Strongly agree.

Results seem to indicate a positive impact of the school in all four constructs, with the median response for all statements of Agree and the mode for all but one statement of Agree. The mean is not shown because the data is on a interval scale. The 18 statements were grouped by construct as reflected in Table 8.

Table 8. Descriptive statistics for the statements

	Statement #	Statement	Median	Mode	Range	Min	Max
Professional Development	1	The education I earned at CEAA has been useful to be part of the economically active population in my region as entrepreneur or employee	4	4	3	2	5
	2	Thanks to the education earned at CEAA, I am able to achieve my professional goals	4	4	3	2	5
	3	Thanks to the education at CEAA, for me it is easier to learn new techniques or knowledge on my own	4	4	2	3	5
	4	I am now a person who is more easily accepted in my community and also in the industry thanks to my knowledge	4	4	4	1	5
Community Engagement	5	The knowledge learned at CEAA has helped to better serve my community	4	4	3	2	5
	6	After finishing my degree at CEAA, I have engaged in community projects	4	4	4	1	5
	7	The community where I now live considers me a great resource given my formation and learning at CEAA	4	4	2	3	5
	8	What I learned at CEAA has helped me to better understand the necessities of my own community	4	4	2	3	5
	9	I have tried to respond to the call of other CEAA alumni to try to form teams to solve problems in our communities	4	4	3	2	5
	10	The experiences at CEAA have allowed me to assume leadership roles in activities or projects in my community	4	4	3	2	5
Support to CEAA	11	It motivates me when I receive CEAA communications through email, newspapers, newsletter or similar	4	4	2	3	5
	12	I have tried to support CEAA recruitment efforts for new students	4	4	4	1	5
	13	I am interested in belonging to an alumni CEAA network	4	4	2	3	5
	14	When CEAA has requested my collaboration on any activity, I have tried to collaborate any way I could	4	3	4	1	5

	Statement #	Statement	Median	Mode	Range	Min	
Culture and Diversity	15	Sharing and collaborating with other ethnic groups during my time at CEEA have allowed me to better work with other ethnic groups in my community	4	4	4	1	5
	16	Thanks to the interaction I had at CEAA with other ethnic groups today I am more sensitive and tolerant towards other ethnic groups	4	4	3	2	5
	17	Today, I am more sensitive to problems impacting my own ethnicity and other ethnic groups	4	4	2	3	5
	18	Thanks to my experience of sharing and interacting with students from other ethnic groups at CEAA, today I better appreciate the cultural diversity of my region	4	4	4	1	5

4.3.5 Inferential analysis

4.3.5.1 Cross Tabulations

Cross tabulation or contingency table analysis was conducted on all demographic variables of the sample, including the created variable SES. A contingency analysis compares the distribution of the group classes in each cell. A Chi-square test is conducted to compare the proportion in each cell. Results indicate that in the proportions of the sample is different for the case of ethnicity vs highest degree in household (significant at 0.1 level) and for the pair highest degree in household vs degree (significant at 0.05 level). Given there were only 2 responses from each Garifuna, Creol, and Rama ethnic groups, a new Ethnicity variable was created where these three ethnic groups are grouped into one.

Table 9. Contingency analysis of demographic variables

Cross tabulation	N	Value	Df	Pvalue
SES vs. Gender	69	0.025	1	0.875
SES vs. Family	65	0.269	1	0.604
SES vs. Ethnicity	69	5.476	3	0.140
SES vs. Degree	69	2.373	3	0.499
SES vs. Highest degree in household	69	0.003	1	0.960
Ethnicity vs. Gender	69	1.95	3	0.978
Ethnicity vs. Family	65	5.091	3	0.165
Ethnicity vs. Degree	69	15.32	9	0.082**
Ethnicity vs. Highest degree in household	69	4.598	3	0.204
Gender vs. Highest degree in household	69	1.869	2	0.172
Gender vs. Family	65	0.694	1	0.316
Gender vs. Degree	69	1.111	4	0.774
Highest degree in household vs. Family	65	0.170	1	0.680
Highest degree in household vs. Degree	69	9.914	3	0.019*
Degree vs. Family	65	3.568	3	0.312

*Significant at alpha=0.05

**Significant at alpha=0.1

The resuls of the contingency analysis is shown in Table 9. Two cases were found significant. First, Ethnicity vs Degree was found significant at confidence level of 0.1 (pvalue of 0.082). The Mestizo ethnic group 59% opted for the Agroforestry degree and 28.2% for the Carpentry degree while in the Mayagna

ethnic group, 23.1% pursued the agroforestry and 76.9% the carpentry degree. In the cases of the Miskitu and the Other (Rama, Creol and Rama) the proportions are similar to the Mestizo ethnic group, where the majority opted for the Agroforestry degree. There were 3 respondents that did not declared what degree they pursued.

The second difference was found when comparing the proportions of Highest degree in household vs Degree (pvalue 0.019, significance level of 0.05), see Table 9. In this analysis the proportion of alumni with the highest degree in household with an Agroforestry degree is 41.7% and for the alumnus who does not represent the highest degree in their household is 81%. The proportion of alumni with the highest degree in household is more balance across the degrees (41.7% and 47.9%) than for the alumnus who does not have the highest degree in their household (81% and 14.35).

4.3.5.2 Correlations of latent constructs

As mentioned earlier, the Likert scale statements were formulated to measure four different constructs or latent variables: professional development, community engagement, support to CEAA, and culture and diversity. The 18 statements from Table 8 were combined to create the four latent variables (see column on left-side). The validity and internal reliability of the data were verified by calculating Chronbach's alpha for each set. In all cases the calculated alpha is higher than 0.7 (cut off value) and confirms that the internal reliability of the items for each new variable is acceptable. See Table 10.

Table 10. Chronbach's alpha results for constructs

Construct	Alpha
Professional Development	0.898
Community Engagement	0.861
Support to CEAA	0.722
Culture and Diversity	0.804

Further, the correlations between the latent constructs were calculated and revealed the following significant correlations (at a 0.01 level):

- Professional Development with Support to CEAA (0.468)
- Professional Development with and Diversity and Culture (0.327)
- Community Impact with Diversity and Culture (0.386)
- Support to CEAA and Diversity and Culture (0.359)

4.3.5.3 Impact of Professional Development on other latent constructs

Another critical question of interest to the researchers was the relationship of professional development and the other constructs. To this end, we explored if the demographic data and Professional Development construct could be determinants of the Community Impact, CEAA support, and Culture and Diversity constructs. The specific model is:

$$\text{Community\_Impact CEAA\_Support Culture\_Diversity} = b_0 + b_1*\text{Gender} + b_2*\text{Ethnic} + b_3*\text{Family} + b_4*\text{Highest\_Degree} + b_5*\text{SES} + b_6*\text{Degree } b_7*\text{P\_Development} + \text{Error}$$

The researchers conducted a statistical analysis that was appropriate for the types of variables the study used and met the assumptions required for the analysis. The results of the analysis show the relationship between Professional Development and the variables Highest_Degree, SES, and Degree is significant (significance level of 0.05). It is interesting to note that the variables Degree and SES do not differ on the Professional Development variable.

Further analysis revealed that:

- Alumni holding the highest degree in their household are more likely to support CEAA than those who don't have the highest degree in their households.
- Alumni with a degree in Agroforestry are more likely to support CEAA and to be more culturally diverse than alumni with the degree in Carpentry or Other.
- Alumni who are economically active have more positive perception of culture and diversity than the alumni who are not economically active.
- There was no significance difference for alumni based on Community Impact and Degree.

4.3.5.4 Median differences of statements by type of groups

Additional analyses of the statement variables by demographic variables was conducted and significant results were investigated to determine which groups had significant differences. The results of this analysis is presented in Table 11.

For the Professional Development statements, statement 3 was found to be significant for Ethnicity. Investigation of this result showed that Mestizo and Mayagna feel more confident learning on their own than Miskitu and Others. Professional Development statements 1, 2, and 3 were found to be significantly different by the group Highest degree in household and Degree. For alumni who hold the highest degree in their household it seems that there is a stronger perception that their education at CEAA has contributed to achieving their professional goals. The differences between degree types show that alumni with Carpentry degrees have a more positive perception of how their degree has helped them to become successful.

For the Community Engagement statements, differences in Degree were found for statements 5 and 6. These results are consistent with the previous set of differences for Degree and indicate that Carpentry alumni have a stronger perception of community involvement.

For the Support to CEAA statements, there were significant differences for Degree with statements 11 and 12 and for SES on statement 13. Consistent with previous answers, it seems that Carpentry alumni have a better perception than Agroforestry alumni of issues related to CEAA.

Table 11. Non-parametric test for Likert statements

Construct	Statement #	Statement	Pvalues by groups			
			Ethnicity	**Highest degree in household**	**Degree**	**SES**
Professional Development	1	The education I earned at CEAA has been useful to be part of the economically active population in my region as entrepreneur or employee	0.268	0.021*	0.021*	0.315
	2	Thanks to the education earned at CEAA, I am able to achieve my professional goals	0.271	0.002*	0.057*	0.092
	3	Thanks to the education at CEAA, for me it is easier to learn new techniques or knowledge on my own	0.018*	0.004*	0.035*	0.123
	4	I am now a person who is more easily accepted in my community and also in the industry thanks to my knowledge	0.455	0.274	0.848	0.355
Community Engagement	5	The knowledge learned at CEAA has helped to better serve my community	0.121	0.395	0.006*	0.952
	6	After finishing my degree at CEAA, I have engaged in community projects	0.091	0.338	0.017*	0.477
	7	The community where I now live considers me a great resource given my formation and learning at CEAA	0.247	0.842	0.079	0.646
	8	What I learned at CEAA has helped me to better understand the necessities of my own community	0.318	0.343	0.064	0.782
	9	I have tried to respond to the call of other CEAA alumni to try to form teams to solve problems in our communities	0.318	0.269	0.097	0.664
	10	The experiences at CEAA have allowed me to assume leadership roles in activities or projects in my community	0.569	0.535	0.541	0.248
Support to CEAA	11	It motivates me when I receive CEAA communications through email, newspapers, newsletter or similar	0.201	0.921	0.000*	0.008*
	12	I have tried to support CEAA recruitment efforts for new students	0.638	0.36	0.046*	0.149
	13	I am interested in belonging to an alumni CEAA network	0.747	0.809	0.207	0.032*
	14	When CEAA has requested my collaboration on any activity, I have tried to collaborate any way I could	0.853	0.489	0.524	0.697
Diversity and Culture	15	Sharing and collaborating with other ethnic groups during my time at CEEA have allowed me to better work with other ethnic groups in my community	0.074	0.128	0.000*	0.320
	16	Thanks to the interaction I had at CEAA with other ethnic groups today I am more sensitive and tolerant towards other ethnic groups	0.862	0.168	0.030*	0.127
	17	Today, I am more sensitive to problems impacting my own ethnicity and other ethnic groups	0.266	0.905	0.060	0.003*
	18	Thanks to my experience of sharing and interacting with students from other ethnic groups at CEAA, today I better appreciate the cultural diversity of my region	0.268	0.851	0.126	0.000*

For Diversity and Culture, Degree had significant differences for statements 15 and 16 while SES had significant differences for statements 17 and 18. For Degree, this again shows a more positive response from Carpentry alumni towards cultural diversity. For SES, this could be an indication that alumni that are economically active have a better perception of culture and diversity than the alumni who are not currently economically active.

Analysis was conducted for Gender and Family, however, no statistically significant differences were found and thus are not included in the table below.

4.3.5.5 Determinants of economic activity

Another question of interest regarded the relationship between the variables and whether or not someone was employed (coded as economically active). The following model was formulated and a statistical test of the model fit was conducted; it was determined that the model was a good fit:

$$\mathbf{SES=b_0+ b_1(Gender)+ b_2(Family)+ b_3(Highest\ degree\ in\ household)+ b_4(Degree)+ b_5(Ethnicity) + Error}$$

Results of this test indicated a significant result for one of the Ethnicity groups; upon further investigation it was found that this group was the Miskitu group, which has better odds (64.5 times) of transitioning from economically inactive to economically active than the other ethnic groups if the rest of the variables are held constant. This is further supported by an examination of SES vs Ethnic groups which shows that 90.9% of the Miskitu ethnic group is economically active. Further details of the MANOVA test are shown in Table 12.

Table 12. Multiple binomial regression analysis

	B	S.E.	Wald	df	Sig.	Exp(B)
Gender(1)	.356	.825	.187	1	.666	1.428
Family(1)	.138	.647	.046	1	.831	1.148
Highest_Degree(1)	.102	.760	.018	1	.894	1.107
Degree			3.665	2	.160	
Degree(1)	-22.141	21049.991	.000	1	.999	.000
Degree(2)	-20.477	21049.991	.000	1	.999	.000
Ethnic			7.770	3	.051	
Ethnic(1)	2.712	1.397	3.766	1	.052	15.058
Ethnic(2)	4.167	1.724	5.841	1	.016	64.521
Ethnic(3)	1.004	1.380	.529	1	.467	2.729
Constant	19.551	21049.991	.000	1	.999	309697138.224

4.3.6 Strengths of the CEAA program

Alumni were also asked to mention the top three most important strengths of the CEAA. The results in **Error! Reference source not found.** were codified after reading the individual comments of each alumnus. The codes were developed to represent the strengths expressed by the alumni. Alumni

provided a total of 186 strengths that were reduced to 59 codified strengths. The overall top-ten strengths are listed in Table 13**Error! Reference source not found.**.

Table 13. Ranking of top strengths of the school by alumni

Strength	Count
Quality of Teachers	33
On-hands approach	12
Quality education	11
Infrastructure	10
Own farm	9
Autonomy	7
Ethnic diversity	7
Culture diversity	6
Agroforestry degree	5
Free education	5

4.3.7 Improvements to CEAA

A total of 102 recommendations or improvements were reported by 63 alumni. The recommendations were coded into 44 new categories. **Error! Reference source not found.** summarizes the most frequently reported improvements the alumni noted. "Increase offer of technical degrees" is the most frequently reported suggestion made by the alumni, followed by "All is well." The third most frequent suggestion was "Become self-sustainable." See Table 14 for the ranking of additional recommendations.

Table 14. Ranking of recommendations

Improvement	Count
Increase offer of technical degrees	15
All is well	12
Become self-sustainable	10
Increase number of teachers	4
Increase sources of funding	4
More residencies	4
Visit remote communities to promote CEAA	4
Increase farm productivity	3
Add chemistry lab	2
Better equipment for field work	2

4.4 Train-the-Trainer proposal

4.4.1 EARTH University's Model

EARTH University was created after USAID left Costa Rica in the early 1990s along with funding from two other organizations, Costa Rica-United States of America (CRUSA) and Fundacion para el Desarrollo de la Cordillera Volcanica Central (FUNDECOR). CRUSA is an organization focused on funding different

projects related to education, economic development, and the environment. EARTH's main campus is located in Guacimo, Limon about 65 miles from the capital city of San Jose. The campus includes 3000 hectares and excellent infrastructure to support teachers and students. A second campus was recently opened in Liberia, Guanacaste and it is nested in a 3,000 acre property. This new campus' most significant feature is the development of educational and research programs in agriculture focused in the dry tropics.

EARTH University offers a bachelor's degree in agriculture to students from more than 45 tropical countries in the world. Student population is about 450 students and most students are from other countries (about 85%) with only about 60 students from Costa Rica. Tuition for the four-year program is about $60,000 and most of the students enjoy partial or full scholarships. Students usually apply for scholarships from their home countries, although EARTH also provides certain levels of support. Students need to reside on campus and there are unique rules and high expectations for student behavior and conduct. Figure 4 shows international students at EARTH University learning about peri-urban agricultural techniques.

Figure 4. International students learning about peri-urban agricultural at EARTH University

The main educational strategy at EARTH is to learn by doing. Students spend most of their time in the fields conducting experiments in search for answers. The relationship between students and professors is very horizontal, creating a unique learning environment between the students and teachers. As students mature and continue to increase their technical knowledge, they are also assigned more responsibility in the fields with the goal to integrate entrepreneurial aspects such as people management skills, leadership, project management, and budgeting in addition to their technical knowledge.

EARTH University is recognized as one of the top agricultural teaching universities in the world. The fact that only one degree is taught allows the University to focus and specialize in one discipline. This level of specialization opens the possibility to develop unique and innovative teaching environments that are

unparalleled. With an annual budget of about $18 million, EARTH's support comes mainly from the Mastercard Foundation, Bill & Melinda Gates Foundation, and a series of specific donors. EARTH's fund-raising model is also recognized as one of the most successful ones in the area of agricultural and agroforestry education.

EARTH University's legal status as a non-profit organization pushed the administration to create a sister private organization to be able to commercialize key products from their farms. The idea of commercializing some of their products is critical to support of EARTH's mission. For example, EARTH's banana plantation extends over 1,000 acres, provides more than 400 direct jobs (farming and processing) and generates about $800,000 of profit each year. These profits are used to provide scholarships for the students and support EARTH's educational programs in various ways.

4.4.2 Previous Regional Experiences with Capacity Building for TVET Teachers

In 2005, EARTH University designed and delivered a regional TVET training program as a series of centralized workshops. The name of the program was "Programa de Capacitación y Seguimiento para Docentes de Colegios Agropecuarios" and it was delivered in Central America and the Dominican Republic and funded by the Ford Foundation. Four high schools or TVET centers were selected by each country initially. A total of 200 teachers coming from 51 agriculture and livestock high schools attended the training. Topics included an assessment of needs, strategic planning, cooperative learning, teamwork, and leadership, follow-up to the implementation of learning tools on multiple intelligences, leadership, teamwork, and enterprise leadership. All sessions were delivered as centralized workshops in selected sites in each country. Only the strategic training session was delivered at EARTH's campus with an attendance of 75 participants including high school/TVET Center directors, sub-directors and teachers from 11 institutions from 6 Central American countries.

A second training effort related to TVET teacher training was conducted in 2005 and it was funded by CRUSA foundation with a budget of $100,000. The goal was to provide training on pedagogical and entrepreneurship aspects to agricultural technical high schools (known as "Colegios Tecnicos Agropecuarios", or CTAPs) teachers in Costa Rica. The training program spanned over two years where two teachers from 12 different CTAPS were selected to participate in the project. The project was conducted in collaboration with the Ministry of Education (MEP) of Costa Rica. Teachers from CTAPS around the country came to EARTH for one week to attend lectures on pedagogy and entrepreneurship. No specific technical training was provided given that there was no common area between the different CTAPS. It was found that the only common learning area was entrepreneurship. After the week of training at EARTH, teachers went back to their high schools to implement their learning by developing an institutional idea into a commercial product or process. In addition, teachers were required to replicate their entrepreneurial projects in order to transfer their learning to other teachers. This replication process allowed transferring knowledge to another 500 teachers. This second project is considered by EARTH as the most successful experience related to TVET's teacher capacity building.

4.4.3 Strategic and Market Penetration Aspects

EARTH University has established itself as world leading institution in agricultural education. The University leadership has been able to design and deliver an educational curriculum capable of creating the next generation's best specialists in sustainable agriculture. The impact of EARTH University has expanded through its alumni network in every country in the humid tropics and dry regions of the world. The University's impact is especially critical in Central America where it has heavily contributed to the advancement of the agricultural and agroforestry socioeconomic sector in this region.

Figure 5. Business model of the proposal for Capacity Development of TVET's teachers.

4.4.4 Curriculum development: Matching TVET weaknesses with EARTH's strengths

One of the important outputs of the case study on the FADCANIC TVET school was to develop a SWOT analysis the School. A more detailed requirement was to identify specific teacher needs. This data was shared with EARTH University in order to try to match these teachers' weaknesses with EARTH University's strengths. As can be seen in Table, most of the teachers' training needs are focused on technical aspects (Type T) and little attention is put into pedagogical (Type P), entrepreneurship (Type E), leadership and management (Type A) or educational technology platforms (Type X, a category which received no response). According to EARTH University's experiences these other aspects are critical for a successful TVET school so they need to be incorporated into the T^3.

Considering the input from the FADCANIC TVET School teachers and the experiences EARTH University has had in the past with similar regional programs, it is proposed to develop ten courses in five modules.

- Technical:

All knowledge aspects related to the science, engineering, and technology of agriculture and agroforestry. Courses will be developed based on needs surveys to TVET teachers, new trends, and specific requests. See training needs from FADCANIC's school in Nicaragua and from Costa Rica's INA in the Appendix section, as an example. The technical courses will be custom-designed based on each countries needs and it involves three technical courses, for a total of 24 hours.

Table 15. FADCANIC TVET school teacher's needs

Type	Training programs needed	Type	Training programs needed
E	Leadership and conservation of forestry and marine resources	**T**	Project management to assure food security and nutrition for rural communities
T	Wood processing and environmental impact.	**T**	Applied nutrition and plant physiology
T	Integrated handling of the ARG program	**T**	Waste and treatment of agricultural residues
T	Germ plasma production	**T**	Specific projects to promote sustainability of natural resources in rural communities
T	Efficient measurements for soil conservation and the environment to confront climate change	**T**	Integrative production systems for crops
E	Farm management	**E**	Management of rural tourism enterprises
T	Ecological Agriculture	**T**	International relationships on indigenous rights for natural resource
T	Resource Management in the farm	**T**	Ecological agriculture to fight climate change
T	Environmental conservation	**T**	Design and development of agroforestry projects in tropical wet regions.
T	Plant physiology	**T**	Artificial insemination (pigs and cows)
T	Organic agriculture	**T**	Minor surgery for small and large animals
T	Renewable energy	**T**	Establishment design for small and large animals
T	Plant nutrition	**T**	AutoCAD drawing
T	Organic agriculture	**T**	Techniques for wood processing
T	Forestry green housing	**E**	Management systems for small and medium size enterprises
T	Furniture finishing processes	**A**	Management for TVET centers
T	Furniture joinery		

- Pedagogy:

In this area, trainees will be exposed to theory, success stories, and best teaching practices. There will be 3 pedagogy courses, for a total of 24 hours of instruction.

- Entrepreneurship:

Trainees will be exposed to business, strategy, marketing, creativity and innovation, productivity, and financial models that can be integrated to technical areas. A key aspect in this module is to implement models currently used by sustainable communities that partner with EARTH University and to engage trainees with industry in their home countries to create internships. Two courses will be designed on this module, for a total of 16 hours. Trainees will also be required to implement a project in their TVET centers after the conclusion of the training with the purpose of transferring knowledge to other TVET teachers unable to attend the training at EARTH's campus.

A key program at EARTH in engaging with local farmers is the sustainable communities initiative. This effort has a goal to transfer knowledge and technology to small farmers in the area. This program has been very helpful in creating opportunities for economic development and to stop migration from rural areas to urban settings as farmers now have better opportunities to sustain their families and profit in a more efficient way from their agricultural and agroforestry activities.

- Information technologies:

In this area, different IT learning platforms, basic statistical software, basic office software, social media and other IT learning resources will be introduced to the trainees. One course will be designed in this module, for a total of 8 hours of instruction.

- Leadership/Administrative:

In this core area, the participants will be introduced to management and leadership concepts for TVET centers. Emphasis will be put on the recruitment, asset management, faculty retention, fund raising, and human resource management. One course will be designed in this module, for a total of 8 hours of instruction.

5. CONCLUSIONS

5.1 A database of TVET establishments in Latin America

Research on secondary sources was conducted on how TVET operates in Latin America. It was determined that there is a formal and non-formal TVET system in place in almost each country. The formal system operates under the control of government, private or non-profit organizations. Although there are some differences in the denomination of the programs, most of the formal TVET programs are delivered in the secondary (basic and upper), post-secondary non-tertiary, and post-secondary tertiary levels. Countries like Mexico, Argentina, Brazil, and Chile have a large arrangement of organizations that deliver TVET on each level with most of the TVET happening at the secondary level. Cuba is the top investor in TVET per student in the secondary system with over $9400 contributed. Second is Argentina with US$4700 per student, and third is Brazil with US$3500 per student. Nicaragua, Guatemala, El Salvador, and Honduras are the Latin American countries that invest the least in secondary education with US$289, US$396, US$802, and US$804 per student respectively.

It was found that in most of the countries agricultural TVET enrollment represents a small percentage of the total TVET enrollment and it appears to be decreasing. For example, in Cuba in 2009 there 45,605 students enrolled in agricultural TVET but in 2014 there were only 16,737. In other countries the proportion of agricultural TVET students to general TVET is very little as in the cases of Uruguay and Chile. In Uruguay where there were 75,000 students enrolled in TVET but only 2,322 in agricultural TVET in 2009. The case of Chile is even more alarming where in 2012 there were over 200 thousand students enrolled in TVET against 7,440 enrolled in agricultural TVET.

An effort to determine the location of agricultural TVET establishments (only formal secondary and post-secondary non-tertiary establishments) in Latin America was made. The database of these type of TVET establishments includes over 523 records. The database is not comprehensive as not every TVET

institution (as defined) is included due to limitations on available data. The database is hosted on the web site http://sim.sbio.vt.edu/?page_id=2315 in visual form using Google Maps.

This database is a critical first step toward further exploring the economic, cultural, environmental challenges and development opportunities along the agricultural and forest product supply chains in regions with adequate TVET program coverage versus those without. Adequate TVET program coverage can be characterized by a program which has a presence in the region, currently offers educational programming, provides sufficient and relevant content with respect to needs and opportunities affected by program, and is accessible by the targeted audience. The database is a first effort toward identifying some of the attributes which describe the presence of adequate TVET program coverage in a region.

However, additional work is needed to better characterize remaining attributes including: breadth and depth of programs' thematic content, and programs which are tailored toward the non-formal education sector. This same geographic dataset can overlay additional existing geographic resource information to identify critical areas in need of TVET support, based on existing and imminent challenges. For example, it is anticipated that the agricultural production systems of the Central American Dry Corridor (i.e., *Corredor Seco*) will face particular challenges in the coming years due to climate change. For many systems, new best management practices are needed to transition toward more climate smart agricultural systems. A robust TVET program along this corridor can serve to facilitate adoption of new best management practices. Furthermore, individuals adequately trained on these practices will have advantages in seeking employment or developing service-based businesses built upon their practice knowledge as entrepreneurs.

The database can assist in identifying TVET program coverage along this corridor and to identify critical gaps with respect to lack of program presence or sufficient content. Similar applications exist for emerging pest and phytosanitary management practices, among other areas. While research continually generates new best practices, these practices are only effective upon their implementation; adequate TVET program coverage can enhance the rates of adoption of best management practices. Characterizing TVET program coverage and capacity serves as a platform to more efficiently identify tailored, and asset-based, engagement opportunities across these broad networks to increase the rates of adoption of new practices in response to challenges and development opportunities along the agricultural and forest product supply chains.

5.2 Case study of FADCANIC TVET school in Nicaragua

Most important best practices of the FADCANIC school (CEAA) include: autonomy from the government, outstanding leadership by FADCANIC leaders, quality and motivation of teachers, support and integration with communities, land ownership, teaching of not only technical aspects of agroforestry but also leadership, entrepreneurship, and communication skills; and ethnic group integration. The biggest concern of this program is securing funding to continue to operate. Although the CEAA school and the CAF center work from the same property, efforts need to be integrated to consolidate both programs in order to achieve sustainability. A more integrated effort has to be developed to gain deeper penetration of the CAF center brand (Wawashang) so other markets in Nicaragua and perhaps internationally can be penetrated.

The CEAA school appears to have dramatic plans to expand. This expansion will include adding new curricula, new buildings, and potentially many more students to the boarding school. The school appears to be a fantastic resource to the region, enabling a diverse and geographically disperse student group to continue in their academic development. Without this school, it appears that educational opportunities would otherwise be nonexistent to these youth. The school appears to have gained a reputation for producing highly successful students whom are able to compete and win in scientific competitions, pursue higher education, and serve as leaders. However, the school does not charge tuition, is not part of the national school system (except for INATEC intervention to approve the curriculum), and is therefore currently dependent on donors for funding operating expenses. It would seem that this level of dependence would increase with any planned expansion. The school is exploring partnering opportunities with Nicaraguan industries.

Given the financial model of the center, its expansion plans, and the sustainability-centered *ethos* of the center, the following observations and opportunities are provided for possible further exploration.

1. Assess costs associated with current practices
2. Evaluate alternatives that may generate a savings, while:
    a. complying with the CEAA´s objectives related to wise stewardship
    b. exploring these opportunities while engaging private sector partners for project support, curriculum refinements, and future alumni employment networking
3. Implement the selected appropriate new practices and systems
4. Integrate and leverage the new practices and systems into student curricula
5. Invest any cost savings into the next project priority

Through this format, some of these efforts could be financed through their current operating expense budget. The “additional” money would come from finding appropriate ways to do what they are currently doing, however, to do so more efficiently. While CEAA`s model already seems heavily reliant on donor funding, the opportunities described in the appendix may present unique partnering opportunities with the private sector which in some cases would seem to create opportunities for project implementation cost savings, enhancing relevancy of related curriculum, and extending network of future alumni into the private sector to improve future employment prospects.

Based on the results of the alumni survey (sent to 80 alumni, respond rate was 86%) it is concluded that there is no relationship of socioeconomic status with gender, number of children, degree, and highest degree in household. The only relationship was found in socioeconomic status and ethnicity where it appears the ethnic groups Rama (n=2), Creol (n=2) and Mayagna (n=13) have the highest unemployment rates. However, this result has to be carefully considered, as sample of size of each ethnic group was very low for the Rama and Creol ethnic groups.

When the variables of gender, family, highest degree in household, degree and ethnicity were used as determinants of socioeconomic status it was found that there is no relationship of the independent variables with the dependent variable. The multivariate analysis of variance (MANOVA) test indicated that the construct Professional Development (education at CEAA) had a strong relationship to the constructs Culture and Diversity, Support to CEAA, and Community Engagement (significance level of 0.05). This result supports the significance of the impact the education from CEAA could have among the

alumni. Alumni also indicated that the most significant strengths of the CEAA are the quality of the teachers, the focus on hands-on teaching, and the available infrastructure. On the other hand, alumni indicated that the most significant improvements to be done at the CEAA are increasing the offerings of additional degrees, exploring self-funding, and increasing the number of teachers.

5.3 Train-the-trainer proposal with EARTH University

A key component of the project was to develop a proposal for a train-the-trainer (T3) program for agricultural TVET teachers. EARTH University, an international higher education institution with outstanding credibility and impact in agricultural education in developing countries, was chosen to formulate the capacity building program. A proposal has been designed based on the experiences of EARTH University in similar capacity building programs in Latin America. Additionally, teacher training needs from the FADCANIC TVET school were used to formulate the different modules. The proposed training program will have five modules in the following areas: technical, entrepreneurship, leadership, information technologies, and TVET management. Technical courses will be custom-designed based on the current needs of the target locations, and the TVET database will be leveraged to facilitate aspects of this needs assessment. Furthermore, the TVET database can be leveraged to identify TVET program contacts to ensure inclusion from priority program areas aligned with training content.

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