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Converting Rice Fields into Green Fertilizer Factories

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Foreword

The Project "Converting Rice Fields into Green Fertilizer Factories" was one of the most important challenges and opportunities of the ESPOL of recent times, as it has forged new paradigms in agriculture, health, environment, economy and culture.

We have fulfilled with amplitude the expectations of the World Bank which financed the project with a value of U.S. $ 196,752 over a period of 24 months, from July 7, 2009 and July 7, 2011. The CTT (Technology Transfer Center), as handler resources unit, allocated faithfully the funds according to the schedule approved by the World Bank. The CQA (Institute of Chemical and Environmental Sciences), Project seat unit, through various actions and under the direction of Dr. Mariano Montaño Armijos, executed the project snugly according to plan and budget.

Other ESPOL units participating mainly included Administrative Vice Presidency, Financial Vice Presidency, Food Engineering, Agricultural Engineering, CICYT (Center of Scientific and Technological Research) and CIPAT (Research Center and Applied Projects to Earth Sciences).

With this Project we have had a very rich interaction with rice guilds, with media, with academics, with the government and with a wide variety of audiences. Dissemination Project through field days, seminars, press, radio, television and internet has awakened a public recognition of *Azolla* as natural, sustainable and economical fertilizing alternative.

While the main objective of the Project was to study and to test applications of the *Azolla* to rice and agriculture, this work has forcibly addressed to unsuspected fields of thought and action. The development of *Azolla* attached to the nitrogen cycle, in the geographical area of the Guayas Ecosystem, links the rice fields, agriculture, health, environment and economy, to the new task of "tropical knowledge".

The rice fields of the Guayas Ecosystem, having incorporate *Azolla* to his tillage, are called to play a strategic role in national life, since, apart from producing rice with advantages of quantity and quality, they will produce: (1) fertilizer for national agriculture, (2) food for livestock, (3) purification of the rivers Daule, Babahoyo and Guayas, (4) soil enrichment, (5) flourishment of natural biota, (6) improvement of aquaculture Guayas river estuary, (7) stimulation of the fisheries of the Gulf of Guayaquil and (8) reduction of global warming, among other benefits.

Moisés Tacle
Rector ESPOL
Guayaquil, November 2012

Presentación

El Proyecto "Converting Rice Fields into Green Fertilizer Factories" representó uno de los retos y oportunidades más importantes de la ESPOL de los últimos tiempos, en la medida que ha forjado nuevos paradigmas en la agricultura, la salud, el medioambiente, la economía y la cultura.

Hemos cumplido con amplitud las expectativas del Banco Mundial que financió el proyecto con un valor de US$ 196 752 durante un período de 24 meses, entre el 7 de julio del 2009 y 7 de julio del 2011. EL CTT (Centro de Transferencia de Tecnologías) como unidad manejadora de fondos asignó fielmente lo recursos de acuerdo a la programación aprobada por el Banco Mundial. El CQA (Instituto de Ciencias Químicas y Ambientales), unidad de asiento del Proyecto, a través de diversas acciones y bajo la dirección del Dr. Mariano Montaño Armijos, ejecutó el proyecto de forma ajustada al plan y presupuesto.

Otras unidades de la ESPOL que intervinieron en el Proyecto incluyeron principalmente la Vicepresidencia Administrativa, Vicepresidencia Financiera, Ingeniería en Alimentos, Ingeniería Agropecuaria, CICYT (Centro de Investigaciones Científicas y Tecnológicas) y CIPAT (Centro de Investigación y Proyectos Aplicados a las Ciencias de la Tierra).

Con este Proyecto hemos interactuado de manera muy enriquecedora con gremios arroceros, con medios de difusión, con académicos, con el gobierno y con una amplia diversidad de público. La difusión del Proyecto a través de días de campo, seminarios, prensa, radio, televisión e internet ha despertado en la ciudadanía el reconocimiento del *Azolla* como una alternativa de fertilización natural, sostenible y económica.

Si bien el objetivo principal del Proyecto fue el estudio y los ensayos de aplicación del *Azolla* al arroz y a la agricultura, este trabajo nos ha encaminado forzosamente a insospechados campos de pensamiento y acción. El desarrollo del *Azolla* acoplado al ciclo del nitrógeno en el entorno geográfico del Ecosistema Guayas enlaza los arrozales, la agricultura, la salud, el medio ambiente y la economía, al novedoso quehacer de "conocimiento tropical".

Los arrozales del Ecosistema Guayas incorporando *Azolla* a su laboreo, están llamados a jugar un rol estratégico en la vida nacional, ya que, aparte de producir arroz con ventajas de cantidad y calidad, van a producir: (1) abono para la agricultura nacional, (2) alimento para la ganadería, (3) depuración de los ríos Daule, Babahoyo y Guayas, (4) enriquecimiento del suelo, (5) florecimiento de la biota natural, (6) mejora de la acuicultura del estuario del río Guayas, (7) estimulación de las pesquerías del Golfo de Guayaquil y (8) disminución del calentamiento global, entre otros beneficios.

Moisés Tacle
Rector ESPOL
Guayaquil, noviembre 2012

DM2008 FULL PROPOSAL TEMPLATE

1. DM PROPOSAL NUMBER AND TITLE

a) **Proposal Number: 5381**
b) **Proposal Title (limit: 15 words): Converting Rice Fields into Green Fertilizer Factories**

2. PROJECT SUMMARY (MANDATORY limit: 250 words)

a) **Rationale:** Food prices are increasing worldwide. In Ecuador agriculture faces great challenges, one of them being the sustained use of artificial nitrogen fertilizers, which contaminate the soil, surface water and groundwater, negatively affecting native environments and long term productivity. The country needs to develop new, sustainable and environmentally friendly models, with crops that make business sense, are competitive, ensure quality and food security. Ecuador needs to accelerate technological development based on its native resources. Currently, purchases of imported chemical fertilizers for agriculture drain funds from the economy with social and environmental effects; these imports represent US$12 million per year for rice crops and they represent about 30 % of current productions costs.

b) **Objective:** To develop Azolla Anabaena (AA) cultivation to increase rice yields, reducing or eliminating the dependency on imported fertilizers.

Azolla is a tiny free floating aquatic fern, which grows in symbiosis with nitrogen-fixing cyanobacteria Anabaena azollae and has the potential to replace artificial nitrogen fertilizers. Therefore the project aims to eliminate the use of artificial nitrogen substances; to incorporate organic nitrogen to the crop; to maintain and improve the quality of rice fields, water and soil; and to strengthen social inclusion.

c) **Innovation:** AA is a new and innovative crop that presents a novel opportunity to expand and diversify the supply of fertilizers and production of rice fields.

Moreover, applications of AA trigger the emergence of innovative forms of rural economy, actions of gender, social inclusion of farmers, organic farming, carbon dioxide sequestration and tropical knowledge.

3. PROBLEM DEFINITION / RATIONALE (Suggested limit: 300 words)

The rice in Ecuador is an essential and primary food for most of the population. The country harvests more than 300 000 ha involving more than 140 000 families. Therefore it is important that rice is produced cost-efficiently and in an environmentally sustainable manner.

The production costs of rice depend on the type of seed, fertilizer and phytosanitary package used to control weed and insects, costs of labor, land preparation, rental equipment for seeding and harvest, and irrigation. The majority of fertilizers are chemical-based, involving heavy imports and cause environmental problems, because more than 40 % of the applied fertilizer is released into the environment, as plants cannot utilize 100 %.

The application of artificial nitrogenous fertilizer in rice cultivation represents a high drain of foreign exchange, while also contaminate the soil, surface water and groundwater, affecting the development of beneficial flora and fauna of the earth, and decreasing productive potential of the land in the long term.

This situation creates a great need and at the same time opens a huge opportunity for urgent development of an alternative fertilizer based on native resources, like AA, and its technical application.

The use of AA in rice fields will increase yield per hectare, while significantly reducing production costs. AA and other less chemical-based fertilizers are cheaper, since they contain less of the expensive urea and represent low field costs.

Comparing current technology with the use of AA, a rice field fertilized with AA is more productive, cleaner and more sustainable in the economic, social and environmental sense.

In Ecuador, in general, the benefits of AA have not been widely known. Rice farmers, mostly eliminated it, thinking that AA was a weed. One of the key objectives of this project is therefore to disseminate knowledge about the benefits of AA cultivation.

4. PROJECT OBJECTIVE (Suggested limit: 400 words)

Azolla is a tiny aquatic floating fern that houses in the gaps in the base of its leaves a nitrogen-fixing cyanobacterium gender Anabaena azollae. Azolla fixes nitrogen from the air during its life and dies when this fixed nitrogen is used by plants.

Growing Azolla in the rice field can produce a fertilizer for rice and other crops.

The project's objectives are:

- To establish a gene bank of Azolla-Anabaena (AA) on ESPOL, and permanent azollaries and seedbeds of symbiont AA (Azolla + Anabaena) in selected cooperatives
- To transfer technology and to extend the application of AA as nitrogenic biofertilizer of rice crops in areas influenced by the project, and to generate own technological package systems concerning the rice-Azolla-Anabaena;
- To eliminate the use and application of artificial nitrogen to the crop and incorporate organic nitrogen, to maintain and improve the quality of the rice fields, water and soil.

The field research of the project could be applied to the entire rice farming industry of the country, which occupies 300 000 hectares, employing 22 % of the economically active

population and benefitting about 140,000 families. The alliance of AGRIPAC and ESPOL articulates scientific research and commercial development.

The geographical area the project seeks to directly address includes the municipalities of Yaguachi and Daule. The area indirectly impacted covers the whole rice-growing area of the Guayas Ecosystem.

Different social impacts and ways of (measuring) AA project include:
(a) Increased yields (t/ha/cycle);
(b) Reduction of agricultural inputs (kg/ha/cycle & L/ha/cycle);
(c) Cost Reduction in rice crop (US$/ha/cycle);
(d) Increase in income (US$/ha/cycle);
(e) Increasing of the beneficial soil organic matter (g/ha);
(f) Increase of soil microbial populations (cell counts/m^2);
(g) Reduction of contaminant water ammonium contents (mg N-NH_3/m^3);
(h) Gender issues (# women + # elderly + # children, planting, harvesting and managing AA in rice crops);
(i) Appreciation of tropical knowledge of Ecuador (# Research publications); and
(j) Social inclusion (# cooperatives & # rice farmers).

Social inclusion is reflected in many aspects including the training of poorly educated farmers who have cultivated rice in a traditional manner, the formation of groups interested in taking advantage of this new technology to improve rice production and environmental protection, the participation of smallholder rice of minor technical and economic capacity, and involving the whole family rice farm in the labour force in handling technical and marketing decisions.

5. KEY PROJECT DESIGN ELEMENTS (Suggested limit: 1100 words)

5a) Innovation (Suggested limit: 500 words)

The leading innovation of this project is the replacement of artificial chemical components by organic nitrogen in rice crops; the implications on chemical and biological agriculture are going to be studied in order to extend this knowledge to other crops in Ecuador and other tropical regions of the planet. AA is a green manure that can be associated in a sustainable manner with rice cultivation and its biochemical reactions are directly linked to the needs of the plant and the environment. The project looks for high levels of savings in natural energy and matter, considering that the end product is green manure with substantial differences from other organic fertilizers, such as humus, compost or bokashi, due to nitrogen content, its structure and functions. Moreover, rice crops become fertilizer factories and generate additional income for farmers due to higher yields and sales from harvested surplus AA. At the end of the growing cycle of rice-Azolla this can be harvested and sold to farmers that grow other crops.

The focus is the emerging rural economy. In this respect, AGRIPAC will develop packaging and marketing with the inclusion of farmers. AA also opens interesting perspectives in other fields such as chemistry and biology of agriculture, carbon sequestration and climate change, global

cycles (carbon, nitrogen, phosphorus and hydrological), and emerging finance and economy, all within the context of tropical knowledge, whenever our country for its exclusive geographic position on the planet presents an opportunity to generate knowledge on issues of tropical agriculture, environment, health, economy, education and engineering.

While the benefits of introducing AA in rice cultivation have been known since 20 centuries ago in China, in Ecuador the enormous potential of a native species of Azolla in the production started to be valued for the environment and the economy of the rice farmers only recently.

This project activates this technology on a commercial scale for the first time. The production of biofertilizer Azolla Anabaena in flooded rice paddies, in order to be extracted, dried, packaged and sold as fertilizer for application in other crops is a novelty in Ecuadorian agriculture. Potential applicantions of a fertilizer 100% natural, renewable and organic are becoming numerous, parallel to the growing number of producers in the country.

Another innovation is that the crop of AA could be linked to the gender issue. The maintenance of AA and its application to rice can be entrusted to women, children and elderly, namely people who stay at home, with economic advantage for them.

TABLE 1: Type of Innovation
Directions: Choose which type of innovation best describes your project. (See Annex B "Typology of Innovation" for reference).
☐ New technology X New product, benefit or results X New delivery method and/or service ☐ New financing method ☐ Application of demonstrated approaches to new types of beneficiaries

TABLE 2: Stage of Testing Out the Innovation
Directions: Choose the most accurate category that describes the *current* stage of the proposed project's innovation (prior to receiving DM funding).
☐ **Idea stage/early stage**: Innovation has not been tested. Idea is still a concept. No prototype exists yet. ☐ **Early testing stage**: Innovation has evolved beyond an untested concept / blueprint. For example, a prototype has been developed but not field-tested on a sufficient scale to indicate viability of idea. **X Proof of concept**: Innovation has been tested and validated to demonstrate that the business model or idea is feasible, but not at a sufficient scale to indicate viability of idea under a variety of conditions. ☐ **Ready for Scale-up / Replication**: Innovation has been successfully validated / field tested under several conditions. It is ready to be scaled-up or replicated in other geographic areas.

5b) Project's Geographic Area of Influence (Suggested limit: 600 words)

The project takes place in the municipalities of Yaguachi and Daule, which are located in the province of Guayas. Although both have very fertile soil, perfect for agricultural production, mainly rice, soil types differ in their structure in the two provinces. It is therefore an objective of the project to find out more about different classes of soil.

The two areas are the most representative of the rice sector in the country. The project's development on these sites will have direct influence in the provinces of Guayas and Los Rios. 98% of the rice production of Ecuador develops in these two regions.

This project will also contribute to acquiring more knowledge about the Guayas Ecosystem. This ecosystem is a good representation of a tropical area covered by the Gulf of Guayaquil and connecting watersheds including 88 municipalities in 11 provinces, in an area of about 6 million hectares (See figure Annex B. Guayas Ecosystem).

The Guayas Ecosystem exhibits peculiarities that are unique in the world, such as its strategic position with regard to longitudinal and latitudinal magnetic axes of the planet, all levels of altitude ranging from the peak of the Chimborazo mountain to the imposing depths of the Pacific Ocean, impressive biodiversity, a valuable estuary of the Guayas River and the production of bananas, cocoa, passion fruit, ivory plant (tagua) and shrimp for the global market.

The interest at any level in the Guayas Ecosystem emerges from the diversity and opportunity of knowledge areas and applications. The themes of environment, agriculture, health, economy, education, engineering, can be developed here in the tropical perspective and extrapolated to the whole tropical zones of the world.

6. IMPLEMENTATION PLAN (Suggested limit: 900 words)

The activities to be implemented in the project include: (1) To develop a genetic bank of Azolla-Anabaena (AA) in ESPOL to maintain a source of seed to researchers and stakeholders; (2) To establish and maintain seedbeds of alive AA (Azollary) in two growers cooperatives in order to provide steadily material to the project; (3) To promote and grow together AA and rice in a single crop (Azoryza); (4) To extend the application of AA to commercial rice crops; (5) To repeat the experiment in ten cycles over two years in order to validate the technical implementation of AA and organic crops of rice in different geographic areas, (6) To expand the use of the Azolla fern culture as green manure among beneficiaries through field days; (7) To create a technological and commercial proposal for sales as green manure throughout AGRIPAC's national chain distribution; (8) To gain knowledge about growing AA in the Guayas Ecosystem, a tropical area, aiming to help solve global issues; and (9) To spread knowledge found locally, regionally and internationally (See chronogram at end the chapter).

The development of the project will build on the following methodologies:

(a) Learning by doing: The producer is directly involved in field activities to enhance the assimilation of knowledge acquired in the training sessions.
(b) Gender sensitive approach: The project will review ways to incorporate women, children and elderly in all planned activities, particularly in the stages of developing the azollary and nursery.
(c) Participatory approach: We seek the incorporation of the leaders of micro businesses in the process in order to better evaluate the progress and difficulties.
(d) Development of documenting culture for certification processes: All activities, procedures and events will be recorded and records kept.
(e) Replication: All methodological approaches outlined above enable the empowerment of micro-entrepreneurs with the use of technology. The role of AGRIPAC is key in this, as thanks to the level of involvement with the various associations and cooperatives, it can help generate the enthusiasm necessary for learning.
(f) Integrated systems approach: Pursuing the establishment of comprehensive states, not simply isolated productive elements.
(g) Quantitative approach in technical, economic and environmental aspects.

Activity \ Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
To develop a gene bank of AA in ESPOL											x	x	x	x										
To establish and keep alive the Azollary in 2 cooperatives	x	x	x	x	x	x	x																	
To promote the growth of AA and rice in a single crop (Azoryza)				x	x			x	x			x	x			x	x			x	x			
To expand the application of AA to commercial crops of rice						x	x	x		x	x	x		x	x	x		x	x	x		x	x	x
To expand the use of culture fern Azolla as green manure among beneficiaries through field days			x			x			x			x			x			x			x			x
To create a package of technological and commercial sale of green manure in the whole chain of distribution of national AGRIPAC							x	x			x	x			x	x			x	x			x	x
To develop tropical knowledge in regard to AA in the Guayas Ecosystem				x	x				x	x				x	x				x	x			x	x
To spread knowledge found locally, regionally and internationally										x	x	x	x								x	x	x	x

Other key elements taken into account by the project:

(a) Corporate Vision: Exploiting the potential of the system- to transform AA rice farmers in true entrepreneurs of new profitable, eco-friendly and cooperative agro-businesses.
(b) Competitiveness: Promote a change of attitude towards the marketing of products. There are alternatives to produce more efficiently (AA can reduce the production costs of rice) and to new markets: organic production and production of organic inputs.

(c) Focus on regional solutions: Considering the socio-economic diversity, cultural and biodiversity, not solutions such as "comprehensive technological package."
(d) Focus on promoting a healthy lifestyle based on healthy food in a healthy environment.
(e) Development of experiences: In technical and socio-cultural issues. The technical experiences relate to procedures for cultivation, fertilization, maintenance and post-harvest crop of AA. The main socio-cultural issues relate to marketing, rice cultivation and agreements of cooperatives, associations and cantonal agricultural centers.

7. COMMUNICATION WITH PROJECT STAKEHOLDERS (Suggested limit: 400 words)

The main stakeholders in the project include farmers, agricultural enterprises, government, academia and NGOs (Non-governmental organizations).

Farmers are directly involved in the project. Communication with them will be through training sessions throughout the project on experimentation sites and through demonstrative field days to show results. An important part of this communication will be the calculations of the economic advantages and calculations for the application of AA to other crops.

The agricultural enterprises will benefit from the project, which will provide a useful technology package. These benefits will be communicated to farmers through training courses, field days and communications.

The government benefits from the implementation of the project, as it is an assistance programme for farmers.

This project is a source of knowledge and practices for the university as well. Initially two graduation theses were scheduled, but this project opens the door to others.

The NGOs will find motivation for their work in this project, since the various issues identified can be supported with high and immediate profit.

The dissemination plan of the project will be carried out by the leading group of stakeholders with whom we will be conduct regular meetings and practical trainings to publicize the virtues and benefits of Azolla fern as fertilizer, and to motivate and engage farmers in the adoption and spreading of the usage of this technology.

The dissemination plan will be implemented in a participatory manner and continuing practice by developing a growing cycle of Azolla as much as rice with Azolla. In each of the sites we will establish pools that demonstrate Azolla cultivation and associated Azolla-rice cultivation. The first phase will be devoted to disseminating knowledge about Azolla, while we distribute the initial Azolla cultures for rice cultivation. In the next phase, we will work in spreading the technology package that relates to the introduction of the Azolla rice and share the results of completed training about Azolla. Finally, the last phase is designed to process information and to the dissemination of the research results.

TABLE 3 (optional): Communication Strategy Worksheet			
Directions: For each audience, fill out the form below			
Audience	**Behavioral change and/or transfer of knowledge desired by the end of DM-funded project implementation.**	**Degree to which the project team has been already interacting with this stakeholder group regarding this project.**	**Is this group already supportive or opposed to the project idea? Indicate if you do not know.**
Rice Farmers	They will ad an extra crop to the rice crop with new activities for the Azolla; extra harvest and sales of AA.	Currently rice growers have a relationship buying seed, fertilizers and agriculture supplies from AGRIPAC.	This group is already supportive to the project idea
Other growers: banana growers, corn growers, cacao growers, sugar cane growers, etc.	The use of a new fertilizer replacing artificial nitrogen.	Currently other growers have a relationship buying seed, fertilizers and agriculture supplies from AGRIPAC.	This group is supportive to the project idea
Agrochemicals Suppliers	New ways of agricultural practices using the new technology.	AGRIPAC is part of the team searching for data to support the development of new agriculture practices.	This group is supportive to the project idea
Academia	Open new fields of study and investigation related to chemistry, biology, soils, water, environment and agriculture.	The principal team is part of ESPOL with faculties that interact.	This group is already supportive to the project idea
Government	The government will have to define policies that benefit environmentally friendly growers of crops	The project through their proposals and results will necessarily interact with the ministry of agriculture and the central government facing the problems of improving rice production and securing the fertilizer supplies at long-term	This group is supportive to the project idea

As we are developing crops of Azolla and rice-Azolla, the dissemination plan is implemented addressing the specific themes designed for each crop.

Likewise, interviews with various media will be conducted in order to obtain greater coverage on the issues raised by the project, thus farmers and entrepreneurs from various sectors of the "rice country" could obtain information about AA.

8. RISK ASSESSMENT (Suggested limit: 500 words)

Potential risks	Potential impact of these risk	Mitigation strategies
Lack of cooperation from farmers to facilitate the experiment.	The project is aborted.	Motivation and participation of farmers and entrepreneurs in order to accept the project and support it. With their cultivation plots their participation and their work.
Lack of credibility towards farmers and entrepreneurs.	The project is aborted.	Dissemination, motivation and participation of farmers, to learn the benefits of the project and approval.
Lack of coordination and collaboration of technical personnel involved in the project.	Delay and failure to meet targets.	Motivation and control of programming through training courses and participation in the project.
Abnormal weather conditions such as the El Niño. phenomenon.	The project is stopped.	Establishing potential alternative sites in order to test the implementation of the project over there.
Lack of aid from the World Bank and AGRIPAC with resignation of base personnel, etc.	The project is aborted.	Discuss and establish precisely the rights and obligations.
Negative government policies in marketing which discourage rice cultivation.	The project is aborted.	Informing and involving the government in advance and seek their support all along.
Political problems affecting the country's rice sector (strikes, road closures, etc.).	The project is delyed.	Planning based on contingencies to avoid problems.

9. SUSTAINABILITY AND GROWTH POTENTIAL (Suggested limit: 600 words)

SUSTAINABILITY FOR ECONOMIC PROFITS. The national market for urea used in rice production is $ 6 million annually. AA alternatively replacing this fertilizer will produce economic benefits for the country as well as the individual growers. The profitability of an Azolla project produces a positive Net Present Value and an Internal Rate of Return higher than banks' interest rates along the time. Therefore the business interests will keep the project going and help sustain it after the DM support is finished. The project promotes changes in the attitudes and abilities of growers to promote agribusiness.

AA growing in combination with rice provides the economic viability of the program and subsequent production. The use of AA in a rice field will improve yields reducing production costs per unit. The rice will be sold in the market recovering costs and making a profit. The extra cost of managing AA in the fields is absorbed by the extra income generated, by increased efficiency and the extra sales of excess AA made to growers of other types of crops like corn or bananas.

Category \ Crop production	Normal	Using AA
Land preparation (US$/ha)	297.8	297.8
Seed (US$/ha)	84.3	84.3
Agricultural Supplies (US$/ha)	152.3	152.3
Labour (US$/ha)	180	280
Fertilizer (US$/ha)	303.72	77.22
Harvest (US$/ha)	266	266
Total (US$/ha)	1284.12	1157.62
Rice Yield (qq/ha)	100	158
Paddy Rice Cost (US$/qq)	12.84	7.33
Paddy Rice Price (US$/qq)	15	15
Profit (US$/qq)	2.16	7.67
Profit (%)	14	51

As it is shown in the table of different categories of costs and revenues, the estimated profit in the normal crop rice is 14 %, while in the crop using Azolla is 51 %.

SUSTAINABILITY OF THE MARKETS. Demand for organic fertilizers is expected to grow seeing the advantages of the use of green manure. AA in rice farms is sustainable, pushing the market to the formation of "factories" of AA in pools of rice. The massive use of this technology will impact on other crops like banana, sugar cane, corn, pineapple and vegetables, by the availability of this organic and cost effective fertilizer. This is expected to raise the supply of AA produced and available, making the cycle sustainable. The media (radio, newspapers and television) coupled with word of mouth advertising will help AA usage become a common practice among growers.

ENVIRONMENTAL SUSTAINABILITY, ENVIRONMENTAL IMPROVEMENT. The project helps maintain soil fertility by producing organic material rich in nitrogen. AA prevents the growth of aquatic weeds, as it covers the mirror of water from the paddy fields, avoiding the use of herbicides. This represents a positive impact on costs and preservation of water quality and the environment.

In the post- project steps the following mechanisms for sustainability will be expected/provided:

(a) ESPOL and AGRIPAC will promote changes before, during and after the AA project, which should change attitudes and abilities of micro enterprises for rice farming business based on market opportunities.
(b) ESPOL through ICQA will continue to contribute to the development of AA as a resource in Ecuador, as a source of knowledge, experience, technical documentation, information material and genetic material from AA.
(c) AGRIPAC will be on track to achieve permanent sources of funding to boost the mechanisms described in paragraph (a).

10. FINANCIAL VIABILITY (Suggested limit: 700 words)

The main budget expenditures include the construction of azollaries, materials and equipment needed for crops, materials and equipment needed to work at the laboratory to support the field work, and things necessary to operate an office. An example of the justification of budget expenditure is included in the box at the end of section.

It requires moreover personnel of various types, starting with an international consultant, the team of fieldwork, laboratory and office staff.

To transfer knowledge about the benefits of AA we will conduct demonstration field days with farmers. To raise awareness of the progress of the project to different constituencies we will use press, radio and TV

Also we will subscribe to databases and information to do the job based on scientific knowledge.

During the execution of the project we will assess the production of AA on a commercial scale, its harvesting and packaging technology, and finally the marketing for AA applications outside the rice paddies.

The data collected in the initial project phases will be confirmed/validated over the life of the project. We will therefore have the ability to commercialize AA, as well as knowledge of the reaction of the market.

During the execution of the project there will be more expenses than in regular farming, but scientific investigation is an investment, so it will spend more money than it will generate. But as a result of the project we will be able to better estimate actual costs and the costs of different forms of operation linked to AA, such as harvesting, drying, packaging and transporting.

A. Works

Construction of Azollaries: It is for all the necessary goods to build the azollaries.

B. Goods (Materials and Equipment)

Equipment	Use	Who will be use	Where it will be used
Laptop Computer	Managing information. Writing documents.	Staff office	Office
Printer	Printing documents	Staff office	Office
Camera	Recording project evolution, meetings and photographing crops	Technician	Countryside
Photocopier	Duplicating documents.	Staff office	Office
Laboratory equipment: Potentiometer Ground-water spot Others	Analysis of samples of different types of paddy	Laboratory Technician	Laboratory
Pump to water extraction	Distribution of water to irrigate crops	Rice Farmers	Countryside
Freezer	To conserve organic and inorganic material, vegetal tissues and chemicals	Laboratory Technician	Laboratory

Subscriptions to ISI. Web of Sciences: It is for library work.

Office supplies: It is for daily work.

Lab materials: Used for technique laboratory analysis.

C. Services:

(1) Personnel Costs

Director: Team leader for planning, organization, leading and controlling the activities.

Associate Biology Researcher: responsible for carrying out work which requires knowledge of biology

Lab analysts: Analysis of water, soil and leaf material.

Organic certification: Studies certification of rice cultivated with Azolla.

Group leader: Transfer field experiences to farmers.

Day labourers (4): Maintaining permanent azollaries and rice crops.

Students-thesis (2): Generating knowledge and design of experiments.

(2) Consultants

International Consulting: Dr. Francisco Carrapiço, Portugal University (http://azolla.fc.ul.pt; fcarrapico@fc.ul.pt)

International Flights: Travel.

(3) Training and Workshop Facilities

National Training: Training of technicians and leaders of groups.

Workshops: Extended trainings to cooperatives.

Demonstrative Field Days: Demonstration of Azolla and rice crops technology.

(4) Travel
Per diem national: Site visits to coopertatives and demonstration plots
National Flights: Internal Travel
Per diem national: Subsistence
D. General Administration/Overhead
Administrative Assistant: Management official.
Financial Management: Financial control of the project.
Telephone: Communication.
Mail and Internet: Communication.
E. Other (please specify)
Papers: Dissemination of Technology.
Bulletin / brochure: Training in coopertativas
Manual: Dissemination of Technology
Dissemination (Media): Dissemination of technology
Reporting: Reports
Site Visits Transportation: Work, progress and control of crops. Training to cooperatives.

11. ORGANIZATIONAL CAPACITY (Suggested limit: 800 words)

ESPOL (www.espol.edu.ec)

ESPOL is an institution of higher education, legal person of public law. In ESPOL the links with the community are articulated through the quality of teaching and scientific research-driven technology under the principle of useful science.

ESPOL has different centers that provide collaboration and support for research serving the community, such as CIR (Centro de Investigaciones Rurales), CIBE (Centro de Investigaciones Biotecnológicas del Ecuador), CICYT (Centro de Investigaciones Científicas y Tecnológicas) and CTT (Centro de Transferencia de Tecnología).

CICYT is responsible for promoting and evaluating research in ESPOL. It has coordinated a large number of research projects in fields of biotechnology, environment, marine science, electricity, mechanics, physics, agriculture, economy, tourism and earth sciences. CICYT also develops training, dissemination, sponsorship of small projects and thesis, promoting research events and internships. It is in charge of the following publications: Technology Review, Journal of Research and Development, and ESPOL Science Memories. In addition, CICYT gives ESPOL´s investigators logistical support, technical advice and produces scientific publications (www.cicyt.espol.edu.ec).

CTT (Technology Transfer Centre), established in 1998, is the responsible unit for executing the Advisory and Monitoring Project Financial Management. Simultaneously, it acts as a Promotion Centre for Projects, which seeks to establish a bond with the productive sector of the country,

and therefore looks for the potential for disseminating research, technology and services of ESPOL (www.ctt.espol.edu.ec).

AGRIPAC *(*www.agripac.com.ec)

AGRIPAC, a 35-year old private company, currently offers lines of credit per agriculture cycle to small, medium and large growers of rice, corn vegetables, bananas, broccoli, flowers, fruits, sugar cane, potato etc. AGRIPAC has a close and long lasting relationship with these growers, because AGRIPAC has always been there for them in good and bad times, providing training, credit lines and new product development that improve their yields.

AGRIPAC has 115 shops around Ecuador so you may say that AGRIPAC is close to where the growers are located, making it easy for them to accesses its services and products. Each shop is managed by a certified agricultural engineer and a shop assistant, who gives recommendations to the growers and helps in problem solving. They are organized in teams all around Ecuador. These teams are groups of shops and of sales representatives that are also certified professionals and that pay regular visits to the field, providing the necessary training and helping the growers with problems. Finally, these teams organize on-site programs and demonstrations, where the grower can see first hand the results of correct agricultural practices.

AGRIPAC also has facilities to receive grains as a service for the growers they can sell or pay their credits there in rice or corn. These plans are tree Victoria Rice, Agrigrain Corn and Balanfarina Corn and feed production.

MARIANO MONTAÑO, Chemical Engineer, Master of Business Administration, Ph. D. (Candidate)

- Lipidology: food and feed; omega 3 fatty acids.
- Development of forest: Forests Trust Rights.
- Environmental studies.
- Preparation and management of projects:

"Implementation of the symbiosis between Diazotroph Azolla and Anabaena as green manure in rice cultivation in the Ecuadorian Littoral"

"An inventory of emissions of dioxins and furans (D & F) in Ecuador (Director), GET/2732-02-4456 project, Global Environmental Facility (GEF) / Ministry of Environment of Ecuador-National Integrated Programm for the sound management of chemicals chemical. 2003"

"Establishment of the residues of fungicides (triazoles and estrobirulinas) in banana leaves and fruit depending on the cycles of plant health applications". Participation in Fair ESPOL Science Prototype- ESPOL Science 2002 - implementation of the Azolla-Anabaena as green manure for rice cultivation. Prototype- ESPOL Science 2005 - System-Rice Azolla in the production of organic rice.

IVAN NOBOA, MBA

- Marketing crops in summer and winter through the operational management of the plant.
- Import and marketing of raw material corn, wheat and soybean meal.
- Organization of the sales force consisting of 228 vendors, technicians organized into 22 teams with goals and shared system of commissions.
- Implementation of a database of 8,287 producers for the development of profitable agricultural programmes. The information in the database allows the sales team be more efficient.
- Developing a structural organization that allows a culture of teamwork and customer service.

MARIUXI ESPINOZA, Biologist

- Experience in the preparation of growth environment for the development of Azolla as a source of nitrogen.
- Participation for 3 years as a biology researcher in the project "implementation of the symbiosis between Diazotroph Azolla-Anabaena as green manure for rice cultivation in the Ecuadorian Littoral" PROMSA-ESPOL/ICQA.
- Collaboration in preparing the project profile Broadcasting "Azolla Anabaena", and as technical coordinator in the dissemination/communication of the project in question.
- Participation in the fair with ESPOL Science. Prototype-ESPOL Science 2002 - implementation of the Azolla-Anabaena as green manure for rice cultivation. Prototype-ESPOL Science 2005 - System-Rice Azolla in the production of organic rice.

Table 4: Summary of Capacity of Implementing Organization
Directions: Please choose any of the following that apply to your organization
☐ New organization that will implement the project ☐ Project team has no project implementation experience in the geographic area(s) impacted by the project X The applicant has a long standing positive relationship with the local communities that will be impacted by the project ☐ Project team's organizational focus is outside the field of sustainable agriculture. ☐ Project team leader or other core project staff need to be hired to implement this project

Table 5: Summary of Capacity of Partner Organization (if applicable)
Directions: Please choose any of the following that apply to your project partner organization.
☐ New partnership to implement the project ☐ Project team that has no project implementation experience in the geographic area(s) impacted by the project X The project partner has a long standing positive relationship with the local communities that will be impacted by the project ☐ Project partner's organizational focus / mission is outside the field of sustainable agriculture.

Table 6: Implementing and Partner Organization Information			
Directions: Fill in the following information about the applicant and partner organization.			
	Number of Full-time employees:	**Date of legal registration with government authority (registered business, NGO) or if government agency, date of creation of organization:**	**Has your organization ever implemented a project with budget size of at least the size of this proposed project (DM funds plus other planned funding sources)? (Yes/No)**
Implementing Organization	906	October 1958	Yes
Partner Organization (if not an individual)	150	April 1972	

12. TEAM LEADER (Suggested limit: 300 words)

Mariano Montaño

Project Experience	Duration (start-end)	Staff	Budget (US$)
Establishment of fungicide residues (triazoles and estrobirulinas) in banana leaves and fruit depending on the cycles of plant health applications.	24 months (10-06 /11-08)	11	49 785.00
Inventories of emissions of dioxins and furans (D & F) in ECUADOR (Director), GEF/2732-02-4456 projects, Global Environmental Facility (GEF) / Ministry of Environment of Ecuador-National Integrated Programme for the Sound Management of Chemicals. 2003.	6 months (2-8/04)	6	40 000.00

Inventories of Persistent organic pollutants (POPs) pesticides in ECUADOR (Director), GEF/2732-02-4456 projects, Global Environmental Facility (GEF) / Ministry of Environment- National Integrated Programme for the sound management of POPs in ECUADOR. 2003.	8 months (3-11/04)	6	60 000.00
Implementation of the symbiosis between Diazotroph Azolla and Anabaena as green manure for cultivation of rice on the Ecuadorian coast, proms, 2001-2004.	42 months (1/01-10/04)	8	110 000.00
Study Water Quality Coastal Ecuadorian Management Program Coastal Resources-AID, 1993.	60 months (11/1987 - 12/1993)	8	300 000.00
Biochemical and Nutrition Research in Reproduction and growth of shrimp, ESPOL / EEC (European Economic Community), 1991.	36 months 1988 - 1991	10	150 000.00
Preliminary Study of fatty acids Partners Food Shrimp, ESPOL / EEC, 1991	12 months 1990-1991	10	150 000.00

TEACHING:

ESPOL: General Chemistry and Organic chemistry for Aquaculture; Chemistry for Economics; Chemistry for Archaeology; Chemistry for Food Technology; General Inorganic Chemistry II; General Inorganic Chemistry I; and Ecology.
ESPOL-UG: Resource Management.
UNIVERSITY OF GUAYAQUIL (UG): Chemical Reactions and Engineering Thermodynamics.
CATHOLIC UNIVERSITY OF GUAYAQUIL: Mathematics.
NATIONAL POLYTECHNIC COLLEGE (EPN, www.epn.edu.ec): General Chemistry.

ACADEMIC TITLE:

Master of Business Administration, ESPOL, Guayaquil, 1987; chemical engineering, National Polytechnic College (EPN), Quito, 1977.

ADDITIONAL UNIVERSITY TRAINING:

Ph. D. (Candidate), University Jaume I (UJI) Castellon, Spain, areas of Experimental Science and Technology, Management Resources and Environment-ecosystems Guayas, 2002 `until today.`

APPENDIX A: CONTACT INFORMATION UPDATE

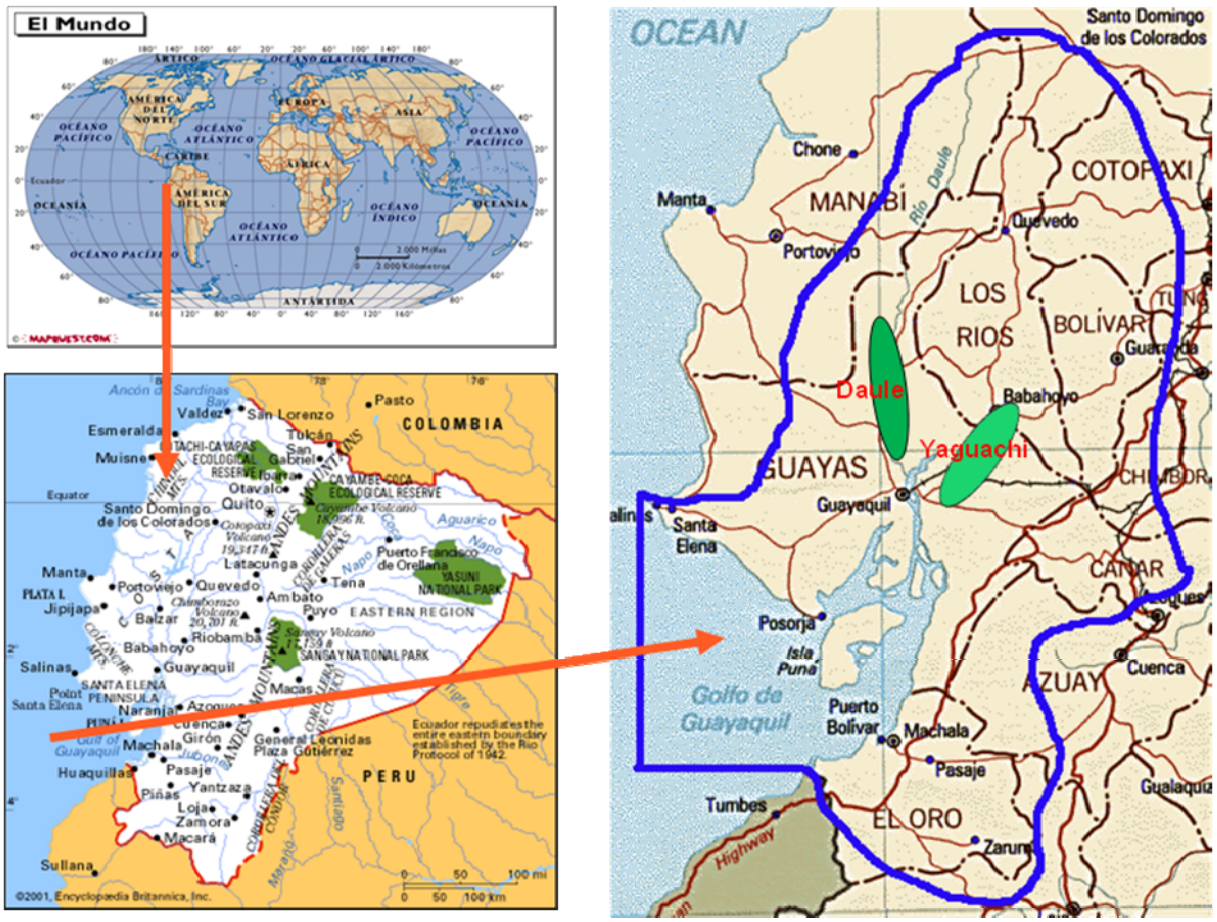
1. Project Team Leader Information	
First Name:	Mariano
Last Name:	Montaño
Position at Organization:	Professor-Researcher
Unit Within Organization:	ICQA
Organization:	ESCUELA SUPERIOR POLITECNICA
Organization Type (Please select): X Academia ☐ Development Agency (Bilateral or Multilateral) ☐ Foundation ☐ Government ☐ Non-Governmental Organization (NGO) ☐ Private Business	
Primary Email Address:	ecosistemaguayas@gmail.com
Secondary Email Address:	mmontano@espol.edu.ec
Organization Website:	www.espol.edu.ec
Telephone:	59342269566
Fax:	59342269566
Address:	Km. 30.5 Vía Perimetral, POBOX 09-01-5863
City:	Guayaquil
State/Province:	Guayas
Postal Code:	09-01-5863
Country:	Ecuador
Organization Date Established: (ESPOL) was created in 1958.	The Escuela Superior Politécnica del Litoral
Describe Your Organization (word limit 50):	ESPOL is an institution of higher education, legal entity of public law, nonprofit, autonomous in the academic, scientific, technical, administrative, financial and economic, with a capacity for self-regulated, seeks the truth and looks for the human development.

2a. Partner Information	
First Name:	Iván
Last Name:	Noboa
Partner Position at Organization:	Project Manager and Grain trade expert
Partner Organization:	AGRIPAC S.A.
Classify Partner Organization (Please Select): ☐ Academia ☐ Development Agency (Bilateral or Multilateral) ☐ Foundation ☐ Government ☐ Non Governmental Organization (NGO) x☐ Private Business ☐ Individual	
Partner Primary Email Address:	enoboa@agripac.com.ec
Partner Second Email Address:	info@agripac.com.ec
Partner Organization Website:	www.agripac.com.ec
Partner Telephone:	59342560400
Partner Fax:	59342313327
Partner Address:	Córdova 623 y P. Solano
Partner City:	Guayaquil
Partner State/Province:	Guayas
Partner Postal Code:	
Partner Country:	Ecuador
Partner Organization Date Established:	1972
Describe Partner Organization (word limit 30):	AGRIPAC is a group of companies forming the largest Agro Industrial Group in Ecuador. Established 35 years ago, it has achieved a clear leadership position and currently enjoys sustained and continued growth
Duration of Partnership: X Pre-existing; for how many months? 24 ☐ New	
Describe Partner's Responsibilities (word limit 50): AGRIPAC has experience in managing and investigating rice crops. Last year a new line of organic products was introduced with great acceptance from the market. The need to develop new technologies is of great importance to keep leadership in the industry. Prices of Nitrogen fertilizers push to look for new technological solutions.	

2b. Second Partner Information (if any)	
First Name:	
Last Name:	
Partner Position at Organization:	
Partner Organization:	
Classify Partner Organization (Please Select): ☐ Academia ☐ Development Agency (Bilateral or Multilateral) ☐ Foundation ☐ Government ☐ Non Governmental Organization (NGO) ☐ Private Business ☐ Individual	
Partner Primary Email Address:	
Partner Second Email Address:	
Partner Organization Website:	
Partner Telephone:	
Partner Fax:	
Partner Address:	
Partner City:	
Partner State/Province:	
Partner Postal Code:	
Date Established:	
Describe Partner Organization (word limit 30):	
Duration of Partnership: ☐ Pre-existing; for how many months? ☐ New	
Describe Partner's Responsibilities (word limit 50):	

3. Project Profile	
Project Title for booth at Marketplace (maximum: 15 words)	How to convert a rice field in green fertilizer factory
Region of Implementation (Please Select One): ☐ Africa ☐ East Asia and the Pacific ☐ Europe and Central Asia X Latin America and the Caribbean ☐ Middle East and North Africa ☐ South Asia ☐ Multi-region	
Country of Implementation:	**Ecuador**
Sub-theme (Please Select One): X Linking small-scale farmers to input-output markets ☐ Improving land access and tenure for the poor ☐ Promoting the environmental services of agriculture in addressing climate change and biodiversity	
Project Duration Using DM funds (up to 24 months):	24

APPENDIX B (optional): Project Geographic Area of Influence (JPG/TIF/GIF map)



Guayas Ecosystem

The World Bank
COUNTRY MANAGEMENT UNIT BOLIVIA, ECUADOR, PERU AND VENEZUELA
INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT
INTERNATIONAL DEVELOPMENT ASSOCIATION

Av. Alvarez Calderón 185, Piso 7
San Isidro – Lima 27
PERU

Tel: (511) 615-0660
Fax: (511) 421-7241

April 30, 2009

Mr. Moisés Tacle Galárraga
Principal *(Rector)*
Escuela Superior Politécnica del Litoral
Km. 30.5 Vía Perimetral
Guayaquil, Guayas-Ecuador
POBOX 09-01-5863

Re: ***"2008 Sustainable Agriculture for Development"***
Development Marketplace Grant No. 805757
Converting Rice Fields into Green Fertilizer Factories Project

Dear Mr. Tacle,

In response to the request for financial assistance made on behalf of *Escuela Superior Politécnica del Litoral* ("Recipient"), I am pleased to inform you that the "2008 Sustainable Agriculture for Development" Development Marketplace ("DM2008") jury on September 26, 2008, selected your proposal for support from DM2008.

I am writing on behalf of the International Bank for Reconstruction and Development and the International Development Association (collectively, "World Bank") to indicate its agreement which supports DM2008, to extend to the Recipient a grant in an amount not to exceed One Hundred Ninety Six Thousand Seven Hundred and Fifty Two United States Dollars (U.S.$ 196,752) ("Grant") on the terms and conditions set forth or referred to in this letter agreement, which includes the attached Annex ("Agreement"), to assist in the financing of the "Converting Rice Fields into Green Fertilizer Factories" project described in the Annex ("Project").

The Recipient represents, by confirming its agreement below, that it is authorized to enter into this Agreement and to carry out the Project in accordance with the terms and conditions set forth or referred to in this Agreement. The Recipient further represents that it intends to obtain from AGRIPAC S.A. an amount equivalent to $84,800 to assist in financing the Project

Please confirm the Recipient's agreement to the foregoing by having an authorized official of the Recipient sign and date the enclosed copy of this Agreement, and returning it to the World Bank. Upon receipt by the World Bank of this countersigned copy, this Agreement shall become effective as of the date of the countersignature.

Very truly yours,

International Bank for Reconstruction and Development
International Development Association

By _____
C. Felipe Jaramillo
Director
Bolivia, Ecuador, Peru and Venezuela
Latin America and the Caribbean Region

AGREED:
Escuela Superior Politécnica del Litoral

By _____
Authorized Representative

Name: Moisés Tacle Galárraga

Title Principal (*Rector*)

Date: 12-may-09

Enclosures:

(1) Standard Conditions for Grants Made by the World Bank Out of Various Funds, dated July 1, 2008

(2) Disbursement Letter dated February 27, 2009, together with World Bank Disbursement Guidelines for Projects, dated May 1, 2006

Article I
Standard Conditions; Definitions

1.01. ***Standard Conditions.*** The Standard Conditions for Grants Made by the World Bank out of Various Funds dated July 1, 2008 ("Standard Conditions") constitute an integral part of this Agreement.

1.02. ***Definitions.*** Unless the context requires otherwise, the capitalized terms used in this Agreement have the meanings ascribed to them in the Standard Conditions or in this Agreement, and the following additional terms have the following meanings:

(a) "AA" means Azolla Anabaena, an aquatic fern that has the potential to replace artificial nitrogen fertilizers.

(b) "AGRIPAC S.A." means a corporate group of seven corporations established on February 9, 1972 and legally operating in the territory of the Republic of Ecuador in accordance with the laws of the Republic of Ecuador.

(c) "ESPOL" means *Escuela Superior Politécnica del Litoral*, an institution of higher education established on October 29, 1958 pursuant to the laws of the Republic of Ecuador.

(d) "Project's Environmental Management Plan" means the *Plan de Manejo Ambiental* approved on February 2, 2009 and referred to in Section 2.03 of this Agreement.

Article II
Project Execution

2.01. ***Project Objectives and Description.*** The objective of the Project is to increase rice yields and reduce dependency on imported artificial nitrogen fertilizers by cultivating AA to be used as a nitrogenic biofertilizer and strengthening social inclusion.

The Project consists of the following activities:

(a) Developing a genetic bank of AA to maintain a source of seed to researchers and stakeholders.

(b) Establishing and maintaining seedbeds of live AA in two cooperatives to provide a steady supply of material for the project.

(c) Promoting the growth of AA and rice together in a single crop.

(d) Extending the application of AA to commercial rice crops.

(e) Validating the technical implementation of AA and organic rice crops in different geographic areas of the Republic of Ecuador by repeating the experiment in multiple cycles.

(f) Expanding the use of the AA as green manure through field day demonstrations with farmers.

(g) Creating a technological and commercial proposal for the sale of AA green manure throughout AGRIPAC's national chain distribution.

(h) Providing training and carrying out of workshops to develop tropical knowledge about growing AA in the Guayas Ecosystem and spread this knowledge globally.

2.02. ***Project Execution Generally.*** The Recipient declares its commitment to the objectives of the Project. To this end, the Recipient shall carry out or shall cause the Project activities to be carried out in accordance with the provisions of (a) Article II of the Standard Conditions, (b) the "Guidelines on Preventing and Combating Fraud and Corruption in Projects Financed by IBRD Loans and IDA Credits and Grants", dated October 15, 2006 ("Anti-Corruption Guidelines") and (c) this Article II.

2.03. ***Institutional and Other Arrangements.*** The Recipient shall ensure that the Project is carried out in accordance with good social and environmental standards and practices. Specifically, the Recipient shall carry out the Project pursuant to the Project's Environmental Management Plan.

2.04. ***Project Monitoring, Reporting and Evaluation.***

(a) The Recipient shall monitor and evaluate the progress of the Project and prepare Project Reports in accordance with the provisions of Section 2.06 of the Standard Conditions and on the basis of indicators agreed with the World Bank. Each Project Report shall cover the period of one calendar semester and shall be furnished to the World Bank not later than one month after the end of the period covered by such report.

(b) The Recipient shall prepare the Completion Report in accordance with the provisions of Section 2.06 of the Standard Conditions. The Completion Report shall be furnished to the World Bank not later than two months after the Closing Date.

(c) Thereafter, but in any event not later than eighteen months after the Closing Date, the Recipient shall exchange views with the World Bank in order to assess the results achieved under the Project, lessons learnt, and factors contributing to the eventual success or failure of the Project.

2.05. ***Financial Management.***

(a) The Recipient shall ensure that a financial management system is maintained in accordance with the provisions of Section 2.07 of the Standard Conditions.

(b) The Recipient shall ensure that interim unaudited financial reports for the Project are prepared and furnished to the World Bank as part of the Project Report not later than one month after the end of each Project Report period, covering that same period, in form and substance satisfactory to the World Bank.

(c) The Recipient shall, upon the World Bank's request, have its Financial Statements audited in accordance with the provisions of Section 2.07 (b) of the Standard Conditions. Such audit of the Financial Statements shall cover the period indicated in the World Bank's request. The audited Financial Statements for such period shall be furnished to the World Bank not later than six months after the date of the World Bank's request.

2.06. ***Procurement***

(a) General. All goods, works and services required for the Project and to be financed out of the proceeds of the Grant shall be procured in accordance with the requirements set forth or referred to in:

(i) Section I (excluding paragraph 1.16) of the "Guidelines: Procurement under IBRD Loans and IDA Credits" published by the World Bank in May 2004 and revised in October 2006 ("Procurement Guidelines"), in the case of goods and works;

(ii) Sections I (excluding paragraph 1.24) and IV of the "Guidelines: Selection and Employment of Consultants by World Bank Borrowers" published by the World Bank in May 2004 and revised in October 2006 ("Consultant Guidelines") in the case of consultants' services; and

(iii) the provisions of this Section.

(b) Definitions. The capitalized terms used in the following paragraphs of this Section to describe particular procurement methods or methods of review by the World Bank of particular contracts, refer to the corresponding method described in the Procurement Guidelines, or the Consultant Guidelines, as the case may be.

(c) Particular Methods of Procurement of Goods and Works

The following methods shall be used for procurement of goods and works for those contracts which the World Bank agrees meet the requirements set forth in the Procurement Guidelines for their use: (A) Shopping; or (B) Direct Contracting.

(d) Particular Methods of Procurement of Consultants' Services

The following methods shall be used for the procurement of consultants' services for those assignments which the World Bank agrees meet the requirements set forth in the Consultant Guidelines for their use:(A) Selection based on Consultants' Qualifications; (B) Single-source Selection; (C) Selection of Individual Consultants; or (D) Sole Source Procedures for the Selection of Individual Consultants.

(e) Review by the World Bank of Procurement Decisions. All contracts shall be subject to Post Review by the World Bank.

2.07. ***Use of Name and Logo.*** The Recipient may not use the name and/or logo of the World Bank and the Development Marketplace or DM2008 program in any manner without first obtaining written permission from the World Bank.

Article III
Withdrawal of Grant Proceeds

3.01. ***Eligible Expenditures.*** (a)The Recipient may withdraw the proceeds of the Grant in accordance with the provisions of (i) Article III of the Standard Conditions, (ii) this Section, and (iii) such additional instructions as the World Bank may specify by notice to the Recipient (including the "World Bank Disbursement Guidelines for Projects" dated May 2006, as revised from time to time by the World Bank and as made applicable to this Agreement pursuant to such instructions), to finance Eligible Expenditures as set forth in the following table. The table specifies the categories of Eligible Expenditures that may be financed out of the proceeds of the Grant ("Category"), the allocations of the amounts of the Grant to each Category, and the percentage of expenditures to be financed for Eligible Expenditures in each Category:

Category	**Amount of the Grant Allocated (expressed in USD)**	**Percentage of Expenditures to be Financed (inclusive of Taxes)**
(1) Works	$10,000	100 %
(2) Goods	$35,852	45 %
(3) Consultants' Services	$43,366	67 %
(4) Travel and Salaries for Project Staff	$91,310	83 %
(5) Operating Costs	$16,224	100 %
TOTAL AMOUNT	$196,752	

For the purposes of this Section, the term (a) "travel and salaries of Project staff" means travel and salaries for incumbent personnel of the Recipient working exclusively for the Project, but excluding salaries of consultants and civil servants and (b) "operating costs" means incremental expenditures directly related to the management and monitoring of the Project (which expenditures would not have been incurred absent the Project), including expenditures for office supplies, maintenance of office equipment, communication charges, operation and maintenance of vehicles, bank charges.

3.02. ***Withdrawal Conditions.*** Notwithstanding the provisions of Section 3.01 of this Agreement, no withdrawal shall be made for payments made prior to the date of countersignature

of this Agreement by the Recipient, except that withdrawals up to U.S. $39,350.40 equivalent may be made for payments made within one year prior to this date but on or after September 26, 2008 for Eligible Expenditures.

3.03. ***Withdrawal Period.*** The Closing Date referred to in Section 3.06 (c) of the Standard Conditions is March 10, 2011.

Article IV
Recipient's Representative; Addresses

4.01. ***Recipient's Representative.*** The Recipient's Representative referred to in Section 7.02 of the Standard Conditions is its Principal (*Rector*).

4.02. ***Recipient's Address.*** The Recipient's Address referred to in Section 7.01 of the Standard Conditions is:

Escuela Superior Politécnica del Litoral
Km. 30.5 Vía Perimetral
Guayaquil, Guayas-Ecuador
POBOX 09-01-5863

Telephone: +59342269566
Facsimile: +59342269566

4.03. ***World Bank's Address.*** The World Bank's Address referred to in Section 7.01 of the Standard Conditions is:

World Bank
c/o "2008 Sustainable Agriculture for Development" Development Marketplace Portfolio Coordinator (PC)
Ms. Kirsten Spainhower
1818 H Street, N.W.
Washington, D.C. 20433
United States of America

Telephone: +1-202-458-2325
Facsimile: +1-202-522-2042

With a copy to:

"2008 Sustainable Agriculture for Development" Development Marketplace Project Supervisor (PS):

Ms. Gabriela Arcos
Garcos@worldbank.org

Appendix

Indicative Withdrawal Schedule

Withdrawal of the proceeds of the Grant shall be made by the Recipient in accordance with the schedule set forth below, subject to receipt by the World Bank of the Application and Supporting Evidence (as defined in Section 3.04 (b) of the Standard Conditions) satisfactory to the World Bank. The Supporting Documentation shall include the Project Report or, in the case of the last period specified in the schedule below, the Completion Report and Unaudited Final Financial Report, indicating the achievement of the items specified below for the respective period so indicated.

Period	Ending of Reporting Period	Expected Activities/Output
0		1. Milestones and withdrawal schedule discussed and agreed with the DM08 Development Marketplace Portfolio Manager (PM) and the Project Supervisor (PS) as specified in the Grant Agreement. 2. Outcome Indicators agreed upon with PS and PM: a. At least 4 ha (hectares) of commercial crops using Azolla as exclusive fertilizer. b. Increased production of paddy rice from 3.5 tons/ha/cycle to 6 tons/ha/cycle, in experimental sites, maintaining the current total cost of production per cycle. c. Technology package implementing Azolla Anabaena rice, transferred at least to 100 rice producers (40 % targeting women) at Daule and Samborondon, as the first pilot experiment. d. Commercial package adopted by the technical department for the sale of AGRIPAC green manure in 10 agencies in the distribution chain within the manure division of AGRIPAC. 3. Completed budget template for Period 1 activities. 4. All legal documents signed by the Project Team and the World Bank Country Director/Manager
	Effectiveness of the Agreement	
Forecast for advance payment to carry out activities for Period 1: $98,376 (50% of Total)		
1		1. Project-Specific Output Indicators (3-5) a. Establish a gene bank of Azolla Anabaena in ESPOL and two azollaries in Samborondon and Daule respectively, for multiple purposes. b. Increase average production rate of Azolla Anabaena established as more than 15 tons/ha/month. c. Conduct at least 300 visits to the Azollaries, including 150 farmers partners, 10 academic researchers, 90 students and 50 general public. d. Detailed M&E Plan prepared that outlines protocol for collecting

		data (targeted beneficiaries differentiated by gender) to measure progress toward outcome indicators in Period 0. Plan should include details on data collection, sources of data, frequency of monitoring, etcetera. e. Baseline survey conducted and data analyzed. f. Draft Communication Strategy with stakeholders prepared. 2. Project Supervisor's or Project Manager's site visit to review progress on all outputs outlined above, including a review of social and environmental standards and practices.
	Six months after effectiveness	**End of activities covering this reporting period**
Forecast for advance payment to carry out activities for Period 2: $59,025.60 - (30% of Total)		
2		1. Project-Specific Output Indicators (3-5) a. At least 2 crop rice leaders spread Azolla in the rice fields in an area of over 4000 m^2 (throughout the project). b. Prepared training materials, consisting of: 3 technical guides (1000 ea), 1 manual Azolla (800 units) (cleared by World Bank Safeguard Specialist). c. Complete field demonstration of at least 6 management practices (one of which must be lead by a World Bank approved Nutrient Management Specialist) for Azolla application on rice fields, with the participation of rice producers of the area affected by the project. d. Dissemination of management practices through at least 12 presentations (radio, television and newspaper). 2.
	12 months after effectiveness	**End of activities covering this reporting period**
Forecast for advance payment to carry out activities for Period 3: $39,350.40 (20 % of Total)		
3		1. Project-Specific Output Indicators (3-5) a. Creation and adoption of commercial technology package (CTP) within the Technical Department (TD) of AGRIPAC by conducting: (a) at least 6 technical visits of TD to experimentation sites; and (b) at least 2 workshops for the TD to assess the quality of the CTP. b. Agricultural input reduced by at least 50% for urea and herbicides applied to the experimental sites. c. Cost benefit analysis of Azolla production is evaluated for its potential for application to other crops. d. At least 3 publications in technical journals produced describing characterization of Azolla and applications. e. At least 2 agreements signed with the agricultural centers from Daule and Samborondon, for adopting the Azolla-rice technology..

		2. Submit Sustainability Plan developed to describe post-DM activities and funding. 3. Submit Evaluation plan (with timeline, budget and activities). Plan includes measurements of project performance using outcome indicators listed above in comparison with baseline data.
	18 months after effectiveness	**End of activities covering this reporting period**
	October 1, 2011	**Completion of all Project activities.**
	December 1, 2011	**Submit Completion Report with Unaudited Final Financial Report to Project Manager and Project Supervisor.**
Total Grant Amount: $196,752		

ESCUELA SUPERIOR POLITÉCNICA DEL LITORAL

"Impulsando la Sociedad del Conocimiento"

December 29, 2008

The World Bank
1818 H Street, N.W. MSN LIMWB
Washington, D.C. 20433
United States of America

Attention: Carlos Felipe Jaramillo, Country Director, Ecuador (Latin America and Caribbean)

Re: "5381, Converting Rice Fields into Green Fertilizer Factories"
"2008 Sustainable Agriculture for Development"Development Marketplace
Grant No. 805757

Dear Mr. Jaramillo:

I refer to the Letter Agreement ("Agreement") between the International Bank for Reconstruction and Development and the International Development Association (collectively, "World Bank"), acting as administrator of grant funds which supports the "2008 Sustainable Agriculture for Development" Development Marketplace, and Escuela Superior Politécnica del Litoral-ESPOL (the "Recipient") providing the above Grant. For the purposes of Section 3.04 (b) of the Standard Conditions, as defined in the Agreement, any of the persons whose authenticated specimen signatures appear below is authorized on behalf of the Recipient to sign applications for withdrawal under this Grant:

Mariano Montaño Armijos, 5381 Project Director: _____

Yours truly,

Moisés Tacle Galárraga
Rector
ESPOL

2008 GLOBAL DEVELOPMENT MARKETPLACE
DM2008 PROJECT IMPLEMENTATION
FINAL REPORT

[07/07/2011]

In order to ensure transparency, accountability, and to share lessons learned, we will post this Progress Report on the Development Marketplace website at www.developmentmarketplace.org
If you would like to share any sensitive information with us, you can do so in section VI. The information provided in this part of the report will be handled as confidential and will not appear on the DM website.

I. Background Information

DM Project Number and Title	5381 Converting Rice Field into Green Fertilizer Factories
Report Author's Name and title (if different from Grantee Leader)	Mariano de Jesús Montaño Armijos
Reporting Period from	8-July-2009 to 7-July-2011

If your contact information has changed, please provide us with the new information.

Contact Name:	Mariano de Jesús Montaño Armijos
Title:	Grantee Leader
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Postal Code:	09-01-5863

II. Progress Against Milestones

1) List the output indicators in the first column as presented in the withdrawal schedule for this milestone period. The second column should indicate the current status of each milestone objective. In the third column, please provide quantitative data and qualitative information describing the status of the project against that particular milestone.

<table>
<tr><th>Milestones (Copy from the Agreement)</th><th>Status (Complete/ In Progress)</th><th>Descriptive Information on the Status</th></tr>
<tr><td>Period 0.2.a. At least 4 ha (hectares) of commercial crops using Azolla as exclusive fertilizer</td><td>Completed</td><td>This objective has been fulfilled beyond what was offered in the project. The rice crops amounted to 10.41 hectares, with the following areas: at Artillería 6.41 ha and at El Mangle 4.00 ha. Yields of Artillería, El Mangle and total reached respectively to 3.98 t/ha, 4.20 t/ha and 4.06 t/ha (Table 1).

The rice plantation owners decided to expand the areas of rice cultivation, from 1.25 to 2.66 ha at Samborondón-Artillería and from 1 to 1.5 ha at El Mangle.

Table 1. Area and production in the project sites

<table>
<tr><th>Experimental sites - Category</th><th>Harvest date</th><th>Variety</th><th>Area (ha)</th><th>Yield (t)</th><th>Prod. (t/ha)</th></tr>
<tr><td>Artillería-Commercial Rice</td><td>2010-01-17</td><td>Capirona</td><td>1.25</td><td>5.95</td><td>4.76</td></tr>
<tr><td>Artillería-Commercial Rice</td><td>2010-06-21</td><td>INIAP 415</td><td>1.25</td><td>4.00</td><td>3.20</td></tr>
<tr><td>Artillería-Commercial Rice</td><td>2011-01-11</td><td>Capirona</td><td>2.66</td><td>11.60</td><td>4.36</td></tr>
<tr><td>El Mangle-Commercial Rice</td><td>2010-06-15</td><td>INIAP 14</td><td>1.00</td><td>3.93</td><td>3.93</td></tr>
<tr><td>El Mangle-Commercial Rice</td><td>2010-12-29</td><td>INIAP 11</td><td>1.5</td><td>5.06</td><td>3.37</td></tr>
<tr><td>Artillería-Commercial Rice</td><td>2011-07-15</td><td>Capirona</td><td>1.25</td><td>3.95</td><td>3.16</td></tr>
<tr><td>El Mangle-Commercial Rice</td><td>2011-09-05</td><td>INIAP 11</td><td>1.50</td><td>7.80</td><td>5.20</td></tr>
<tr><td>Total</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Artillería</td><td></td><td></td><td>6.41</td><td>25.5</td><td>3.98</td></tr>
<tr><td>El Mangle</td><td></td><td></td><td>4.00</td><td>16.79</td><td>4.20</td></tr>
<tr><td>Project</td><td></td><td></td><td>10.41</td><td>42.29</td><td>4.06</td></tr>
</table>

In the project, rice farmers have maintained a strong interest in the use of Azolla, including organic farming inputs. Finall product can be called "biogenic rice" due to its special features for human health and environment.</td></tr>
<tr><td>Period 0.2.b. Increased production of paddy rice from 3.5 tons/ha/cycle to 6 tons/ha/cycle, in experimental sites, maintaining the current total cost of production per cycle.</td><td>Completed</td><td>The project has obtained a yield of rice production of 4.06 t / ha (Table 1), higher than the national average of 3.14 t / ha (www.corpcom-ec.com). However, the expected production has not achieved. There are three main reasons for this objective has not been achieved, in the first place are the soil characteristics that are not suitable for high production, second was solar luminosity diminished by the eruptions of the Tungurahua volcano, and third the recent emergence of snail plague.

Choosing experimental sites

Experimental sites have been established in two rice grower cooperatives (Figure 1):

• Artillería-Salitre located near Samborondón
• El Mangle-Santa Lucía located near Daule

The project tooke place in the municipalities of Salitre (Artillería) and Santa Lucía (El Mangle), which are located in the watersheds of Daule and Vinces</td></tr>
</table>

Rivers. Although both municipalities have very fertile soils, perfect for agricultural production, mainly rice, soil types differ in their structure in the two watersheds. It was therefore important to test the development of rice with *Azolla* fertilizer in two different soil types.

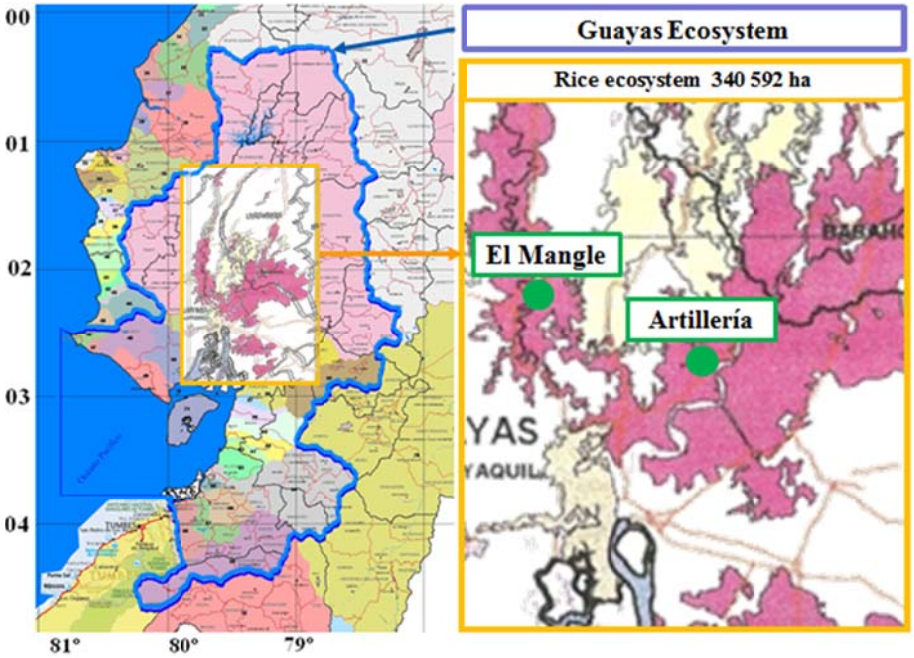


Figure 1. Project experimental sites in the rice ecosystem

The two areas are the most representative of the rice sector in the country. The project's development on these sites will have direct influence in the provinces of Guayas and Los Rios, which produce almost all the rice of Ecuador.

This Project will also contribute to acquiring more knowledge about the Guayas Ecosystem. This ecosystem is a good representation of the global tropical area, and is composed by the Gulf of Guayaquil and connecting watersheds, including 107 municipalities in 13 provinces, in an area of about 8.7 million hectares. These and other useful features of Guayas Ecosystem are indicated in Table 2 (Montaño, 2010).

On average, 79 % of overall Ecuadorian agricultural, livestock and fisheries production is generated in the Guayas Ecosystem (Montaño, 2010).

To gather information of rice production, data collection forms were designed and filled in the manner that presented below. Only there are records from Artillería; El Mangle has no information.

Paddy rice production in 2003-2009 period at the Artillería azorizary site shown in Table 3. The site of commercial rice has information from 2002 to 2009 (Table 4).

Table 2. Productive features of Guayas Ecosystem

Category	Percentage	Quantity	Weight
Extension	31 %	87 347 km^2	
Population	42 %		
Provinces	13		
Municipalities	107		
Rice	96 %	340 592 ha	1 341 129 t
Bananas	90 %	176 930 ha	6 866 066 t
Hard corn	60 %	97 200 ha	
Cocoa	74 %	398 104 ha	
Cofee	61 %	171 923 ha	26 010 t
Sugar cane	92 %	89 424 ha	
Shrimp	83 %	146 796 ha	135 000 t
Fishing	75 %	180 451 t	

Table 3. Rice paddy production at azorizary site (Artillería)

Year	Season	Productión (bag/block)	Fertilization	Área (ha)	Yield (t/ha)
2003		58.30	Urea	0.15	6.71
2004		55.55	Urea	0.15	6.40
2005		75	Urea	0.15	8.64
2006	Invierno	61	Urea	0.15	7.03
2006	Verano	55.55	Urea	0.15	6.40
2007	Invierno	44.44	Urea	0.15	5.12
2007	Verano	48.71	Urea	0.15	5.61
2008	Invierno	64.44	Urea	0.15	7.42
2008	Verano	66.66	Urea	0.15	7.68
2009	Invierno	58.33	Urea	0.15	6.72

Table 4. Rice paddy production at commercial rice site (Artillería)

Year	Season	Productión (bag/block)	Fertilización	Área (ha)	Yield (t/ha)
2002	Invierno	32.74	Urea	1.01	3.77
2002	Verano	44.33	Urea	1.01	5.11
2003	Invierno	38.76	Urea	1.01	4.46
2003	Verano	49.86		1.01	5.74
2004	Invierno	46.57	Urea	1.01	5.36
2004	Verano	37.63	Urea	1.01	4.33
2005	Invierno	38.25	Urea	1.01	4.41
2005	Verano	51.75	Urea	1.01	5.96
2006	Invierno	51.5	Urea	1.01	5.93
2006	Verano	39.63	Urea	1.01	4.56
2007	Invierno	47.76	Urea	1.01	5.50
2007	Verano	41.76	Urea	1.01	4.81
2008	Invierno	54.21	Urea	1.01	6.24
2008	Verano	54.47	Urea	1.01	6.27
2009	Invierno	50	Urea	1.01	5.76

<table>
<tr>
<td></td>
<td></td>
<td>High rice production values at Artillería are due to high utilization of urea fertilizer. For this reason, the reversal of urea to Azolla has submitted a punishment for production.

It is hoped that over time rice yields will improve by continuing to work with Azolla green fertilizer.

Moreover, records of production rates of Azolla in Artillería and El Mangle showed different values, as indicated in Table 5.

Table 5. Azolla production rates al Artillería and El Mangle
<table>
<tr><th>Harvest date</th><th>Yield (t/ha/day)</th></tr>
<tr><td>Artillería</td><td></td></tr>
<tr><td>07-sep-09</td><td>0.54</td></tr>
<tr><td>15-oct-09</td><td>0.57</td></tr>
<tr><td>23-oct-09</td><td>2.95</td></tr>
<tr><td>07-nov-09</td><td>1.06</td></tr>
<tr><td>19-nov-09</td><td>1.13</td></tr>
<tr><td>02-mar-10</td><td>0.09</td></tr>
<tr><td>06-abr-10</td><td>0.25</td></tr>
<tr><td>19-ago-10</td><td>0.10</td></tr>
<tr><td>26-ago-10</td><td>0.32</td></tr>
<tr><td>27-ago-10</td><td>9.09</td></tr>
<tr><td>06-sep-10</td><td>1.14</td></tr>
<tr><td>23-sep-10</td><td>0.40</td></tr>
<tr><td>Mean</td><td>1.47</td></tr>
<tr><td>El Mangle</td><td></td></tr>
<tr><td>10-nov-09</td><td>0.44</td></tr>
<tr><td>12-dic-09</td><td>0.50</td></tr>
<tr><td>12-ene-10</td><td>1.47</td></tr>
<tr><td>01-feb-10</td><td>0.14</td></tr>
<tr><td>05-feb-10</td><td>1.7</td></tr>
<tr><td>10-feb-10</td><td>1.13</td></tr>
<tr><td>10-mar-10</td><td>0.49</td></tr>
<tr><td>24-jun-10</td><td>0.44</td></tr>
<tr><td>Mean</td><td>0.50</td></tr>
</table>
In Table 5 it appears that Azolla performance in Artillería is higher than the performance in El Mangle. On average, in the Project, the growth of Azolla has been established in a rate of 1 t/ha/day.</td>
</tr>
<tr>
<td>Period 0.2.c. Technology package implementing Azolla Anabaena rice, transferred at least to 100 rice producers (40 % targeting women) at Daule and Samborondón, as the first pilot experiment.</td>
<td>Completed</td>
<td>Technology package for the development and use of Azolla includes 3 steps: Azollary (Az), Azoryzary (AzRz), and rice (Rz). Growing areas of each step are multiplied by 10, as shown in Figure 2, ie starting with 100 m^2 of Azollary (Az), 1000 m^2 of Azoryzary and 10 000 m^2 of rice field are achieved.

Azolla needs shade from sunlight to grow well, for this reason a 50 % covering mesh is used to protect the azollary. Once grown, Azolla is transferred to Azoryzary where rice foliage provides shade for proper growth; from here mature Azolla finally goes to commercial rice where they grow together. The cycles of each plantation have the following extension (Figure 2): 60 days the Azolla, 120 days the rice of AzRz and 120 days the commercial rice. The Azolla is transferred on 30 days from planting rice, in the AzRZ as in Rz.</td>
</tr>
</table>

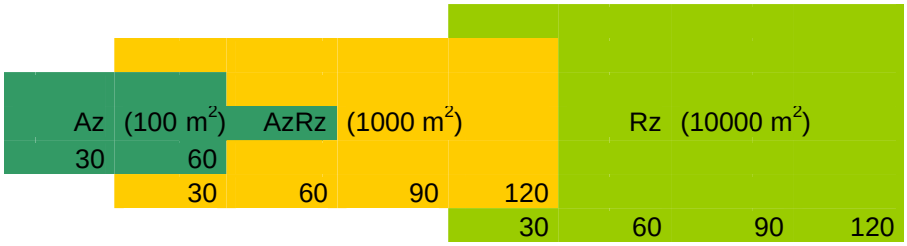
		 Figure 2. Azollary (Az), Azoryzary (AzRz), and rice (Rz). Periods, areas and transfer Integrated and sustainable management on rice cultivation in the Project has required the application of a technology package as shown in Annex 1. (Paquete tecnológico del cultivo de arroz con *Azolla* e insumos sostenibles).
Period 0.2.d. Commercial package adopted by the technical department for the sale of AGRIPAC green manure in 10 agencies in the distribution chain within the manure division of AGRIPAC.	Closed and surpassed	Agripac, associated with this Project, has not worked as planned. Iván Noboa, Agripac officer, was initially very supportive, but unfortunately was transferred to Quito and finally left the company. Other staff and managers paid little attention. In the second rice crop in Artillery a pest's migration there was from nearby rice crops treated with chemicals. Agripac diagnosed presence of Hydrellia, mites (*Schizotetranychus oryzae*) and burning leaves by *Pyricularia oryzae*. Agripac recommended an "orange control products" but ultimately were not provided. Finally, the collaboration of farmers Rafael Décker at Artillería and Román Family in El Mangle, as well as SCIAPLI Company, and ESPOL have been key to successfully execute the Project. *Azolla* technology as fertilization commercial package is being introduced by farmers interested in changing the urea-based fertilizer on their crops. The SENESCYT Project "Development of productive system tuna-cochinilla at Santa Elena Peninsula" implemented the use of *Azolla* as organic fertilizer (Resabala, 2008). A tailored commercial package technology called ComposTunAzo was designed for this Project (Annex 2. Ficha Técnica). In conclusion, there are small but important advances in other applications such as gardening (Corporación MYL-Figure 3), banana (SEBIOCA-Figure 4, La Fortuna-Figure 5, REYBANPAC-Grupo Wong), pig farming (La Manga-Figure 6), and most extensive rice fields (KINGELSA-Figure 7).

Figure 3. Tomatoes outcome of applying *Azolla* (Fineness of Marjorie Macías-MYL)

Figure 4. Left with normal fertilizer, right with *Azolla* manure. SEBIOCA experiment (Montaño et al., 2010).

Figure 5. La Fortuna. Banana extension experiment

Figure 6. La Manga Pig farming based on *Azolla* (Demonstration site)

		 Figure 7. Massive development trials of *Azolla* in rice fields (KINGELSA) Some representative corn and cocoa farmers have requested to extend *Azolla* to their crops. The question is to produce massive *Azolla* and that will still take some time; this cannot be met within the horizon of the Project which was planned to develop an area of 4 ha of rice and *Azolla*. This area cannot get to satisfy neither in small quantities the latent demand for agricultural and livestock production in Ecuador. This outcome is, therefore, still a full working task and should be reviewed as a strategy of the present Project.
Period 1.1.a. Establish a gene bank of *Azolla Anabaena* in ESPOL and two azollaries in Samborondón and Daule respectively, for multiple purposes	Completed	Location and design of the facilities where the *Azolla* genetic bank will operate have been approved by the ESPOL authorities. On May 12, 2010 Moisés Tacle, Rector of ESPOL, opens the *Azolla* germplasm Bank (http://www.youtube.com/watch?v=9fea2xVS4OM) and operation starts. On this date the cultivation and exhibition pool was inoculated with *Azolla*. In order to obtain an adequate growth *Azolla* was fertilized with organic products including "bioles", efficient microorganisms (EM), compost and phosphate products. In the genetic bank *Azolla* is harvested regularly once a month or when the fern completely cover the water surface. The *Azolla* germplasm bank has served on many occasions to present the new paradigm of fertilization, agriculture, environment, health and economy of Ecuador (Figure 8). The genetic bank received maintenance and biol applications developed by the working group. In the period the genetic bank produced the *Azolla* crops quantities showed in Table 6.

Figure 8. *Azolla* germplasm bank and stakeholders

Table 6. *Azolla* production quantity in Genetic Bank

Date	Qty (kg)
2010-07-9	7.5
2010-08-2	3.5
2010-09-3	34.4
2010-10-6	37.3
2010-11-5	43.2
2010-12-7	40.9
2011-04-6	38.5
2011-05-7	40.5
2011-06-6	41.2
2011-07-5	40.7

Period 1.1.b. Increase average production rate of *Azolla Anabaena* established as more than 15 t/ha/month.	Completed	According to data presented in Table 5, *Azolla* average production in azollaries at Artillería and El Mangle has been respectively 44 and 15 t/ha/month.
Period 1.1.c. Conduct at least 300 visits to the Azollaries, including 150 farmer partners, 10 academic researchers, 90 students and 50 general public.	Completed	This activity has been concluded. It was made a representative field day in the area of San Gabriel, with the assistance of rice farmers and other crops (bananas, maize, cocoa, etc). Annex 3 attached. Also on the following link is included the log of this event http://www.youtube.com/watch?v=stHCIp_TWT4 In addition, a theoretic-practical seminar was organized, which was attended by over 50 technicians involved in *Azolla* development for agriculture and animal feed (Annex 4. List of participants at the seminar and http://elproductor.com/2011/08/04/azolla-alternativa-economica/). Also at Escuela Superior Politécnica del Litoral (ESPOL), students developed different works regarding to environment of *Azolla* and rice (Annex 5. Lista de estudiantes y trabajos).

<table>
<tr><td></td><td></td><td>Three students from the ICQA-ESPOL, with the issues of agriculture, rice and Azolla won the international competitions, Bayer 2010 and 2011. This is shown in the links below:

http://www.beja.bayerandina.com/ganadores/ganadores.html
http://www.youtube.com/user/vart12345#p/u/17/41LE2_X8O5g

Various national and international academics have been associated with the Project (Annex 6. Lista de académicos)</td></tr>
<tr><td>Period 1.1.d. Detailed M&E Plan prepared that outlines protocol for collecting data (targeted beneficiaries differentiated by gender) to measure progress toward outcome indicators in Period 0. Plan should include details on data collection, sources of data, frequency of monitoring, etcetera.</td><td>Completed</td><td>M&E Plan was prepared in order to meet the indicators of Period 0.2.a-b-c-d, ie:

a. At least 4 ha (hectares) of commercial crops using Azolla as exclusive fertilizer.
b. Increased production of paddy rice from 3.5 tons/ha/cycle to 6 tons/ha/cycle, in experimental sites, maintaining the current total cost of production per cycle.
c. Technology package implementing Azolla Anabaena rice, transferred at least to 100 rice producers (40 % targeting women) at Santa Lucía (El Mangle) and Samborondón (Artillería), as the first pilot experiment.
d. Commercial package adopted by the technical department for the sale of AGRIPAC green manure in 10 agencies in the distribution chain within the manure division of AGRIPAC.

These results are shown in the milestones of Period 0 of this report. Other additional results regarding to water, soil and foliage of Azolla have been monitored, and are presented in Annexes 7.</td></tr>
<tr><td>Period 1.1.e. Baseline survey conducted and data analyzed.</td><td>Completed</td><td>Initial studies were conducted in the areas of Samborondón and Mangle in order to characterize the water and soil from work sites. There were physical-chemical analysis of water (Annex 7.1) and soil samples (Table 7).

Table 7. Baseline analysis of soils

<table>
<tr><th>Parameter (Unity)</th><th>Artillería (6-fb-04)</th><th>Artillería (01-jn-09)</th><th>El Mangle (11-oc-09)</th></tr>
<tr><td>Sand (%)</td><td>19</td><td>48</td><td>10</td></tr>
<tr><td>Silt (%)</td><td>33</td><td>14</td><td>50</td></tr>
<tr><td>Clay (%)</td><td>48</td><td>38</td><td>40</td></tr>
<tr><td>Class (%)</td><td>A</td><td>AAr</td><td>AL/FAL</td></tr>
<tr><td>Bulk density (g/cm3)</td><td>1.16</td><td>1.26</td><td>1.40</td></tr>
<tr><td>pH (u)</td><td>7</td><td>7.2</td><td>7.20</td></tr>
<tr><td>Conductivity 1:1</td><td>0.33</td><td>0.26</td><td>0.88</td></tr>
<tr><td>OM (%)</td><td>0.6</td><td>0.9</td><td>1.3</td></tr>
<tr><td>N (%)</td><td>0.04</td><td>0.05</td><td>0.08</td></tr>
<tr><td>CEC (meq/100 g)</td><td>31</td><td>33.2</td><td>22.1</td></tr>
<tr><td>Na (meq/100 g)</td><td>1.88</td><td>1.64</td><td>0.56</td></tr>
<tr><td>K int. (meq/100 g)</td><td>0.42</td><td>0.20</td><td>0.27</td></tr>
<tr><td>Ca (meq/100 g)</td><td>19.8</td><td>15.9</td><td>12.8</td></tr>
<tr><td>Mg (meq/100 g)</td><td>19.5</td><td>13.2</td><td>26.3</td></tr>
</table>
</td></tr>
</table>

		P (ppt) 15.2 0.7 2.3 Fe (ppt) 30.2 39.7 407.1 Mn (ppt) 17.7 4.8 46.4 Zn (ppt) 1.4 2.6 2.3 Cu (ppt) 4.8 1.8 3.0
Period 1.1.f. Draft Communication Strategy with stakeholders prepared.	Completed	The communication strategy with stakeholders serves the purpose of creating the appropriate commitments for the project meets its objectives and expected results are obtained. There are different contexts of stakeholders who each require a specific communication strategy. The communication strategy with stakeholders takes place in the following contexts: • Direct communication to farmers in project sites • Communication to farmers in areas affected by the project • Communication with authorities and organizations • Communication to the community • Communication to students **1. Direct communication to farmers in Project sites** This communication takes place at all times that the project's technical group comes into contact with people in places where crops *Azolla* and rice grow. Esta comunicación tiene la propiedad de ser verbal, directa, permanente y multifacética. En este sentido se planea visitar al menos dos veces a la semana los sitios de cultivo. Durante estas visitas se establece comunicación con los dueños de los arrozales, con los cuidadores y con los trabajadores de toda índole. This communication is the property of being verbal, direct, continuous and multifaceted. In this sense, plans to visit at least twice a week the farm sites. During these visits, communication with the owners of rice paddies, and workers of all kinds is established. Topics covered in such communications are about: • Knowledge of *Azolla* • *Azolla* cultivation • *Azolla* Harvest • Application of *Azolla* for rice • Rice cultivation • Crop pests and management • Fertilization management • Water and irrigation • Soil and clay • Preparation of sustainable supplies It keeps track of all visits by filling out a field diary. When appropriate, measurements are taken for pH, conductivity,

temperature, dissolved oxygen, chlorophyll and heliophany. For this purpose, data recording forms are designed and equipped with and then migrated to the computer system.

2. Communication to farmers in areas affected by the project

To convey the experimental results, knowledge and technology, field days were conducted. This activity aimed to interest to rice farmers of the influence Project areas to adopt the *Azolla* technology in the fertilization of their crops.

It was planned the achievement of at least 6 field days. The main issues addressed in such cases were:

- *Azolla* biology
- *Azolla* and fertilization of rice
- Establishment of a azollario
- How to plant, harvest and apply *Azolla* in the paddy
- Farmer Testimonials of Artillery and El Mangle
- Measure weight / area of *Azolla* biomass
- Calculations of production and growth rate of *Azolla*
- Demonstration of application of *Azolla* as fertilizer
- Calculations of applying *Azolla* to rice and other crops
- Calculations of area, production and yield of rice
- Economic Analysis of the *Azolla*-rice system and other crops
- Evaluation of *Azolla* application to livestock (pigs, guinea pigs, chickens, fish)
- Nitrogen balance in productive ecosystems
- *Azolla* in improving health, economy and environment (Montaño, 2010a)

3. Communication with authorities and organizations

This communication is done through visits and presentations in various settings, including in particular:

- ESPOL (ICQA-Institute of Chemical and Environmental Sciences, CTT-Center for Technology Transfer)
- Chambers of Agriculture
- Ministry of Agriculture, Livestock, Aquaculture and Fisheries (MAGAP)
- Unions and other stakeholders

ESPOL is the basis institution for Project execution. It has to have the support of its authorities led by the Rector. The Rector knows of objectives and progress of the project. Official documents (reports, applications) are signed by the Rector.

Within the ESPOL, ICQA and CTT units are important: ICQA Academic Unit is responsible for the Project because the Project Director is Professor of the CTT is the unit responsible for financial management of the Project.

The Chambers of Agriculture mission is contribute to agricultural development through information systems on production and marketing of

products, markets, inputs and prices, technological developments, events and business opportunities, becoming through interaction between actors different production chains and supporting institutions.

The Chamber of Agriculture of the 2nd Zone was contacted in order to explore the possibility of reaching agreements for using *Azolla* as a fertilizer in rice and other crops.

The MAGAP (Ministry of Agriculture) is promoting an initiative that could tie the Project. This is the Agrarian Revolution Schools (ERAs). In this sense, it looks to create links to deploy research in the areas of work of the ERAs. Farmers are willing to participate and collaborate with land and labor.

The unions and other stakeholders have many needs. The Project also has a versatile design to accommodate the requirements of the guilds. A basis guild is the Cooperative San Gabriel which has been included from the starting of *Azolla* works.

4. Communication to the community (Media)

Media made up of newspapers, magazines, radio, television and Internet are considered important elements of support to communicate and disseminate results. The main media set, and its scope is given in Annex 8. *Azolla* program dissemination.

Topics covered by the media generally refer to the given in field days and others as:

- What is *Azolla* and its benefits
- *Azolla* in Ecuador, a substitute for urea
- Studies give a better use of *Azolla* fern in rice instead of urea
- *Azolla*: Lever to promote new functions of paddies in Ecuador
- Biogenic rice, biogenic bananas, biogenic livestock, healthy citizenry
- Nitrogen in the life of every citizen of Ecuador
- Nitrogen, health, economy and environment

5. Communication to students

The Project Manager, as Professor, has in the student community another appropriate environment to extend ideas on *Azolla* structure and functions. Many students are from farming families or have friends in that field.

The Institute of Chemical and Environmental Sciences (ICQA-ESPOL) has established the initiative Science and Technology Entrepreneurship Competition (CSECT) that develop the students of Laboratory Practice (ie http://www.youtube.com/user/vart12345?blend=21&ob=5#p/u/1/6O1ndA2FuUc). In the CSECT a lot of research works about *Azolla* have been exhibited to students and teachers from ESPOL, and other educational establishments, as well as citizens of Guayaquil.

Some issues raised in the CSECT are listed in the Annex, and the following links:
http://www.youtube.com/watch?v=vNphW5t8V0M
http://www.youtube.com/watch?v=vNphW5t8V0M

<table>
<tr>
<td>Period 2.1.a. At least 2 crop rice leaders spread Azolla in the rice fields in an area of over 4000 m2 (throughout the project).</td>
<td>Completed</td>
<td>At El Mangle and Artillería azorizaries rice crops have been done in approximate area of 1 000 m^2, adding to the present day a total area of 4 400 m^2 (Table 8).

Table 8. Azorizaries. Cultivated areas and production

<table>
<tr><th>Date</th><th>Azorizary</th><th>Yield (t/ha)</th><th>Sowing (ha)</th></tr>
<tr><td>04/Jn/2010</td><td>Artillería</td><td>5.45</td><td>0.12</td></tr>
<tr><td>6/Ap/2010</td><td>El Mangle</td><td>4.70</td><td>0.10</td></tr>
<tr><td>10/Jn/2010</td><td>Artillería</td><td>5.15</td><td>0.12</td></tr>
<tr><td>5/Jl/2011</td><td>Artillería</td><td>5.05</td><td>0.12</td></tr>
</table>
</td>
</tr>
<tr>
<td>Period 2.1.b. Prepared training materials, consisting of: 3 technical guides (1000 ea), 1 Manual of Azolla (800 units) (cleared by World Bank Safeguard Specialist).</td>
<td>Completed</td>
<td>Azolla Project prepared training materials, consisting of: 4 technical guides (1000 ea), 2 Azolla manuals (800 units) in English and Spanish (Table 9. Annexes 9. Training materials).

Table 9. Prepared training materials

<table>
<tr><th>Output (Annex)</th><th>Category</th><th>Type</th><th>Copies</th></tr>
<tr><td>Azolla in Guayas Ecosystem (9.1)</td><td>Technical Guide</td><td>Diptych</td><td>1 000</td></tr>
<tr><td>Azolla en el Ecosistema Guayas (9.2)</td><td>Guía Técnica</td><td>Díptico</td><td>1 000</td></tr>
<tr><td>Azolla bioabono alternativo para el arroz (9.3)</td><td>Guía Técnica</td><td>Tríptico</td><td>1 000</td></tr>
<tr><td>Azolla bioabono alternativo para el arroz-Información Básica (9.4)</td><td>Guía Técnica</td><td>Tríptico</td><td>1 000</td></tr>
<tr><td>Azolla in Ecuador. Alternative Biofertilizer for Rice (9.5)</td><td>Manual</td><td>Magazine</td><td>300</td></tr>
<tr><td>Azolla en el Ecuador. Biofertilizante Alternativo para el arroz (9.6)</td><td>Manual</td><td>Revista</td><td>500</td></tr>
</table>
</td>
</tr>
<tr>
<td>Period 2.1.c. Complete field demonstration of at least 6 management practices (one of which must be lead by a World Bank approved Nutrient Management Specialist) for Azolla application on rice fields, with the participation of rice producers of the area affected by the project.</td>
<td>Completed</td>
<td>Several field demonstration activities (conferences, seminars, field days, etc.) have been performed throughout the project as indicated in Table 10.

Table 10. Field demonstration activities

<table>
<tr><th>Fecha</th><th>Lugar</th><th>Tema</th><th>Asis-tencia</th></tr>
<tr><td>24-sep-09</td><td>San Gabriel-Daule-Capacitaciones</td><td>Preparación de abonos.</td><td>80</td></tr>
<tr><td>18-20-sep-09</td><td>CODEMICRO-Capacitaciones</td><td>Seminario-Taller Azolla bioabono alternativo para el arroz.</td><td>70</td></tr>
<tr><td>23-nov-2009</td><td>CODEMICRO-Capacitaciones</td><td>Inducción sobre Azolla a técnicos y representantes de los medios de comunicación. Condiciones agroecológicas para el desarrollo de la AA .Qué es el recurso AA?. Siembra y cuidados del azollario.</td><td>30</td></tr>
<tr><td>27-nov-2009</td><td>San Gabriel-Taller</td><td>Manejo de la AA: nutrición, sombra, plagas y</td><td>35</td></tr>
</table>
</td>
</tr>
</table>

				enfermedades. Cultivo asociado arroz-*AA* en piscina. Registros y certificación: importancia, formas y procedimientos; documentación y certificación. Temas referentes al desarrollo de la *AA* y su cultivo en asocio con el arroz.	
		02-dic-2009	Samborondón-Día de campo	Manejo "orgánico" del cultivo asociado arroz-*AA*: nutrición, malezas, plagas y enfermedades. Índices de producción y productividad. Estimaciones y cálculos técnico-económicos. Oportunidades comerciales de la *AA* como abono.	50
		22-ene-2010	El Mangle Día de campo	Resultados de la tecnología de producción de *AA* en asocio con arroz.	40
		27-28/08/10	Universidad Católica -San Gabriel-Daule	Presentación del Proyecto *Azolla* en el Seminario teórico-práctico sobre: Agroecología y producción de biofertilizantes.	100
		04/09/10	Sectores de influencia del Proyecto	Capacitación para los agricultores los días 4 y 5 de septiembre-2010	100
		1,2,4-oct-2010	Samborondón-Día de campo	Desarrollo de *Azolla Anabaena* y su cultivo con el arroz Oportunidades comerciales de *Azolla-Anabaena* como abono.	45
		9,10,16,17-oct-2010	El Mangle-Día de campo	Manejo orgánico del cultivo asociado con arroz-*Azolla*: nutrición, plagas y enfermedades. Primeros resultados de la tecnología de producción de *Azolla Anabaena* en asocio con arroz.	43
		13-14-15-ene-2011	Samborondón-Taller	Preparación practica de productos orgánicos para el enriquecimiento de cultivo de *Azolla*. Procedimiento practico para obtener *Azolla* seca.	30
		3,4,5-ene-2011	El Mangle-Capacitaciones	Producción del cultivo de arroz en asociación con *Azolla.* Beneficios del arroz cultivado con *Azolla*. Impactos Ambientales de la producción de arroz cultivado con *Azolla*.	21
		6,7,8-ene-2011		Procedimiento teórico para obtener Azolla seca. Preparación teórica de	27

				productos orgánicos para el enriquecimiento de cultivo de *Azolla*	
			12-mar-2011	San Gabriel-Día de Campo	*Azolla*: Otras connotaciones. 220
			31-mz-2011	ESPOL-Guayaquil	El mejor sustituto para la urea. 60
			7/jul-2011	Samborondón-Día de Campo	Cosecha de arroz abonado con *Azolla*. 50

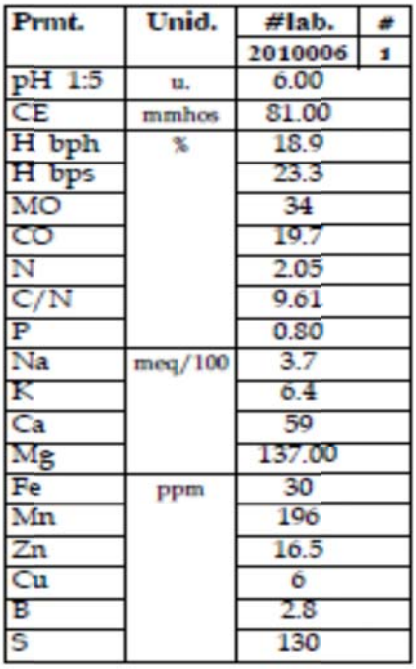
Period 2.1.d. Dissemination of management practices through at least 12 presentations (radio, television and newspaper).

Completed

Table 11. Dissemination of Project through press, radio, television and internet

Fecha	Medio	Nombre del evento (link)
09/09/09	San Gabriel-Daule	Bondades del Helecho *Azolla*- Reportaje en RTS-TV. (www.rts.com.ec).
01/07/10	Tropicana-Agronoticias Guayaquil.	Azolla y sus bondades. Primer Reportaje en radio Tropicana (www.tropicana.com.ec)
18/08/10	Radio Tropicana-Agronoticias	Usos y beneficios comprobados de *Azolla*. Segundo Reportaje en radio Tropicana (www.tropicana.com.ec)
08/09/09	Tropicana-Agronoticias Guayaquil.	Azolla y sus bondades. Tercer Reportaje en radio Tropicana (www.tropicana.com.ec)
27/04/10	San Gabriel-Daule	Agricultural and livestock sector. *Azolla* uses and benefits already achieved (www.tctelevision.com)
12/05/10	ESPOL	Inauguración del Banco Genético – ESPOL(http://www.youtube.com/watch?v=9fea2xVS4OM)
01/07/10	ESPOL	Inauguración del Banco de Germoplasma. Revista Focus-ESPOL, edición 43 (www.focus.espol.edu.ec)
05/08/10	VISTAZO Nº 1031 Edic. verde	La bendición del Azolla (www.vistazo.com)
15/09/10	Radio Pública	Usos y beneficios comprobados de *Azolla* (www.radiopublica.ec)
01/15/11	El Universo	Estudios dan un mejor arroz al usar helecho en vez de urea (www.eluniverso.com)
15/02/11	Diario El Universo	*Azolla* - Día de campo
19/02/11	Diario El Universo	Alternativas de sustitución de la urea
05/03/11	Diario El Universo	Investigación: *Azolla* en reemplazo de la úrea en arrozales
19/03/11	Diario El Universo	Seminario - Manejo del *Azolla* en el agro
17/03/11	Revista en Contexto	El *Azolla* como sustituto de la Urea
21/03/11	Diario El Comercio	El uso del *Azolla* en cultivo de arroz
15/04/11	Diario el Costanero	El *Azolla* sustituto de la Urea
Varios	Tropicana	Horario AAA Estelar Noticiero - La Hora de Don Ramón

		Varios	CRE	Horario A Programa Agropecuario
		Varios	Tropicana	Horario A Madrugada - Programa Agropecuario "Encuentro con el Agro"
		Varios	Tropicana	Horario AA Noticiero Agropecuario "Agro Noticias"
		Varios	Teleradio	Horario Estelar Noticiero -Primera Emisión
		Varios	Atalaya	Horario Estelar Noticiero -Primera Emisión
			CN3	Noticiero (Horario Estelar): Qué es el *Azolla* y Beneficios
			RTU	Reportaje Noticiero
			CANELA	Reportaje en programa Ecuador Productivo
		Varios	Internet	*Azolla*: Salud. Economía y medio ambiente. (www.dspace.espol.edu.ec/bitstream/123456789/10257/1/Azolla% 20Salud% 20Econom% C3% ADa% 20Medioambiente.pdf)
		Varios	RTU- Internet	El *Azolla* en Ecuador, un sustituto de la urea
		Varios	Blog Azollazo-Internet	Blog de Información del Proyecto Banco Mundial
		Varios	Mail Masivo-Internet	Envío a la Base de Datos del Sector Agropecuario del Ecuador (Información de los Eventos del Programa *Azolla*)
		Varios	Agrytec- Internet	El *Azolla*, fertilizante natural que puede remplazar la urea

Period 3.1.a. Creation and adoption of commercial technology package (CTP) within the Technical Department (TD) of AGRIPAC by conducting: (a) at least 6 technical visits of TD to experimentation sites; and (b) at least 2 workshops for the TD to assess the quality of the CTP.	Closed		Due to low participation and lack of linkage of the Company Agripac with the Project, this activity cannot be enforced according to Disbursement letter. Some criteria have already been issued in the sections Period 0.2.d and Period 3.1.b. The technical project group has developed a *Azolla*-based generic fertilizer to apply to early stages of rice cultivation. Its composition is shown in Table 12. Table 12. Composition of *Azolla*-based generic fertilizer

Prmt.	Unid.	#lab.	#
		2010006	1
pH 1:5	u.	6.00	
CE	mmhos	81.00	
H bph	%	18.9	
H bps		23.3	
MO		34	
CO		19.7	
N		2.05	
C/N		9.61	
P		0.80	
Na	meq/100	3.7	
K		6.4	
Ca		59	
Mg		137.00	
Fe	ppm	30	
Mn		196	
Zn		16.5	
Cu		6	
B		2.8	
S		130	

<table>
<tr>
<td>Period 3.1.b. Agricultural input reduced by at least 50 % for urea and herbicides applied to the experimental sites.</td>
<td>Completed</td>
<td>During this growing season took place a pest migration from nearby crops treated with chemicals. Agripac diagnosed the presence of Hydrellia, mites (Schizotetranychus oryzae) and rice leaves burnt by Pyricularia oryzae. Agripac recommended a control product that ultimately was not provided. Therefore, the Technical Working Group decided to apply to rice 20 L of biol, 0.5 L of PyriSec and 1 kg of Bayer Garden, with good results.

Both at Samborondón-Artillería as at El Mangle, a weed control and Biolfertilizer applications were made. In addition, physical and chemical parameters were regularly measured in azollaries.

The biomass collected from azollaries was transferred to rice in order to provide natural nitrogen to rice crop.

The azoryzaries have been inoculated with Azolla, which has provided enough biomass for fertilization of rice crops. Fertilization and pest control of both Azolla and rice included natural materials that farmers are used to blend in order to produce Biol, compost and EM (effective microorganisms).

Nitrogen fertilization of crops in the Project areas was done exclusively with Azolla. Urea and herbicides were not applied at all. Pest control was carried out with phyto repellents. In addition, other used farming inputs were the following: compost, Biols, effective microorganisms (EM), phosphate rock and potassium sulphate.</td>
</tr>
<tr>
<td>Period 3.1.c. Cost benefit analysis of Azolla production is evaluated for its potential for application to other crops.</td>
<td>Completed</td>
<td>A baseline analysis refers to the balance of nitrogen, ie inputs and outputs, in the Guayas Ecosystem, whose results are presented in Table 13. These data show that the Azolla covering all Guayas Ecosystem rice, can provide enough nitrogen to the agriculture, livestock and biota of the area.

Tabla 13. Nitrogen balance of Azolla and urea in Guayas Ecosystem

<table>
<tr><th>Sources and Sinks</th><th>Urea (kgN/ha/year)</th><th>Azolla (kgN/ha/year)</th></tr>
<tr><td colspan="3">Sources</td></tr>
<tr><td>Fertilizer Urea-Azolla</td><td>38</td><td>50</td></tr>
<tr><td>Animal feed</td><td>14.1</td><td>14.1</td></tr>
<tr><td>Forest biological fixation</td><td>6.2</td><td>6.2</td></tr>
<tr><td>Atmospheric deposition</td><td>5.2</td><td>5.2</td></tr>
<tr><td>Agricultural biological fixation</td><td>4.3</td><td>4.3</td></tr>
<tr><td>Total</td><td>68</td><td>80</td></tr>
<tr><td colspan="3">Sinks</td></tr>
<tr><td>River drainage</td><td>25</td><td>37</td></tr>
<tr><td>Food export</td><td>24.6</td><td>24.6</td></tr>
<tr><td>Denitrification</td><td>9.4</td><td>9.4</td></tr>
<tr><td>Volatilization</td><td>6.7</td><td>6.7</td></tr>
<tr><td>Storage in soil and plant</td><td>2.3</td><td>2.3</td></tr>
<tr><td>Total</td><td>68</td><td>80</td></tr>
<tr><td>Reference</td><td>Borbor., 2005</td><td>Montaño, 2010</td></tr>
</table>

On the other hand, analysis of costs and benefits of Azolla production takes into consideration at first place the demand and cost of urea fertilizer in the main crops of Ecuador (Table 14).

This information suggests that economic boundaries of the analysis of Azolla as a nitrogen fertilizer in Ecuador reaches U.S. $ 313 million, which is the cost of urea.</td>
</tr>
</table>

<table>
<tr><td></td><td></td><td>Table 14. Urea annual costs (Balanzátegui y Rivera, 2005)

<table>
<tr><th>Product</th><th>Total Area Sown (ha)</th><th>Urea-annual demand (t)</th><th>Annual Cost (US$)</th></tr>
<tr><td>Rice</td><td>349 726</td><td>69 945.20</td><td>69 945 200</td></tr>
<tr><td>Corn</td><td>435 008</td><td>108 752.00</td><td>108 752 000</td></tr>
<tr><td>Cocoa</td><td>434 418</td><td>173 767.20</td><td>86 883 600</td></tr>
<tr><td>Coffee</td><td>324 911</td><td>16 245.55</td><td>8 122 775</td></tr>
<tr><td>Sugar cane</td><td>131 852</td><td>39 555.60</td><td>19 777 800</td></tr>
<tr><td>African palm</td><td>162 202</td><td>24 330.30</td><td>12 165 150</td></tr>
<tr><td>Cotton</td><td>2 228</td><td>445.60</td><td>222 800</td></tr>
<tr><td>Bananas</td><td>266 124</td><td>14 636.82</td><td>7 318 410</td></tr>
<tr><td>Total</td><td></td><td></td><td>313 187 735</td></tr>
</table></td></tr>
<tr><td>Period 3.1.d. At least 3 publications in technical journals produced describing characterization of Azolla and applications.</td><td>Completed</td><td>Three scientific papers are prepared: (1) Azolla caroliniana en el nanoambiente (Guerrero et al., 2009; Anexo 10), (2) Evaluación preliminar de la aplicación del Azolla como fertilizante en plantas meristemáticas de banano William en el invernadero de SEBIOCA-ESPOL, Revista Tecnológica ESPOL, En prensa, Guayaquil (Montaño et al, 2010b; Anexo 11), y (3) Ecosistema Guayas (Ecuador): Recursos, Medio Ambiente y Sostenibilidad en la perspectiva de Conocimiento Tropical (Montaño, 2010; Anexo 12).</td></tr>
<tr><td>Period 3.1.e. At least 2 agreements signed with the agricultural centers from Daule and Samborondón, for adopting the Azolla-rice technology.</td><td>Completed</td><td>It has signed an agreement between the Escuela Superior Politécnica del Litoral (ESPOL) and Association of Municipalities of Ecuador (AME), in order to generate Azolla in rice municipalities and to fertilize with this manure the cocoa municipalities (Annex 13).

Along the same lines, two agreements are going for signatures: one with the Government of El Oro (http://www.eloro.biz/) and another with CEPESIU (www.cepesiu.org).</td></tr>
</table>

References

Balanzátegui Mario y Carlos Luis Rivera, 2005. Proyecto de Comercialización de urea por parte del BANCO NACIONAL DE FOMENTO, Zonal Guayaquil. No publicado.

Borbor Córdova Mercy J., 2005. MODELING HOW LAND USE AFFECTS NUTRIENT BUDGET IN THE GUAYAS BASIN-ECUADOR: ECOLOGICAL AND ECONOMIC IMPLICATIONS, College of Environmental Science and Forestry, State University of New York, Syracuse, New York.

GUERRERO Sofía (ESPE), MONTAÑO Mariano (ESPOL), FERNÁNDEZ Eduardo (UAM), CARRAPICO Francisco (UL), 2009. *Azolla* caroliniana en el nanoambiente, ESPOL, Guayaquil (No publicado).

Montaño Mariano, 2010. Ecosistema Guayas (Ecuador): Recursos, Medio Ambiente y Sostenibilidad en la perspectiva de Conocimiento Tropical, Tesis de grado Ph. D., ESPOL-Universidad Miguel Hernández (España).

Montaño Mariano, 2010a. *Azolla* en el mejoramiento de la salud, la economía y el medioambiente, Disponible en http://www.dspace.espol.edu.ec/bitstream/123456789/10257/1/Azolla%20Salud%20econom%c3%ada%20Medioambiente.pdf

Montaño Armijos Mariano, Cristóbal Mariscal, María del Carmen Figueroa, Mariuxi Espinoza, Galo Robles, Christian Saavedra, William Bonilla, Nancy Macías, 2010b. Evaluación preliminar de la aplicación del Azolla como fertilizante en plantas meristemáticas de banano William en el invernadero de SEBIOCA-ESPOL, Revista Tecnológica ESPOL, En prensa, Guayaquil.

Resabala Carola, 2008. PROGRAMA DE DESARROLLO DEL SISTEMA PRODUCTIVO TUNA-COCHINILLA EN LA PENÍNSULA DE SANTA ELENA COMO UNA OPORTUNIDAD DE DESARROLLO AGROINDUSTRIAL, Proyecto SENESCYT, Quito, Ecuador.

2) If you did not achieve some of your stated milestones, please explain the reasons and the plan and timeframe for addressing the issue(s).

All milestones have been achieved. Those ones reported in progress are scheduled for the next reporting period.

III. Overall Project Progress

Please note that all information reported in the remaining sections should reflect progress for **this** reporting period only.

1) To date, have any elements of project implementation exceeded the original plan?

☐ Yes X ☐ No

If yes, describe your achievements:

2) What have been the main challenges of your project to date? What, if any, adjustments have you made to your original business plan in order to overcome the challenges and meet your objectives?

Challenges:	Adjustments:
Azolla extraction from rice crops. *Azolla* drying Fertilizers preparation.	An *Azolla* suction system is being designed to be constructed in the next period. This system will be used to harvest the fern from rice in less time and more efficiency. A portable greenhouse Quonset type was built in order to dry *Azolla*. Finally a mill farm wastes is operating. The mill will serve for manufacturing fortified organic fertilizers based on *Azolla*.
Pest Growth: Caracol (Achatina fulica)	It is noted that the identified pest problem is seriously affecting the rice and *Azolla*, establishing a control with repellents based organic jasmine, pepper, garlic, etc..

3) Do you have any concerns about meeting your next milestones's outcome indicators?

☐ Yes X☐ No

If yes, what are the concerns? Please describe your plan to address those challenges or note any technical assistance from the Development Marketplace that may help you overcome such obstacles.

4) **Co-financing:** Has your organization secured co-financing funds per the planned project budget.

☐ Yes ☐ No X☐ Not Applicable

If yes, provide the following information.

Funding Sources	Date of Award	Amounts Funded/ Committed	Purpose of funding	Type of funds
Organization Names	*[MM/YYYY]*	*US$000,000*	*e.g., maintain existing operations, grow the project, replicate project to a new location, other (please specify)*	*grant, loan, etc.*

If co-financing which was part of the project budget has not been secured, what is the plan and timeframe to secure these funds?

IV. Ancillary Achievements

1) **Partnerships:** During project implementation project grantees often identify new partnerships that help them achieve their project objectives and/or contribute to project implementation, either financially or through in-kind donations. Has your organization formed any new partnerships to help implement this project? Please note that this section does not include training sessions, which can be reported in Section VI, Question 2.

☐ Yes X☐ No

If yes, specify type of the organization from the list below:

Partner Organization Name	**Type of Organization** (e.g., local government, national government, NGO, bilateral development agency, multilateral development agency, private corporation, other)	**Nature of Partnership** (e.g., financial management, marketing, technical/ product design, monitoring and evaluation, technical assistance, other (please specify))	**In kind or financial partnership?**
EXAMPLE: DFID	*Bilateral development agency*	*Financial management, TA*	*In kind*

2) **Awards/recognition:** Have you or has your organization received any awards/recognitions or media attention as a result of your DM-funded project during this period?

☐ Yes x☐ No

If yes, please specify the sources and identify the names.

Award/Recognition Name	**Type of award** (e.g., local, national, international)	**Date of award**	**Description of award**	**Web links/news clips, if available**
EXAMPLE: BBC News	*International*	*July 2007*	*News coverage of project*	*www.bbc.com*

V. Requests to the DM

1) Do you have any comments or suggestions for improvement of the overall process and support provided by the DM Grantee or Project Supervisor?

No

VI. Confidential Report

In recognition of concerns over confidentiality, we have included several questions in the following section which will not be posted on the DM site. The project expenses report in Annex I is also confidential.

1) **Revenue generation:** Has the project generated any direct revenue or income? If so, please indicate the amount, source, and time period(s) involved:

No

2) **Capacity Building:** During the period covered by this report, have you or any partner organization undertaken training or other capacity building activities related to the project (e.g., financial management, marketing/outreach, fundraising)? If yes, please describe and indicate if the service was paid by your organization or was in-kind.

No

3) Please provide any additional confidential comments or requests in the box below. Information provided in this section will be handled as confidential and will not be posted on the DM website.

VII. Next Steps

1) Send this Progress Report to your Project Supervisor and Portfolio Analyst via email cc to the DM Teamdmwinner@worldbank.org

2) The Project Supervisor and Portfolio Analyst will review the report and will either

i. approve the report and authorize disbursement via email with cc to dmwinner@worldbank.org; OR

ii. not approve (or not authorize disbursement) but respond with comments, questions, requests for grantee to address with cc to dmwinner@worldbank.org (in this case, the grantee would address Project Supervisor's concern to move to approval)

3) In the meantime, send signed Request for Payment to DM Team
i. Via fax +1-202-522-2042; OR
ii. Scanned document via email to dmwinner@worldbank.org; OR
iii. Mail signed Withdrawal Application Form to DM Portfolio Analyst to:

OnurOzlu
The World Bank
1818 H Street, NW
MSN: MC8-802
Washington, DC 20433, USA

4) Upon receipt of the following, the DM Team can process disbursement only if three items are present:
i. Progress Report &Financial Report in Annex I (please see attached Excel spreadsheet)
ii. Signed Request for Payment or Withdrawal Application Form
iii. Project Supervisor's approval of report and authorization of payment

Attachment: Project Expenses for this Reporting Period

Please provide an un-audited summary of expenses during this reporting period by completing the attached two worksheets, reporting on both actual and planned expenses. This financial reporting section is based upon the project budget summary per period submitted to your Project Supervisor and Portfolio Analyst.

A. General Project Expenses. Includes a budget breakdown based on the DM award and should include data on actual and planned project spending for the appropriate reporting period.

B. Sum of Project Funds. Includes information on all project funds, including non-DM funds and co-financing. Please provide actual and planned/anticipated co-financing divided by major project activity.

Important note: In the event that the progress report submission is delayed, you MUST submit your financial report every 6 months. When you submit your progress report, please submit an updated financial report.

Anexo 1

Paquete tecnológico del cultivo de arroz con Azolla e insumos sostenibles

Proyecto 5381 Converting Rice Field into Green Fertilizer Factories
Guayaquil agosto 2009

Día	Op.	Trabajo
1	Semilla. Preparación	Romplonearel terreno para semillero. Prepararsustrato-BT en un tanque de 200 Ly dejar reposar 48h antes de usar. Batir la mezcla 2 veces al día.
2		
3		Aplicar al suelo 10 L de EM (microorganismos eficientes)+sustrato-BT al momento del fangueo. Aplicar al azollario una rociada de la mezcla. Paletear el terreno para nivelar. Remojar la semilla de arroz con sustrato-BTpor 24 h.
4		Retirar la semilla en remojo y dejar reposar por 24 h más cubriendo con panca húmeda de arroz, para que germine.
5		Cosechar *Azolla* del azollario e inocular al arroz, dejando $2m^2$ de biomasa para su propagación. Fertilizarel follaje del azollario con 4L de EM+ 4 L de Bioles+sustrato-BF+sustrato BT disueltos en 100 L de agua. Fertilizarel semillero con fósforo (5 kg)+Azolla seca (1 saco)+compost (1 saco).
6		
7		
8	Semillero. Desarrollo	Sembrar semilla germinada de arroz al semillero. Dimensiones del semillero: 1.2 m de ancho por 20 m largo. Dejar espacios entre cada semillero de 40 cm para labores culturales (maleza, plagas, etc).
9		Regar y drenarel semillero repitiendo esta actividad las veces que sean necesarias hasta obtener excelentes plantas.
10		
11		
12		Regar y drenarel semillero repitiendo esta actividad las veces que sean necesarias hasta obtener excelentes plantas.
13		
14		
15		
16		Regar y drenarel semillero repitiendo esta actividad las veces que sean necesarias hasta obtener excelentes plantas. Limpiar manualmente la hierba y controlar plagas. Fertilizar el follaje del semillero con sustrato-BF+ EM (1 L)+Bioles(1 L) disueltos en 40 L de agua.
17		
18		Regar y mantener una lámina mínima de agua, para mantener suave al terreno. Romplonearel terreno para el arrozal. Preparar sustrato-BT en un tanque de 200 Ly dejar reposar 48 h antes de usar. Batir la mezcla 2 veces al día.
19		

20		Aplicar al suelo 10 L de EM (microorganismos eficientes)+sustrato-BT al momento del fangueo. Aplicar al azollario una rociada de la mezcla. Paletear el terreno para nivelar; espaldear los muros y otros.
21		Fertilizar con 3 sacos fósforo+2 sacos de carbón+2 sacos de humus+2 sacos de compost+10 sacos de Azolla seca y mantener una lámina de agua de 10 cm.
22		
23	Arroz comercial. Desarrollo	Transplante de lechuguin al arrozal, sembrar a una distancia de 25x25 cm
24		
25		
26		Colocar Azolla Fresca (20 sacos). Riego lámina baja y permanente de agua.
27		
28		Riego lámina baja y permanente de agua.
29		
30		Prepararsustrato-BT.
31		
32		Aplicación foliar de EM(10 L) +Bioles(10 L) +Sustrato BF (3 L)+Sustrato BT (200 L)Control de plagase insectos+ Garden Plant(1kg) + Horizonte (10 L).
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37		Fertilizar con 2 sacos de Muriato de Potasio + 2 sacos de carbonizado de residuos de arroz.
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41		
42		Control manual de malezas. Mantener siempre lámina de agua para evitar malezas. Preparar Sustrato-BT.
43		Control manual de malezas. Mantener siempre lámina de agua para evitar malezas.
44		Control manual de malezas. Mantener siempre lámina de agua para evitar malezas. Aplicación foliar de Horizonte (10 L) +EM (10 L) +Bioles(10 L) + Sustrato BF (3 L) + Sustrato BT (200 L). Control de plagas e insectos.
45		
46		Cosechar *Azolla* del azollario e inocular al arroz, dejando $2m^2$ de biomasa para su propagación. Fertilizarel follaje del azollario con 4 L de EM+ 4 L de Bioles+sustrato-BF+sustrato BT disueltos en 100 L de agua.
47		Colocar Azolla Fresca (10 sacos) al arroz.
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52		Preparación de sustrato BT en un tanque con 200 L dejar reposar 48 h antes de usar, mover 2 veces al día.
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54		Aplicación foliar deHorizonte (10 L) +EM (10 L) +Bioles(10 L) + Sustrato BF (3 L) + sustrato BT (200 L). Control de plagas e insectos.
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64		Aplicación foliar deHorizonte (10 L) +EM (10 L) +Bioles(10 L) + Humus de lombriz (5 L) disueltos en 200 L de agua.
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74		Aplicación foliar deHorizonte (10 L) +EM (10 L) +Bioles(10 L) + Humus de lombriz (5 L) disueltos en 200 L de agua.
75		
76		
77		Fertilización con 2 sacos de Muriato de Potasio + 2 sacos de carbón
78		
79		
80		Preparación de sustrato BT
81		
82		Aplicación foliar deHorizonte (10 L) +EM (10 L) +Bioles(10 L) + sustrato BF (3 L) + Humus de lombriz (5 L) disueltos en 200 L de agua.
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92		Aplicación foliar deHorizonte (10 L) +EM (10 L) +Bioles(10 L) + Humus de lombriz (5 L) disueltos en 200 litros de agua.
93		
94		
95		Control manual de malezas. Mantener siempre lámina de agua para evitar malezas.
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102		Aplicación foliar de Bioles(20 L) disueltos en 200 L de agua.
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109		Aplicación foliar de Bioles (20 L) disueltos en 200 L de agua.
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116		Aplicación foliar de Bioles (20 L) disueltos en 200 L de agua.
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130		Cosecha

Anexo 2 **FICHA TÉCNICA** **Fecha revisión 2: 24-febrero-2011**	
NOMBRE COMERCIAL	**ComposTunAzo**
DESCRIPCIÓN 	ComposTunAzo es un fertilizante para los cultivos de tuna. Mejora las propiedades físicas del suelo. La materia orgánica favorece la estabilidad de la estructura de los agregados del suelo agrícola, reduce la densidad aparente, aumenta la porosidad y permeabilidad y aumenta su capacidad de retención de agua en el suelo. El uso de ComposTunAzo mejora las propiedades químicas aumentando el contenido en macronutrientes (N-P-K) y micronutrientes, permitiendo la capacidad de intercambio catiónico (CIC) y constituye en fuente y almacén de nutrientes para cultivos. Empleando ComposTunAzo se puede mejorar la actividad biológica del suelo, ya que actúa como soporte y alimento de los microorganismos que viven a expensas del humus y contribuyen a su mineralización.
CARACTERÍSTICAS MICROBIOLÓGICAS 	ComposTunAzo se elabora mezclando Azolla-Anabaena (*Azolla caroliniana-Anabaena azollae*), con materia orgánica, principalmente de hojarasca de árboles de Guaba (*Inga sp*), Caimito (*Chrysophyllum caimito* L.), Guachapelí (*Albizzia guachapele*) y Cacao (*Theobroma cacao*), todo lo cual activa el desarrollo de un amplia gama de poblaciones de bacterias, hongos y actinomicetes. ComposTunAzo presenta óptima relación de carbono a nitrógeno (C/N) haciendo que las distintas cepas de bacterias sincronicen su acción bioquímica neutralizando la formación contaminante de Dióxido de Carbono (CO2) y Amonio (NH3). Otros materiales del CompostUnazo incluyen Estiércol, Roca fosfórica, Carbón Mineral, Carbonizado de tamo de arroz, Zeolita, Nitrato de Potasio (NO3K), Tierra de finca, Microorganismos (Bacterias) y Pseudomonas. Esta composición reproduce un compost de óptima calidad.
CARACTERÍTICAS EXTRÍNSECAS	Textura: Granulosa Color: Marrón oscuro-negro ceniza Olor: Agradable tenue

CARACTERÍSTICAS QUÍMICAS	Composición — Valor — Porcentaje Nitrógeno total (N) 1.8 % Fósforo total (P2O5) 1 % Potasio Soluble en agua (K2O) 1 % Calcio (Ca) 1 % Materia Orgánica (MO) 40 % Cenizas (fracción mineral) 60 % Humedad máxima 45 % Relación C/N 20 Aporta además: Magnesio (0.9 – 1%), Cobre (4%), Manganeso (0.5 %), Zinc (3 – 4 %)
REQUISITOS TÉCNICOS DEL PRODUCTO	• Registro • Labores Agronómicas: De acuerdo a los requerimientos técnicos que garanticen un buen desarrollo vegetativo de los cultivos. • Control de malezas: Libre de malezas.
MODO DE EMPLEO	• Abonar las plantas de tuna 1 vez al año. • La cantidad aconsejada de ComposTunAzo para el cultivo es 5 lb por planta cada año. • Es necesario desbrozar en el área del cultivo y limpiar la basura cercana a las plantas de tuna. • Llevar control de las condiciones del cultivo removiendo la tierra y del sistema de goteo, ya que las buenas condiciones el área del cultivo reproducen un desarrollo óptimo de la tuna que es el hábitat de las cochinillas.#
PRECAUCIONES Y RECOMENDACIONES	ComposTunAzo debe almacenarse en un sitio fresco. Aplicarlo en temporadas de lluvias o en condiciones de riego y de acuerdo a las características topográficas del cultivo.

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Anexo 3. DÍA DE CAMPO
Proyecto 5381 Converting Rice Field into Green Fertilizer Factories
San Gabriel 12 de marzo 2011

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134	René Alvarado Villafuerte	080264537	renealvi@hotmail.com	Lomas
135	Jorge Robinson	080555693		Lomas
136	karen leon	093338012		Asociacion Prolica
137	Almea segura	091603244		Sta. Lucia
138	Pablo sotomayor	092834687	pablo_sotomayor@hotmail.com	Palestina
139	Yuri Marin Cedeño	094728280	ymarin95@hotmail.com	Bolivar
140	Arevalo coronel veronica	097725776	marevaloregion5@gmail.com	Guayaquil
141	Tello Magno adrian	099629336		Recinto el Padro
142	Guaranda Fajardo	094762475		Recinto el Padro
143	Medina Obando Lerry	099085970	fudeconec22@hotmail.com	Vinces
144	Lcdo. Emilio herrera	094949383	e-herrera1976@hotmail.com	Samborondón
145	carlos zuñiga	097563446		Samborondón
146	Torres Franco telmo	092268080		Samborondón
147	Villao Arriaga Manuel	2105190		Samborondón
148	Gurumendi Pineanada Martha	089828503		Samborondón
149	Loor Duarte Roberto	092393456		Samborondón
150	Segura Candelario Hipolito	099327698		Pedro Carbo
151	Nestor Diaz Mendoza	093585650		Vinces
152	Nixon Diaz Mendoza	091351829		Vinces
153	Byron muñoz	097170070		MAGAP
154	Jennifer Franco	089106333		Guayaquil
155	Manuel Ramirez Mosquera	094441873		Samborondón
156	Cervantes Jose	093727456		Chongon
157	Mosquera Unda Rodrigo	080371761		Guayaquil
158	Lcda. Leonor Ochoa	099419797	recoragro@yahoo.com	Guayaquil
159	Vera Piguave Felipe	091189721		Daule
160	Castro Roman Alberto	091851711	albertocastro1983@hotmail.com	Quevedo
161	Torres Santos Carlos	08261955		
162	Torres Silvia	082849552		Ventanas
163	Manzaba Coello Felipe	081893713		San Gabriel
164	Virginio Segura Castro	099165247		Daule
165	Cevallos Montalvo Alfredo	099027196		Guayaquil
166	Ketty Arias Cedeño	092035033		Guayaquil
167	Barberan Arches	083677803	andres.barberan@hotmail.com	Guayaquil
168	Erwin Plaza	092037113		Balzar
169	Luis Cardozo	091635842		Samborondón
170	Manuel Herrera Villega	097196846		Samborondón
171	Julio Verrardo	099994679		Daule
172	Boarge Martinez	093816720		Guayaquil
173	Gabriel Vega	089181855	gabriel0714@hotmail.com	Guayaquil
174	Luis Merchan	090384169		Pedro Carbo
175	Yepez Pluas	091684248		Pasaje
176	Diaz Lauso	093625205	eberto_diaz@hotmail.com	
177	Yimmy Chávez	081654622	jimmychavezr@hotmail.com	

Anexo 4

#	Apellido	Nombre	Teléfono	Mail
1	Acosta	Jimmy	*095102265	
2	Altamirano Guerrero	Carlos	*093472488	
3	Arevalo (MAGAP)	Veronica		
4	Bajaña	Kleber	*098267410	
5	Bajaña	Margarita		mbajana73@yahoo.es
6	Bajaña (MAGAP)	Shirley		
7	Bastidas	Juan	*092183028	
8	Bonilla	Carlos		
9	Briones	Ingnacio		
10	Cabezas	Juvenal	0-80095002	ycamo78@hotmail.com
11	Camacho (MAGAP)	Adolfo		
12	Carrera Andrade	Jose	*081640199	ppcarrera39@yahoo.com
13	Clavijo	Daniel	*086822794	
14	Colamarco	Sandra	*099101283	
15	Coloma Coloma	John	2488793/ 081932687	jcolomac@hotmail.com
16	Coronel Macias	Ubaldo	*094990388	ubaldo-93@hotmail.com
17	Echeverria	Luis	*2385162 - *099409361	luisecheverriac@hotmail.com
18	Figueroa (MAGAP)	Priscila		
19	Guaillas Jarama	Carlos Eduardo		carloseduardo_guaillas@hotmail.com
20	Guaman (MAGAP)	Milton		
21	Guerrero	Olga	*081413514	GANADOR CONCURSO AZOLLA
22	Gutiérrez Pincay	Víctor	2231113	hsucre@aduana.gob.ec
23	Gutiérrez Pincay	Sixto	2231113	hsucre@aduana.gob.ec
24	Leticia Suarez		*2236100 ext 167	
25	Lopez	Eduardo	*084564956	GANADOR CONCURSO AZOLLA
26	Lòpez	Cesar	0-91764584	cesarlopezf55@hotmail.com
27	Magañanes (MAGAP)	Teodoro		
28	Marcillo (MAGAP)	Jairo		
29	Mariscal Zeballos	Cesar		fundac.cmariscalz@gmail.com
30	Marques	Mariano		
31	Marques	Julian		
32	Martinez	German	0-87211530	
33	Molina	Jorge		
34	Montaño	Pablo	*097196837	ing.pablomonaño@yahoo.com
35	Muñoz Zeas	Mario	*097354839	
36	Noboa	Paola		noboa.pao162@hotmail.com
37	Ortega	Lourdes		lula_lhom@hotmail.com
38	Parapi	Manuel	*091610621	

39	Parra Rambay	Marcos	*093547796	ingmarcosparra@hotmail.com
40	Peralta	Luis	2750504	
41	Pezantes	Francisco	*099550330	rociopezantes@hotmail.com
42	Pinoargote Chang	Miryam		bitsynana@hotmail.com
43	Ramirez	Jesus	* 099574452	jesseolat@hotmail.com
44	Rivera Fernandez	Francisco		
45	Runa Angulo	Nataly	*090628068	natalyruna@hotmail.com
46	Salazar	Enrique	*086228859	GANADOR CONCURSO AZOLLA
47	Sanchez	Primitivo		
48	Sanchez	Andrea	*095648868	
49	Santana	Santiago	0-87211530	
50	Serrano	Sara	*092059577	
51	Solorzano (MAGAP)	Amada		
52	Toro	Xavier		xtoro@espol.edu.ec
53	Torres Cuadros	Ronald	*088306438	
54	Tumbaco	Tedy	*094676312	
55	Tutiben (MAGAP)	Peter		
56	Varas	Eduardo		ervarasa@yahoo.com
57	Villamar	Jose	*080085768	agrojota2006@hotmail.com
58	Zambrano	Jorge		

Anexo 5
Proyecto 5381 Converting Rice Field into Green Fertilizer Factories

Lista de Estudiantes y trabajos

#	Nombre	Trabajo
1	Gustavo Molina. Ganador del Concurso Piensa Verde 2010 de Bayer (Primer puesto)	Aplicación del recurso Azolla-Anabaena como fuente de nitrógeno verde en los arrozales del Ecuador
2	Andrés Román. Ganador del Concurso Piensa Verde 2010 de Bayer (Segundo puesto)	Disminución de las emisiones de CO2 por medio de la carbonización de la panca de arroz
3	Jhonathan Morán	
4	Lissett Iturburu	Generación de corriente eléctrica microbiana
5	Javier Ron Arteaga	
6	Jose Luis Cortez Villao	Las bacterias de nuestro Interior
7	Jaime Jose Veliz Ibarra	
8	Santiago Romer	
9	Luis Castillo	
10	Bryan Avilés Arroyo	
11	Fernando Ronquillo Zambrano	
12	Fernando Parrales	El potencial de las diatomeas en el ambiente de los arrozales
13	Antonio Delgado	
14	Jacque Cobos	
15	Eduardo Castillo	Producción del Biocarbón
16	Carlos Javier Satian Carguaitongo	
17	Alex Pacheco	
18	Alejandro Monar	
19	José García	Diseño de un fangueador
20	Israel Espinoza	
21	William Ontaneda	
22	Gabriela Vélez	
23	Darwin Israel Guamán Saca	Caracterización de suelos de arrozales
24	Walter James Flores Zambrano	
25	José Pastor	
26	Fernando Jiménez	
27	José Luis Bueno Quinde	
28	Efrén David Masache Narváez	
29	Juan Granda	Gases efecto invernadero en arrozales
30	Miguel Torres	
31	Alexix Fernando Lema Ordoñez	
32	Juan Carlos Mendoza Soledispa	
33	Carlos Torres Reyes	Elaboración de bloques para la construcción a base de la

34	Andrea ZuñigaYong	cáscara de arroz
35	Luis Ugarte	
36	Moisés Carrasco	
37	Karem Tumbaco	
38	Gustavo Moscoso	
39	Ronald Zamora	
40	Andony Calderón	
41	Jenny Gutierrez	Azolla. Una promisoria alternativa de alimentación humana
42	Eduardo Castillo	
43	Alfredo Moscoso	
44	Christian Macías	Azolla: Sistema de aspiración del helecho desde los arrozales
45	Leonela De la Cruz	
46	Danny Fuentes	
47	Andrea Ortega	
48	Roberto Murillo	
49	Andrea Gavilanes	
50	Andrea Barcia	Azolla: Invernadero portatil para el secado del helecho
51	Diana Tinoco	
52	Rebeca Nathaly Parra Narea	
53	Ricardo Fabián Rodríguez Avilés	
54	Diego Francisco Sánchez Urbina	
55	Verónica Ordoñez	
56	Bruno Geovanny Jara Yépez	Azolla: Molino de desechos orgánicos a base de Azolla
57	Javier Adolfo Rojas Muñoz	
58	Alejandro Ali Vaziri Landívar	
59	Jorge Velásquez	
60	Denis Viera	
61	Paola Quiroz Zambrano	USO DE LA AZOLLA COMO ALIMENTO PARA PECES
62	María Belén Contreras	
63	Diego M. Encalada Parrales	USOS DE LA CÁSCARA DEL ARROZ: “POLVILLO”
64	Cristhian B. Morcho Porras	
65	Vanessa Steffanie Albarracín Meneses	Arcillas en agricultura, artesanías e industria
66	Valeria Paulina Romero De La Torre	
67	Gabriela Stefany Torres Perero	
68	Freddy Alejandro Matamoros Paredes	
69	Edinson Fernando Suarez Villón	
70	Lissette Mariela Yépez Cedeño	
71	Walter Vega Crespín	Pruebas de reproducción de *Azolla anabaena*
72	Tomas Andrés Yaguana Espín	Azolla medios
73	María R. Reyes Acosta	Depuración de mercurio con Azolla
74	Héctor Leonardo Troya Mendoza	ECUADOR: REFERENTE MUNDIAL DE NITRÓGENO
75	María Rosa Reyes. Ganadora del Concurso Innova Verde 2011 de Bayer (Primer puesto)	Remoción de mercurio de agua mediante Azolla-Anabaena

Anexo 6
Proyecto 5381 Converting Rice Field into Green Fertilizer Factories

Lista de académicos

#	Nombre	Universidad	Email
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3	Wilson Pozo, Ph.D. (candidate)	Universidad Estatal de Guayaquil	wpozog@gye.satnet.net
4	Vicente Riofrío, Ph.D.	ESPOL, Ecuador	tesis1.vicente@gmail.com
5	Antonio Sotomayor, M.Sc.	Instituto Tecnológico de Vinces, Ecuador	anedsoma@yahoo.com
6	Carola Resabala, M.Sc.	ESPOL, Ecuador	cresabal@espol.edu.ec
7	José Guillermo Cárdenas, M.Sc.	ESPOL, Ecuador	institutodeambiente@hotmail.com
8	David Matamoros, Ph.D.	ESPOL, Ecuador	dmata@espol.edu.ec
9	Juan Carlos Navarro	Instituto de Acuicultura de Torre La Sal, España	jcnata@gmail.com
10	Javier Marriott, Biol.	ESPOL, Ecuador	jemcbio01@hotmail.com
11	Rodrigo Estrella, Dr.	Universidad Central, Ecuador	drrodrigoestrella@hotmail.com
12	Eduardo Fernández, Ph.D.	Universidad Autónoma de Madrid, España	eduardo.fernandez@uam.es
13	Francisco Carrapico Ph.D.	Universidad de Lisboa, Portugal	fcarrapico@fc.ul.pt

PROTOCOLO DE MUESTREO Y ANÁLISIS DE AGUA

Anexo 7.1

Proyecto 5381 Converting Rice Field into Green Fertilizer Factories

Localización de las muestras:	Hacienda La Victoria-Samborondón; Mangle-Santa Lucía
Identificación de etiqueta:	Rotulados con la fecha, lugar, propietario,
Etiquetas:	Dimensiones 9 x 1.5 cm
Volumen de la muestra:	500 ml de muestra de agua
Recipientes de almacenaje	Envase plástico
Descripción del muestreo:	Anotar temperatura del agua al momento de toma de muestra. Sumergir completamente la botella en el agua a muestrear, según procedimiento establecido. Llenar la botella con 500 ml de agua Tapar y sellar la botella evitando que queden burbujas de aire en su interior, enviar de inmediato a laboratorio para análisis de indicadores definidos
Material complementario:	Balde, fundas, marcadores, etiquetas, cuaderno de campo.

Resultados:

Parámetro	Unidad	Artillería	El Mangle
Código		2010105	2010106
pH	u.	7.94	7.20
CE	u-mhos	231.1	288.5
SDT	mg/l	151	191
Ca	meq/l	0.420	0.55
Mg		0.800	0.94
Na		0.680	0.87
K		0.077	0.04
Suma		1.977	2.40
CO3H		1.40	2.00
SO4		0.30	0.12
Cl		0.60	0.57
Suma		2.30	2.69
N-NH4	ppm	8.0	11.0
N-NO2		0.048	0.002
N-NO3		46	49
P-PO4		3.52	2.23

Responsable: Jorge Coronel, Tesante Proyecto Azolla
Aprobación: Mariano Montaño, Director del Proyecto 5381
Fecha: 31 octubre 2010

	PROTOCOLO DE MUESTREO Y ANÁLISIS DE SUELO Anexo 7.2 Proyecto 5381 Converting Rice Field into Green Fertilizer Factories	Banco Mundial

Localización de las muestras:	Muestras de Samborondón y Mangle
Identificación de etiqueta:	Rotulados con fecha, lugar y propietario.
Etiquetas:	Dimensiones 9 x 1.5 cm
Volumen de la muestra:	Un kg de muestra de suelo
Recipientes de almacenaje	Bolsas de polietileno y envío inmediato al Laboratorio
Descripción del muestreo:	Extraer con una pala 3 submuestras de suelo por hectárea a una profundidad de 0 - 20 cm que se colocan en un balde, recorriendo el terreno en zig-zag y posterior homogeneización para obtener la muestra compuesta de 1 kg de suelo.
Material complementario:	Pala, balde, fundas, etiquetas, cuaderno, marcadores entre otros.

Resultados (AC = Arroz Comercial)

Referencias		Samborondon Bolita	La Bolita Afuera	La Bolita Azolario	Samborondon AC
Prmt.	Unid.	01-Jun-09	27-Jul-10	27-Jul-10	27-Jul-10
Arena	%	48	10	7	7
Limo		14	32	35	28
Arcilla		38	58	58	65
Clase	------	AAr	A	A	Ap
DA	gr/cm3	1.26	1.28	1.20	1.20
pH	u.	7.2	6.6	6.7	6.8
CE 1:1	mmhos	0.26	0.39	0.48	0.60
MO	%	0.9	1.8	2.0	1.9
N		0.05	0.11	0.12	0.11
CIC	meq /	33.2	34.6	37.0	39.2
Na	100 gr	1.64	0.85	1.01	1.12
K int.		0.20	0.70	0.36	0.53
Ca		15.9	31.7	14.1	14.6
Mg		13.2	5.6	13.0	12.5
P	ppm	0.7	3.7	2.3	2.6
Fe		39.7	171.9	133.3	150.0
Mn		4.8	187.5	137.5	30.0
Zn		2.6	2.3	2.8	2.7
Cu		1.8	4.6	5.1	7.1

Responsable:	Jorge Coronel, Tesante Proyecto Azolla
Aprobación:	Mariano Montaño, Director del Proyecto 5381
Fecha:	20 mayo 2009

ANEXO 8

Difusión del Programa Azolla

Medios Impresos	Cobertura	Tiraje
Diario El Universo	Nacional	150.000
Diario El Universo	Nacional	150.000
Diario El Universo	Nacional	150.000
Diario El Universo	Nacional	150.000
Diario El Universo	**Nacional**	150.000
Diario el Costanero	**Costa**	16.000
Diario El Comercio	**Nacional**	120.000
Revista en Contexto	Nacional	6.000

Radios		Número de Oyentes Apróximado
Tropicana	Nacional	30.000
CRE	Nacional	4.000
Tropicana	Nacional	6.000
Tropicana	Nacional	7.000
Teleradio	Costa	10.000
Atalaya	Nacional	20.000

Televisión		Número de Televidentes Apróximado
CN3	Guayaquil, Quito	15.000
RTU	NACIONAL	35.000
CANELA	Guayaquil, Quito	10.000

Web		
RTU	Mundial	40. 000 VISITAS AL MES
Blog Azollazo	Mundial	250 Usuarios
Mail Masivo	Ecuador	5.000 correos
Agrytec	Mundial	25. 000 VISITAS AL MES
Agrytec	Mundial	25. 000 VISITAS AL MES

Titular
Estudios dan un mejor arroz al usar helecho en vez de úrea
Azolla - Día de campo
Investigación Azolla en reemplazo de la úrea en arrozales
Seminario - Manejo de la azolla en el agro
Alternativas de sustitución de la úrea
La azolla sustituto de la Urea
El uso de la azolla en cultivo de arroz
La azolla como sustituto de la Urea

Horario AAA Estelar Noticiero - La Hora de Don Ramón
Horario A - Programa Agropecuario
Horario A Madrugada - Programa Agropecuario " Encuentro con el Agro"
Horario AA Noticiero Agropecuario " Agro Noticias"
Horario Estelar Noticiero -Primera Emisión
Horario Estelar Noticiero -Primera Emisión

Noticiero(Horario Estelar) : Que es la Azolla y Beneficios
Reportaje Noticiero
Reportaje en programa Ecuador Productivo

La azolla en Ecuador, un sustituto de la úrea
Blog de Información de Nuestro Proyecto
Envio a la Base de Datos del Sector Agropecuario del Ecuador. (Información de los Eventos del Programa Azolla)
LA AZOLLA, FERTILIZANTE NATURAL QUE PUEDE REMPLAZAR LA ÚREA
Publicación del 1er Seminario de Azolla

Fecha
ENERO. 15, 2011
FEBRERO. 15, 2011
MARZO. 05, 2011
MARZO. 19, 2011
FEBRERO. 19, 2011
Abril 15, 2011
MARZO. 21, 2011
MARZO. 17, 2011

Annexes 9. Training materials (Period 2: Project-Specific Output Indicator #1.b.)

Anexo 9.1

Escuela Superior Politécnica del Litoral (ESPOL)
Instituto de Ciencias Químicas y Ambientales (ICQA)
Guayaquil-Ecuador

Washington DC, September 2008

ORGANIZATIONAL CAPACITY: Projects

- Establishment of fungicide residues (triazols and strobirulins) in banana leaves and fruit depending on the cycles of plant health applications.
- Inventories of emissions of dioxins and furans (D & F) in ECUADOR, GEF/2732-02-4456 projects, Global Environmental Facility (GEF) / Ministry of Environment of Ecuador-National Integrated Programme for the Sound Management of Chemicals.
- Inventories of Persistent organic pollutants (POPs) pesticides in ECUADOR, GEF/2732-02-4456 projects, Global Environmental Facility (GEF) / Ministry of Environment- National Integrated Program for the sound management of (POPs) in ECUADOR.
- Study Water Quality Coastal Ecuadorian Management Program Coastal Resources-AID.
- Biochemical and Nutrition Research in Reproduction and growth of shrimp, ESPOL / EEC (European Economic Community).
- Improving the production process of natural fiber toquilla straw for the manufacture of hats and other crafts in the commune of Barcelona at St. Elena Peninsula.
- Programme of education and research in tropical agriculture for sustainable watershed related to Guayas River and the Gulf of Guayaquil.

TEAM LIDER

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Washington D.C., September 2008

2008 Global Development Marketplace
Sustainable Agriculture for Development

Guayas Ecosystem

The Guayas Ecosystem is the laboratory for investigation of the Azolla, from collecting seed, following the trials of adapting to conclude with its application to crops of rice.

The development of this knowledge is focused on the opportunity to generate tropical knowledge very useful for humanity but which is in its infancy activation.

Escuela Superior Politécnica del Litoral (ESPOL)
Instituto de Ciencias Químicas y Ambientales (ICQA)
Guayaquil-Ecuador

Anexo 9.2

Escuela *Superior Politécnica del Litoral* (ESPOL)
Instituto de Ciencias Químicas y Ambientales (ICQA)
Guayaquil-Ecuador

Nitrógeno sostenible para la Agricultura y Ganadería del Ecuador

Proyectos ejecutados y en curso

Desarrollo del Recurso Azolla Anabaena y aplicaciones en los sectores agrícola, pecuario y acuícola, SENACYT.

Converting Rice fields into Green Fertilizer Factories, BANCO MUNDIAL.

Establecimiento de residuos de fungicidas (triazoles y estrobirulinas) en hojas y frutos de banano en función de los ciclos de las aplicaciones fitosanitarias-CONESUP.

Programa de educación e investigación en agricultura tropical sostenible de las cuencas hidrográficas relacionadas con el río Guayas y el Golfo de Guayaquil, PROMSA.

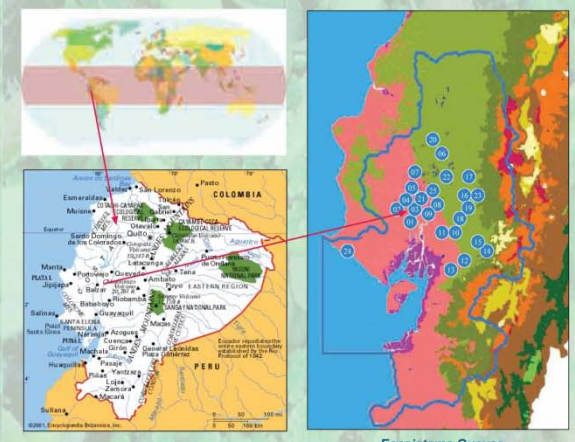
Programa de desarrollo del sistema productivo tuna-cochinilla en la Península de Santa Elena como una oportunidad de desarrollo agroindustrial, SENACYT.

Inventarios de plaguicidas orgánicos persistentes de en el Ecuador, Facilidad Medio Ambiental Mundial (FMAM)/Ministerio de Medio Ambiente de Ecuador (MAE).

Inventario de emisiones de dioxinas y furanos en el Ecuador, Facilidad Medio Ambiental Mundial (FMAM)/Ministerio de Medio Ambiente de Ecuador (MAE).

Bioquímica y Nutrición de la reproducción y crecimiento de camarones, Comunidad Económica Europea (CEE).

Estudio de Calidad del Agua Costera del Ecuador, Programa de Manejo Costero de Recursos Costeros-AID-URI-PMRC.



Ecosistema Guayas
Sitios de muestreo de Azolla

Ecosistema Guayas es el laboratorio natural para la investigación de Azolla, desde la recolección de semilla, seguido de ensayos de adaptación hasta concluir con su aplicación en los cultivos de arroz y agrícolas en general.

El desarrollo de Ecosistema Guayas se centra en la oportunidad de generar conocimiento tropical de gran utilidad para la humanidad.

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ecosistemaguayas@gmail.com
mmontano@espol.edu.ec
Telf.: 042-269566
042-269559
042-247463ontacto:

Auspicio

Escuela Superior Politécnica del Litoral (ESPOL)
Instituto de Ciencias Químicas y Ambientales (ICQA)
Guayaquil-Ecuador

Anexo 9.3


Bioabono
Azolla helecho acuático.
Funciona como biofertilizante en los cultivos de arroz reemplazando a la urea.
Su aplicación como abono puede hacerse con Azolla fresca o Azolla seca.
Director del Proyecto
Marjano Montaño Armijos
Ing. Quím., MAE, Ph.D.
Teléfono: 2269566 2237674
E mail: ecosistemaguayas@gmail.com
Azolla:
Bioabono alternativo para el arroz
ESCUELA SUPERIOR POLITECNICA
DEL LITORAL (ESPOL)
INSTITUTO DE CIENCIAS QUIMICAS
Y AMBIENTALES (ICQA)

Anexo 9.4

Azolla en Ecuador

Azolla Anabaena, un pequeño helecho acuático, es un recurso natural promisorio del Ecuador que se probó como fertilizante alternativo de arroz con excelentes resultados en el Ecosistema Guayas.

Algunos sitios probados de desarrollo del Azolla incluyen:

Guarumal

Saraguro

Daule

Director del Proyecto
Mariano Montaño Armijos
Ing. Quím., MAE, Ph. D.
Teléfono: 593 4 269566 593 4 237674
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Azolla: Bioabono alternativo para el arroz

ESCUELA SUPERIOR POLITECNICA
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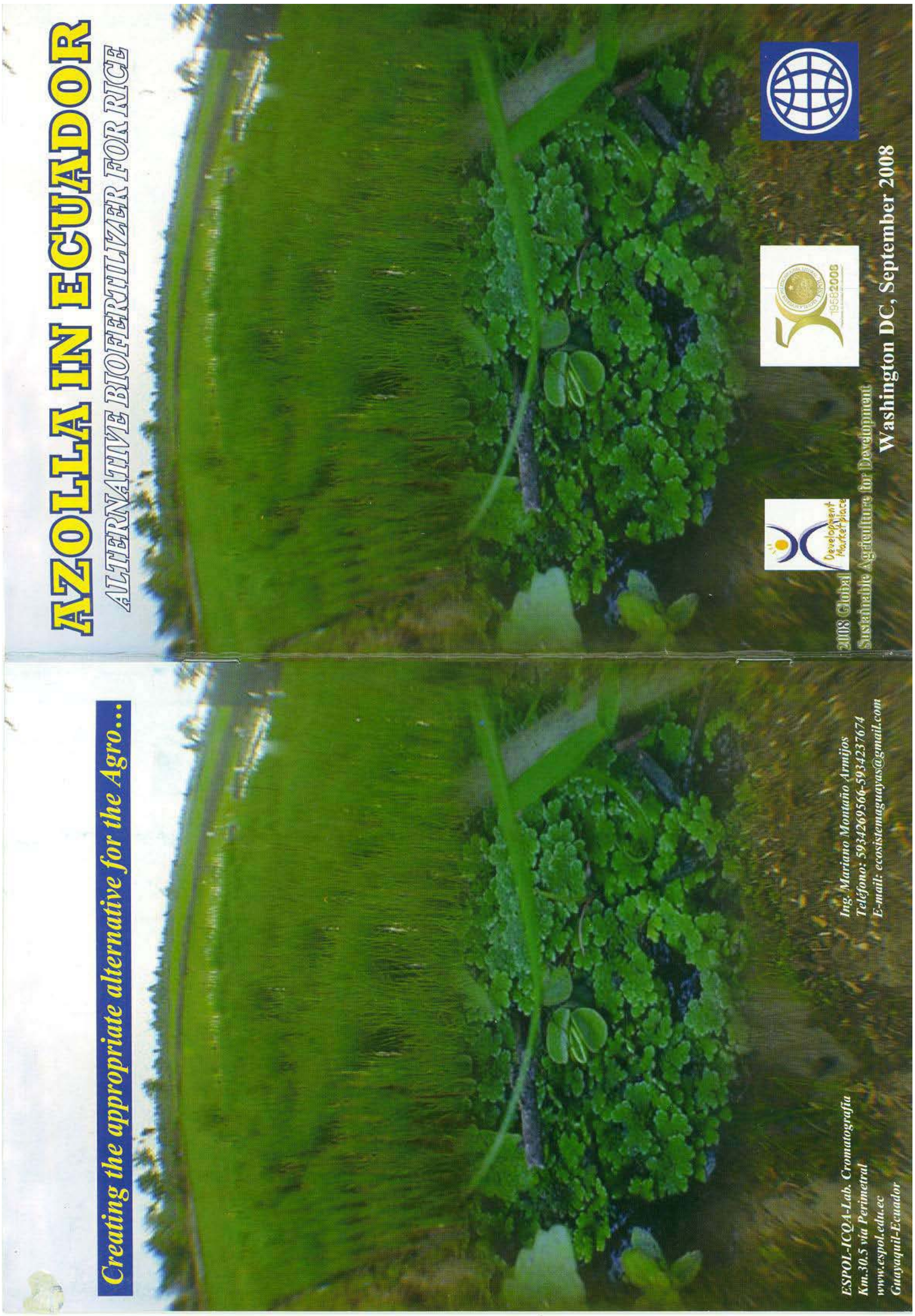
INSTITUTO DE CIENCIAS QUIMICAS
Y AMBIENTALES (ICQA)

Anexo 9.5



AZOLLA IN ECUADOR
ALTERNATIVE BIOFERTILIZER FOR RICE
Development Market place
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Sustainable Agriculture for Development
Washington DC, September 2008
Creating the appropriate alternative for the Agro...
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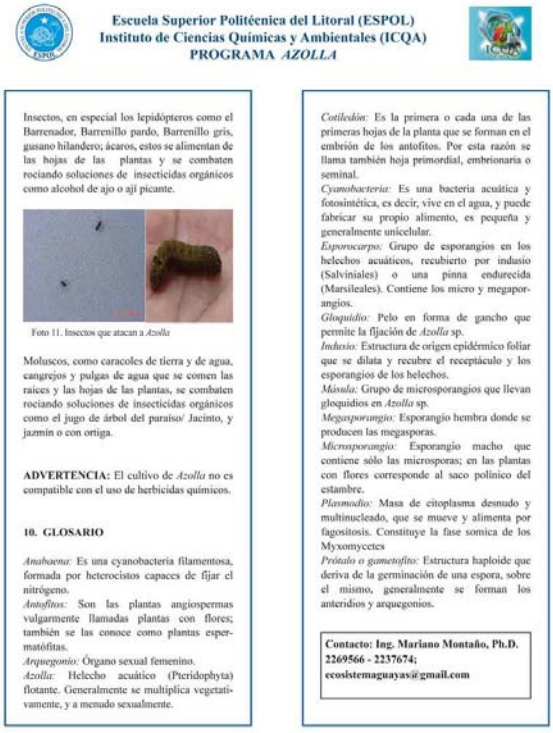
Anexo 9.6



Escuela Superior Politécnica del Litoral (ESPOL)
Instituto de Ciencias Químicas y Ambientales (ICQA)
PROGRAMA *AZOLLA*

Insectos, en especial los lepidópteros como el Barrenador, Barrenillo pardo, Barrenillo gris, gusano hilandero; ácaros, estos se alimentan de las hojas de las plantas y se combaten rociando soluciones de insecticidas orgánicos como alcohol de ajo o ají picante.

Foto 11. Insectos que atacan a *Azolla*

Moluscos, como caracoles de tierra y de agua, cangrejos y pulgas de agua que se comen las raíces y las hojas de las plantas, se combaten rociando soluciones de insecticidas orgánicos como el jugo de árbol del paraíso/ Jacinto, y jazmín o con ortiga.

ADVERTENCIA: El cultivo de *Azolla* no es compatible con el uso de herbicidas químicos.

10. GLOSARIO

Anabaena: Es una cyanobacteria filamentosa, formada por heterocistos capaces de fijar el nitrógeno.
Antofitos: Son las plantas angiospermas vulgarmente llamadas plantas con flores; también se las conoce como plantas espermatófitas.
Arquegonio: Órgano sexual femenino.
Azolla: Helecho acuático (Pteridophyta) flotante. Generalmente se multiplica vegetativamente, y a menudo sexualmente.

Cotiledón: Es la primera o cada una de las primeras hojas de la planta que se forman en el embrión de los antofitos. Por esta razón se llama también hoja primordial, embrionaria o seminal.
Cyanobacteria: Es una bacteria acuática y fotosintética, es decir, vive en el agua, y puede fabricar su propio alimento, es pequeña y generalmente unicelular.
Esporocarpo: Grupo de esporangios en los helechos acuáticos, recubierto por indusio (Salviniales) o una pinna endurecida (Marsileales). Contiene los micro y megasporangios.
Gloquidio: Pelo en forma de gancho que permite la fijación de *Azolla* sp.
Indusio: Estructura de origen epidérmico foliar que se dilata y recubre el receptáculo y los esporangios de los helechos.
Másula: Grupo de microsporangios que llevan gloquidios en *Azolla* sp.
Megasporangio: Esporangio hembra donde se producen las megasporas.
Microsporangio: Esporangio macho que contiene sólo las microsporas; en las plantas con flores corresponde al saco polínico del estambre.
Plasmodio: Masa de citoplasma desnudo y multinucleado, que se mueve y alimenta por fagositosis. Constituye la fase somica de los Myxomycetes
Prótalo o gametofito: Estructura haploide que deriva de la germinación de una espora, sobre el mismo, generalmente se forman los anteridios y arquegonios.

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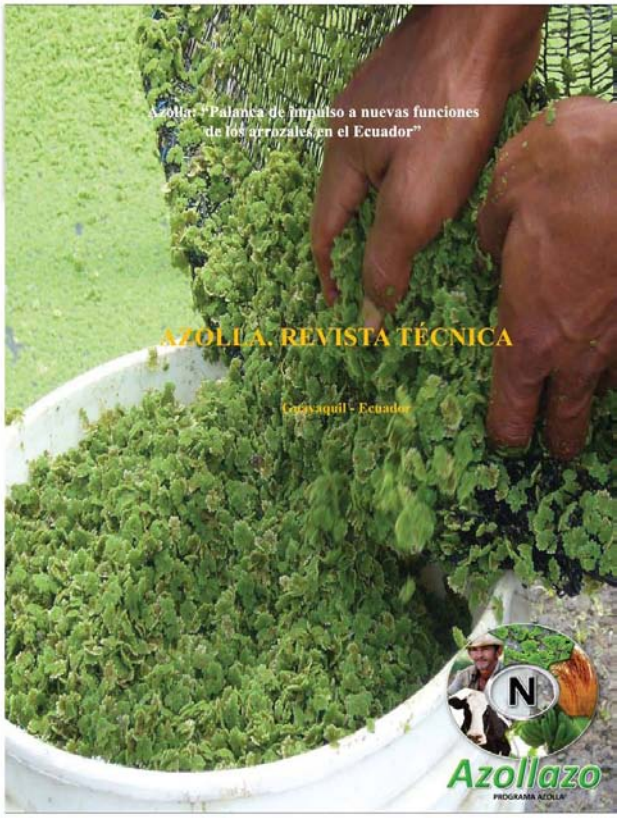

Azolla caroliniana en el nanoambiente

Azolla caroliniana en el nanoambiente

GUERRERO Sofía (ESPE), MONTAÑO Mariano (ESPOL), FERNÁNDEZ Eduardo (UAM), CARRAPICO Francisco (UL)

RESUMEN

Se sabe que la cianobacteria *Anabena* aporta con especies nitrogenadas al helecho hospedero *Azolla caroliniana*, y esto se debe a la actividad enzimática de las ferroproteínas y molibdoproteínas, la cuales realizan la fijación del nitrógeno. Estas enzimas, así mismo, por la saturación de especies nitrogenadas en el medio, pueden verse autoinhibidas y dejar de fijar nitrógeno, siendo esta una condición estresante para *Anabena.* El nitrógeno es un constituyente del anillo porfirínico de las clorofilas, sin él éstas no se forman y a su ausencia se utilizan pigmentos auxiliares como carotenoides y ficobiliproteínas. Por esto es probable que las hojas de *Azolla c.* se tornen rojas después de cierto tiempo de proliferación en el medio acuoso. Para esto se han propuesto dos análisis tanto *In vivo* como *In vitro* para evaluar los niveles de especies nitrogenadas en el medio. Los resultados de los análisis de agua, suelo y foliares (*Azolla c.* y arroz) mostraron que las especies químicas nitrogenadas presentes en el agua de los azolarios no muestran variaciones significativas que implique la coloración de *Azolla*. En el azorizario se registró un déficit de potasio en el suelo, lo que indicaría una fertilización desproporcional, así mismo en otro punto se constató la presencia de algas verdes, lo que se presume sería el causante de la clorosis y manchas marrones en las hojas del arroz.

INTRODUCCIÓN

Dentro de los proyectos "Desarrollo del recurso Azolla Anabaena y aplicaciones en los sectores agrícola, pecuario, y acuícola", y "Converting Rice Fields into Green Fertilizer Factories" se ha realizado una investigación sobre el cambio de la coloración en hojas de Azolla, siendo éstas influenciadas por la presencia de especies químicas nitrogenadas presentes en el medio acuoso, alterando aspectos metabólicos en la simbiosis.

El hospedero *Azolla*, contiene pigmentos fotosintéticos como la clorofila a, clorofila b y carotenoides asociados a los cloroplastos; mientras que los filamentos de *Anabaena* presentan clorofila a, ficobiliproteínas y carotenoides (estos dos últimos son pigmentos accesorios). Esta suma de pigmentos fotosintéticos principales y accesorios, permiten al organismo simbiótico ampliar el rango de disponibilidad de la energía luminosa aprovechable.

Es probable que esta característica sea la responsable del cambio en la coloración en las hojas de *Azolla*, de verde a rojo (Mosquera y Calderón, 2002).

Los pigmentos fotosintéticos absorben determinadas longitudes de onda (λ= nm) de la luz solar (Figura 1), por lo que la coloración roja en *Azolla* puede deberse a la ausencia de clorofila a y b.

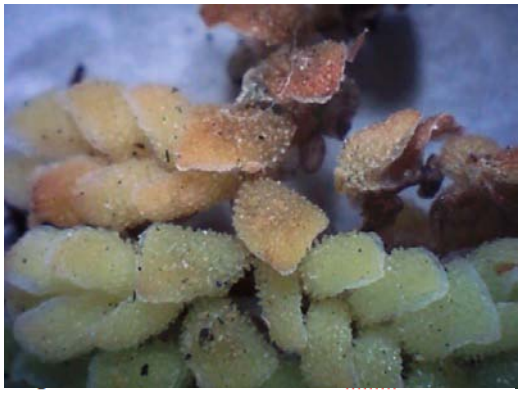

Figura 2. Cambio en la coloración en *Azolla c.* de verde a rojo. 40 X.

Cuando *Azolla* muere, cae hacia el sedimento liberando todo el nitrógeno fijado por *Anabaena*, saturando el ambiente acuoso de especies químicas nitrogenadas de fácil asimilación, por lo que *Azolla* aprovecha esta gran disponibilidad y prescinde del nitrógeno fijado por *Anabaena*, que se ubica en moléculas orgánicas y pasa a formar parte de los pigmentos como la clorofila en menor porcentaje. Este acontecimiento autoinhibe la actividad enzimática de la ferroproteína y molibdo-ferroproteína de *Anabaena*. Además, la fijación de nitrógeno implica un gran gasto energético para toda cianobacteria, a razón de 18 a 24 ATP´s; aún se desconoce las razones de este "despilfarro"

energético. Por ello, es probable que *Anabaena* se vea estresada cuando su hospedero prescinde del nitrógeno que ésta le aporta (Prescott, 2002). La clorofila necesita del nitrógeno para formar su anillo porfirínico, en cambio, las ficobiliproteínas y carotenoides prescinden de él, siendo estos pigmentos, los que absorben la luz (λ= 500-550 nm) y reflejan el color rojo en las hojas de *Azolla c.* (Mosquera y Calderón, 2002).

ANÁLISIS Y TRATAMIENTOS

La coloración de *Azolla* podría estar influenciada por los efectos de las especies químicas nitrogenadas en el agua en la inhibición enzimática de *Anabaena*, se sugiere realizar análisis *In vitro* como *In vivo*, en cuanto a: la tasa de crecimiento, el contenido de clorofila y proteína; cuantificación de la actividad enzimática nitrato reductasa y nitrogenasa, así como la cantidad de células vegetativas y heterocistos presentes en cada parcela (Análisis *In vivo*) y tratamiento (Análisis *In vitro*) para determinar las causas de la coloración en *Azolla* (Mosquera y Calderón, 2002).

Análisis *In vitro*

Este análisis aporta con resultados más homogéneos y confiables, ya que la técnica se desarrolla bajo condiciones más controladas en cuanto a temperatura, intensidad de la luz, disponibilidad de nutrientes y específicas longitudes de onda de luz. Los medios de cultivo IRRI para la simbiosis *Azolla- Anabaena* aportan con nitrógeno en forma de iones: NO_3^+ y NH_4^+, como se detalla en la Tabla 1.

Medio IRRI +N		Medio IRRI -N	
Macronutrientes	(g / litro)	Macronutrientes	(g / litro)
NH_4NO_3	1.650	....	....
$CaCl_2$	0.333	$CaCl_2$	0.333
$MgSO_4$ $6H_2O$	0.492	$MgSO_4$ $6H_2O$	0.492
K_2SO_4	0.274	K_2SO_4	0.274
NaH_2PO_4	0.120	NaH_2PO_4	0.120
Micronutrientes	(mg / litro)	Micronutrientes	(mg / litro)
Fe	0.2	Fe	0.2
Mn	0.1	Mn	0.1
Zn	0.012	Zn	0.012
Cu	0.005	Cu	0.005
Mo	0.005	Mo	0.005
B	0.635	B	0.635

(International Rice Research Institute)

Tabla 1. Medios de cultivo para *Azolla* con y sin nitrógeno. *Extraído de Mosquera y Calderón, 2002.*

Materiales y Métodos:

Utilizando doce recipientes de plástico de 500mL, de los cuales se toman cuatro y se coloca el medio IRRI con (+N), y en otros cuatro restantes, se coloca el medio IRRI sin nitrógeno (-N). En todos los frascos se siembra *Azolla c.* por igual llenando todo el espacio del recipiente. A partir de estos, se forman tres grupos de cuatro, se separan dos recipientes IRRI (+N) y dos IRRI (-N). A los tres grupos se los mantendrá bajo una lámpara (Sylvania® DXM Tungsten-halogen) con filtros de interferencia (Lee Filters®) (Ray *et al*, 1973). Para la luz azul se utilizaran Lee filters Tokyo Blue 071 para una (λ= 400-500 nm) y para el color rojo, Bright Red 026 para una (λ= 600-700 nm). Se coloca a cada grupo bajo la lámpara con su respectivo filtro. Para la luz blanca, no se utilizará filtro. El fotoperíodo es de 12 horas de luz y 12 horas de oscuridad, con temperaturas que oscilan entre (23 – 25) °C, durante un mes (Mosquera y Calderón, 2002).

Análisis *In vivo*

La presencia de clorofilas depende de la cantidad de iones nitrato y amonio en el agua, el nitrito es un compuesto intermedio, por lo que su concentración siempre será muy baja. Para establecer una relación de las especies químicas de nitritos, nitratos y amonio, con la coloración roja en *Azolla*, se realizaron análisis en el agua y suelo de estas especies donde la *Azolla* se encontró verde y cuando se tornó roja. Así mismo un análisis de muestras foliares de *Azolla* y arroz, en cuanto a ciertos micro y macroelementos que podrían estar involucrados en la coloración roja de *Azolla* (Mosquera y Calderón, 2002).

Se tomaron muestras de agua, suelo y foliares a partir de un *Azollario* (Piscinas con cultivos de *Azolla),* y un *Azorizario* (Arrozal con cultivo de *Azolla*) ubicados en la provincia del Guayas, cantón Daule, recinto: Boquerón.

Materiales y Métodos

En el azollario, se tomaron muestras de cada uno de los puntos numerados del 1 al 7 (Fig. 3). Se observó que los puntos 2 y 3 no tenían proliferación de *Azolla* como en el resto de puntos, por lo que se prescindió de la muestra de suelo y agua debido a que ambas se encuentran en la misma condición y se presume presenten resultados similares.

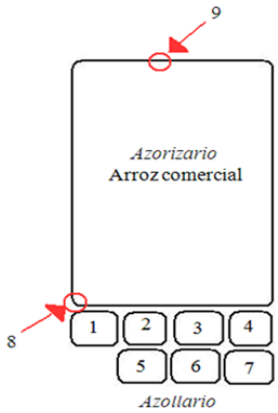

Figura 3. Los números indican los puntos muestreados.

La *Azolla* se mostró roja solamente en los puntos 1 y 5. El azollario se encuentra cubierto con un zarán (rollo de polisombra 50 %), lo cual disminuye la intensidad de la luz, imitando el ambiente natural de *Azolla* en los arrozales, siendo que el arroz le brinda sombra.

El azorizario tiene un cultivo de arroz comercial (INIAP 11) de 2 meses y medio, faltando para la cosecha, mes y medio. Se tomaron dos puntos en el azorizario (Fig. 3), punto 8 y 9; se realizó el muestreo en estos dos puntos debido a que el cultivo presentaba notables diferencias: En el punto 8 se observó que las hojas de *Azolla* eran de color rojo y muy escasas, además de estar en suspensión con una gran cantidad de algas verdes, por otro lado las plantas de arroz mostraban hojas cloróticas y con manchas marrones. En el punto 9 se observó una gran proliferación de *Azolla* con un intenso color verde, así mismo las plantas de arroz se veían verdes y saludables.

RESULTADOS Y DISCUSIÓN

Los análisis se realizaron sobre todas las muestras en el Laboratorio de Análisis Agrícola del Dr. Jorge Fuentes (Guayaquil-Ecuador).

En el agua del azollario, los niveles de nitratos se encuentran dentro de los rangos normales, NO_3^- (2.1 - 54.1) ppm, mientras que para el amonio, los datos sobrepasan el rango normal NH_4^+ (2- 18)ppm. En el punto 5 se obtuvo el valor más alto (28 ppm), recordemos que en éste punto, la coloración de *Azolla* era roja, por el contrario en el punto 2, no se registró proliferación del helecho, dando un resultado de NH_4^+ (18)ppm (Espinoza y Gutiérrez, 2003).
En los puntos 2 y 3 es notoria la ausencia del helecho acuático, es probable que esta especie de *Azolla* prolifere con mayor éxito en concentraciones más altas que 18 ppm.

Los niveles óptimos de nitrato en el agua para el crecimiento de *Azolla Pinnata* y *A. mycrophylla* es de 2.5 mmol/L, mientras que en altos niveles de nitrato (15 mmol/L) ocurre una disminución en la producción de heterocistos (Pabby *et al*, 2001).

Según Rai y colaboradores (2000), a pH altos (> 7), hay una mayor actividad de la enzima nitrogenasa en las hojas de *Azolla*, por lo que debería existir mayor concentración de nitrógeno en sus hojas.
El pH en todos los puntos estudiados tanto del azollario como del azorizario, fue normal, ubicándose en el rango de pH: 7.4-8.6; sin embargo, se constató una fuerte merma de proliferación de *Azolla* en los puntos 2 y 3 del azollario.
En el agua del punto 8 del azorizario se registraron concentraciones normales de fosfatos (0.01-0.82 ppm) y calcio (11.6-28.6 ppm). Igualmente las concentraciones de potasio son normales sin que revelen diferencias entre los puntos 2 y 7, con valores respectivamente de 5.083 ppm y 2.346 ppm, Rango óptimo (1.27 - 6.5) ppm (Espinoza y Gutiérrez, 2003).
Según Rimache (2008) el pH óptimo para el suelo de un arrozal es de 6.6, un medio ácido ayuda a la liberación microbiana de nitrógeno y fósforo de la materia orgánica, además las concentraciones de sustancias que interfieren en la absorción de nutrientes, tales como aluminio, manganeso, hierro, dióxido de carbono y ácidos orgánicos, están por debajo del nivel tóxico.

En suelo del punto 8 se evidencian niveles altos de amonio (60 ppm), en comparación con el punto 9 (37 ppm). Según Castilla (2003) en suelos con bajo contenido de materia orgánica (MO) la producción de amonio disminuye, mientras que en otros con contenido medio - alto de materia orgánica, la producción de amonio es altísima.
El contenido de MO en el punto 9 (3.72 g/kg) no muestra una gran diferencia con relación a los otros puntos, lo que indica que este factor no influye en la alta concentración de amonio en el suelo.

El fósforo en el suelo mostró valores diferentes:
En el punto 8 (3.9 ppm), en el punto 9 (9.6 ppm), en el punto 6 (9.8 ppm) y en el punto 1

(4.8 ppm). El rango óptimo es de (5.0 - 53.0) ppm.
En un arrozal la deficiencia de fósforo en el suelo, presenta hojas estrechas, pequeñas y muy erectas de un color verde oscuro, los tallos son largos y se retarda el crecimiento. Las hojas jóvenes parecen saludables, pero las viejas toman un color parduzco y mueren (Rimache, 2008). Estas características se ajustan a lo observado en el azorizario en los puntos 8 y 9. Así mismo, la deficiencia de fósforo, está asociada a otros desórdenes nutricionales como toxicidad de hierro a bajo pH, deficiencia de hierro, salinidad y alcalinidad del suelo. Estas últimas características no se ajustan a la concentración de hierro registrada en los puntos 8 (640 ppm) y 9 (143 ppm) (Rimache, 2008).

Los resultados foliares de *Azolla* mostraron porcentajes homogéneos de nitrógeno tanto en el azollario como en el azorizario, con valores de 5.06 %N en el punto 9 y 4.57 %N en el punto 3. Un rango normal es de 2.6–5.7 %N (Sanginga y Van Hove, 1989).
Los niveles de P se mostraron homogéneos en todos los puntos, correspondiendo al punto 9 el mayor valor (5.06)ppm, y al punto 3 el menor valor (4.57)ppm; por esto se presume que el fósforo no influye en la coloración de *Azolla.*

En las hojas de *Azolla* hay una alta concentración de cationes (Ca++, K+ y Na+), mientras que la concentración de iones cloruro y el pH son menores en hojas viejas, que en otro grupo de hojas. La concentración de calcio contribuye al envejecimiento del vegetal y al mantenerse homogéneos los valores de calcio se infiere que el mismo no influye en la coloración de *Azolla* (Rimache, 2008).
Los valores correspondientes a las muestras foliares del arroz son homogéneos, excepto en el fósforo, sin embargo en el suelo, este elemento presenta una gran deficiencia en el punto 8.

Existen daños que son producidos por las algas en los arrozales, dependiendo de la especie y etapa del cultivo del arroz, las algas compiten por la disponibilidad de luz, nutrientes y oxígeno disuelto, produciendo clorosis y marchitez en las hojas de arroz, en consecuencia las algas dificultan la alimentación de las plántulas *(Rimache, 2008*). Siendo las algas tan acaparadoras, es probable que sean las responsables tanto de la clorosis de las hojas del arroz, como de la ausencia de *Azollas* en el punto 8 (azorizario).

Extraído y modificado de (Espinoza y Gutiérrez, 2003).

Característica	Suelo	Agua
	Rango	Rango
pH	5,2-7,4	7,4-8,6
*C.E. (mS/m)	0,03-0,4	0,14-11,9
**M.O (g/Kg)	1,9-46,8	-
P (ppm)	5,0-53,0	0,0-0,6
k(ppm)	24-272	1,27-6,5
Ca (ppm)	115-1395	11,6-286
Mg (ppm)	-	2,3-36-3
Fe (ppm)	-	1,53-11,9

Tabla 3. Rangos de concentración de ciertos parámetros para el suelo y agua.

CONCLUSIONES

Los niveles de especies químicas nitrogenadas como amonio y nitratos, han presentado diferencias que no apoyan al cambio de coloración en *Azolla*, es posible que esta variación sea más notoria realizando el análisis *In vitro*, mediante el cual es menos probable tener factores externos que puedan incidir sobre los resultados finales.
En el azorizario se obtuvieron datos finales muy variables con respecto a *Azolla* y su coloración. Posiblemente se deba a que la planta de arroz cubre al helecho en ciertas zonas más que en otras, permitiendo el paso de determinadas longitudes de onda de la luz.
Las diferencias en cuanto a ciertos nutrientes como el fósforo, hacen pensar que la forma de fertilización del suelo no es tan homogénea.
Las algas verdes tienen una taza de proliferación alta y compiten por el alimento, lo que podría incidir sobre la clorosis y las manchas marrones en las hojas del arroz.

RECOMENDACIONES

Para el análisis *In vivo*, es importante medir simultáneamente los niveles de clorofila (espectrofotometría según longitudes de onda) y la actividad enzimática de Nitrato Reductasa y Nitrogenasa (Reducción del acetileno), relacionando los resultados con su medioambiente. De igual manera, para el análisis *In vitro*, se debe medir la concentración de molibdeno, debido a la función que

desempeña en la actividad enzimática fijadora de nitrógeno y así determinar un posible stress en *Anabaena*.

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Evaluación preliminar de la aplicación del *Azolla* como fertilizante en plantas meristemáticas de banano William en el invernadero de SEBIOCA-ESPOL

Evaluación preliminar de la aplicación del *Azolla* como fertilizante en plantas meristemáticas de banano William en el invernadero de SEBIOCA-ESPOL

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Resumen

SEBIOCA (Sociedad Ecuatoriana de Biotecnología, www.sebioca.espol.edu.ec) es la responsable de la propagación y comercialización masiva de plantas meristemáticas, con el propósito de aumentar los rendimientos de la producción agrícola nacional de grandes y pequeños agricultores, lo que se consigue aplicando procesos estrictos biotecnológicos y de control de calidad. El banano al igual que todas las plantas, necesita para crecer principalmente agua y nitrógeno, es decir, riego y fertilización. Los cultivos de banano en el país se extienden a 266 124 ha de sembrío y utilizan tradicionalmente urea como abono, en cantidades que alcanzan anualmente 14 637 t [3]. Azolla es un diminuto helecho acuático flotante que alberga en sus hojas a la cianobacteria Anabaena. El simbionte Azolla-Anabaena es un demostrado bioabono para el arroz y demás cultivos del Ecuador y por esta razón se ha propuesto extender su uso a través de los Proyectos "Desarrollo del Recurso Azolla Anabaena y Aplicaciones en los Sectores Agrícola, Acuícola y Pecuario" (SENACYT) y "Converting Rice Fields into Green Fertilizer Factories" (Banco Mundial . En Sebioca-espol se propuso probar las bondades del Azolla como fertilizante de banano para lo cual se establecieron 7 tratamientos, cada uno con 5 plantas, a las que se abonó con Azolla (BanAnAzo) más los fertilizantes utilizados regularmente por Sebioca. Las dosis utilizadas de BanAnAzo fueron de 200 g, 400 g y 600 g por plántula. Se pudo demostrar de manera preliminar en el experimento que el Azolla reemplaza a los fertilizantes químicos nitrogenados en el cultivo de banano, ya que el tratamiento con 400 g de BanAnAzo produjo el mejor desarrollo en altura, números de hojas y diámetro del seudotallo de las plántulas.

Palabras Claves: *Azolla, Anabaena, bioabono, plantas meristemáticas, banano.*

Abstract

SEBIOCA (Ecuadorian Biotechnology Society, www.sebioca.espol.edu.ec) is responsible for mass propagation and marketing of meristematic plants, with a view to enhancing the performance of national agricultural production of large and small farmers, which is achieved by applying strict biotechnological processes and quality control. Bananas, like all plants, needs to grow mostly water and nitrogen, ie, irrigation and fertilization. The banana plantations in the country cover 266 124 ha and use urea as traditional fertilizer in amounts that reach 14 637 t annually [3]. Azolla is a tiny floating aquatic fern containing in its leaves the cyanobacterium Anabaena. The Azolla-Anabaena symbiotic is a shown biofertilizer for rice and other crops in Ecuador and for this reason it has proposed to extend its use through the projects "Desarrollo del Recurso Azolla Anabaena y Aplicaciones en los Sectores Agrícola, Acuícola y Pecuario" (SENACYT) and "Converting Rice Fields into Green Fertilizer Factories" (World Bank). In SEBIOCA-ESPOL set out to prove the benefits of Azolla as a biofertilizer for bananas for which seven treatments were set, each with five plants, which was fertilized with Azolla plus fertilizers used regularly by SEBIOCA. The doses used of Azolla were 200 g, 400 g and 600 g per plant. It could be demonstrated in a preliminary experiment that Azolla replaces the nitrogen chemical fertilizers in the cultivation of bananas, and that treatment with 400 g of Azolla produced the best height growth, leaf number and pseudostem diameter of plants.

Keywords: *Azolla, Anabaena, biofertilizer, plant meristem, banana.*

1. Introducción

SEBIOCA (Sociedad Ecuatoriana de Biotecnología, www.sebioca.espol.edu.ec) es un concepto académico empresarial de la Escuela Superior Politécnica del Litoral (ESPOL) dirigido a la propagación y comercialización masiva de plantas meristemáticas. El propósito es aumentar los rendimientos de la producción agrícola nacional de grandes y pequeños agricultores, lo que se consigue aplicando procesos estrictos biotecnológicos y de control de calidad. Las etapas más importantes de esta evolución incluyen cuarentena, para descartar presencia de microorganismos patógenos, propagación "in Vitro" y aclimatación final en invernadero, utilizando, entre otros materiales, sustratos fertilizantes procedentes. El agricultor recibe, de esta manera, plántulas de excelente calidad genética y fitosanitaria.

El banano contiene 75 % de agua, 22 % de carbohidratos, principalmente azúcares, y el resto está constituido por minerales, vitaminas A y C, grasas y proteínas. El banano es un producto de alto valor alimenticio, especialmente para los niños, mujeres embarazadas y ancianos [1].

Ecuador posee condiciones climáticas adecuadas para el cultivo de banano, esto es, abundante luz solar, buena calidad del suelo y ambiente cálido y húmedo; sin embargo, en un mercado cada vez más competitivo en el cual la permanencia en el negocio ya no depende solo de buenos precios, los mejoramientos tecnológicos, se convierten en elementos determinantes para su sustentabilidad [1, 2].

El banano al igual que todas las plantas, necesita para crecer principalmente agua y nitrógeno, es decir, riego y abono. Los cultivos de banano en el país se extienden a 266 124 ha de sembrío y utilizan tradicionalmente urea como abono, en cantidades que alcanzan anualmente 14 637 t [3].

En el Instituto de Ciencias Químicas y Ambientales (ICQA) de la ESPOL, hace mucho tiempo se plantearon distintas iniciativas que basadas en los conocimientos de química y en los recursos naturales nacionales, pudieran traducirse en bienes y servicios, útiles al sector productivo. Entre otras respuestas a dichas inquietudes, desde el año 2000 se viene trabajando en la temática de *Azolla* [4],

Azolla es un diminuto helecho acuático flotante que alberga en sus hojas a la cianobacteria *Anabaena.* El simbionte *Azolla-Anabaena* es un demostrado abono verde para el arroz y demás cultivos del Ecuador y por esta razón se ha propuesto extender su uso a través de los Proyectos "Desarrollo del Recurso Azolla Anabaena y Aplicaciones en los Sectores Agrícola, Acuícola y Pecuario" [5] y "Converting Rice Fields into Green Fertilizer Factories" [5a] con auspicio de la SENACYT (Secretaría Nacional de Ciencia y Tecnología) y el Banco Mundial respectivamente.

La incorporación del *Azolla* a la agricultura representa la aplicación plena de los preceptos de la soberanía alimentaria, en la medida en que se garantiza el acceso físico, económico y ecológico a alimentos inocuos y nutritivos para la unidad familiar, la localidad y el país [6]. En esta misma línea, SEBIOCA ensaya sustratos de fertilización que le brinden autonomía y economía, y que sean amigables con el medio ambiente. De otro lado este trabajo se enmarca en la misión nacional de generación de conocimiento tropical [7].

El objetivo general de este trabajo es determinar la eficiencia del abono *Azolla* como sustrato orgánico en plantas meristemáticas de banano William en invernadero, a través de los parámetros de altura y diámetro del seudotallo.

2. Materiales y métodos

2.1. Materiales y equipos

Los materiales utilizados en el experimento incluyeron: (a) 12 kg de *Azolla* seca (BanAnAzo), 16 kg de sustrato agrícola de SEBIOCA (SUS); (b) 35 plantas meristemáticas de banano William, de 5 cm de altura; (c) fertilizante sin nitrógeno (SEBIOCA-N) y (d) fertilizante nitrogenado (SEBIOCA-N) compuesto de sustrato (SUS), 1.5 g/L sulfato de amonio, 2.5 g/L nitrato de potasio y 1g/L Nitrofosca Foliar.

El sustrato agrícola de SEBIOCA (SUS) se compone de suelo franco limoso (25 %) y tamo de arroz (75 %). El fertilizante sin nitrógeno (SEBIOCA-N) se compone de sulfato de potasio (3 g/L), Novaplex (1.2 cc/L), Basfoliar Algae (4 cc/L) y Fertilom Combi (0.5 g/L). El fertilizante nitrogenado (SEBIOCA+N) se compone sulfato de amonio (1.5 g/L), nitrato de potasio (2.5 g/L) y Nitrofosca Foliar (1g/L).

El riego se realizó de forma manual en todos los tratamientos. En el caso de fertilización con BanAnAzo (T1, T2, T3) el riego consistió exclusivamente de agua, en el caso de los tratamientos T4, T5 y T6 se utilizó una solución acuosa de SEBIOCA-N, y en el tratamiento T7 se utilizó una mezcla de soluciones acuosas de SEBIOCA-N y SEBIOCA+N.

Los equipos que se usaron en la medición de los parámetros de control incluyeron: pHmetro RUSSELL RL060P- ORION TERMO, Conductímetro RUSSELL RL060C- ORION TERMO, Medidor de Clorofila SPAD-502 Konica Minolta, Termohidrógrafo CONTROL COMPANY y Luxómetro TRACEABLE.

2.2. Diseño experimental

El ensayo se llevó a cabo en las instalaciones sebioca entre el 5 de marzo y el 13 de mayo del 2010. El diseño experimental se estableció con 7 tratamientos, incluyendo un tratamiento testigo; cada tratamiento estuvo compuesto de 5 plantas de banano acompañado de los materiales de cultivo, como se muestra en la Tabla 1.

Para determinar los requisitos de fertilización nitrogenada del experimento se tomaron en consideración criterios bibliográficos [8] así como de informantes clave [9]; de otro lado, las características del *Azolla* fertilizante (BanAnAzo) se derivaron del Proyecto *Azolla* (Tabla 2). De esta manera se estableció que la aplicación adecuada de BanAnAzo por planta, en 8 semanas, era de 400 g. Para probar otras condiciones se aplicaron también 600 g/planta y 200 g/planta (Tabla 1).

Tabla 1. Características del diseño

Trata-miento	Plantas	BanAnAzo (g)	SUS (g)	SEBIOCA-N	SEBIOCA+N	Riego
T1	5	2000	2000			Agua
T2	5	1000	3000			Agua
T3	5	3000	1000			Agua
T4	5	2000	2000	(+)		Solución SEBIOCA-N
T5	5	1000	3000	(+)		Solución SEBIOCA-N
T6	5	3000	1000	(+)		Solución SEBIOCA-N
T7	5	0	4000	(+)	(+)	Solución SEBIOCA+N

Simbología:
T = Tratamiento.
SEBIOCA-N = Tratamiento normal de SEBIOCA sin aplicación de productos que contengan Nitrógeno.
SEBIOCA+N = Tratamiento normal de SEBIOCA con aplicación de productos que contengan Nitrógeno.
BanAnAzo = Abono de *Azolla* utilizado en el experimento.
SUS= Sustrato agrícola usado por SEBIOCA.

Tabla 2. Cálculos del diseño experimental

Categoría	**Valor**	**Referencia**
Aplicación (kg N/ha/año)	180	INIAP [8]
Siembra (plantas/ha)	1400	SEBIOCA [9]
Experimento (semanas)	8	SEBIOCA [9]
Requerimiento (g N/ planta)	19.78	
Características del abono (BanAnAzo)		
Azolla fresca-Humedad (%)	90	Proyecto Azolla [4]
N-Az (%) de Azolla seca	5	Proyecto Azolla [4]
Humedad-BanAnAzo (%)	12	Proyecto Azolla [4]
Aplicación BanAnAzo (g/ planta)	449.6	

La medición de los parámetros pH, Conductividad, Luminosidad, Temperatura, Humedad y Clorofila (Tabla 2), se extendió durante 8 semanas, que corresponden a un ciclo en el invernadero. Estas mediciones se efectuaron una vez por semana, así como las mediciones de los parámetros físicos establecidos en el ensayo, incluyendo número de hojas, altura y diámetro del seudotallo de las plantas.

2. 2. Estadística

El análisis estadístico de los parámetros establecidos en este trabajo se realizó con el software de aplicación general INFOSTAT, con el cual se aplicó estadística descriptiva con las medidas resumen: media y desviación estándar (DE), con objeto de observar el comportamiento y desarrollo de las plantas en cada uno de los tratamientos. Los parámetros sometidos a estadística fueron la altura de las plantas como en diámetro del seudotallo.

Se utilizó análisis de la varianza (ANAVA) para probar las hipótesis referidas de los parámetros establecidos en el ensayo, a más de la Prueba de Duncan de comparación múltiple, conocida también como prueba de rangos múltiples, y de esta forma establecer cuál fue el mejor tratamiento.

3. Resultados y discusión

El primer resultado fue que las plantas de los tratamientos 3 y 6, es decir a las que se aplicó 600 g de BanAnAzo por planta, se marchitaron y murieron; por esta razón no se presentan registros de T3 y T6 en la Tabla 3. Esta Tabla contiene además los rangos de resultados de los distintos parámetros de control. En el caso de luminosidad, temperatura y humedad, se registraron dentro (interna) y fuera (externa) del invernadero. Los demás parámetros se midieron en el ámbito que se indica en la Tabla 3.

Tabla 3. Parámetros de control

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Parámetro	Rangos	Ámbito de medición
pH agua (u)	6.3 - 7.1	Agua de riego
Conductividad (µS)	243 - 330	Agua de riego
Luminosidad interna (lux)	3800 - 98000	Interior del Invernadero
Luminosidad externa (lux)	3100 - 41200	Exterior del Invernadero
Temperatura interna (°C)	28 - 35	Interior del Invernadero
Temperatura externa (°C)	29 - 36	Exterior del Invernadero
Humedad interna (%)	48 - 85	Interior del Invernadero
Humedad externa (%)	50 - 84	Exterior del Invernadero
Clorofila T1 (%)	38.5 - 56.14	Segunda hoja de cada planta
Clorofila T2 (%)	42.52 - 50.48	Segunda hoja de cada planta
Clorofila T4 (%)	44.7 - 57.54	Segunda hoja de cada planta
Clorofila T5 (%)	41.7 - 56.6	Segunda hoja de cada planta
Clorofila T7 (%)	36.5 - 64.18	Segunda hoja de cada planta

La evolución del crecimiento de las plantas a lo largo de las 8 semanas de experimentación se muestra en la Tabla 4, en donde, cada valor es resultado promedio de 5 plantas. En las Figuras 1 y 2, por su lado, se aprecian las plantas en la primera y octava semana de crecimiento.

Tabla 4. Promedios de altura, diámetro y números de hojas

Semana/	0	1	2	3	5	7	8
Tratamiento	Altura promedio (cm)						
T1	5.0	6.0	6.5	8.4	13.4	27.6	35.0
T2	5.0	6.3	6.3	8.3	9.8	21.1	24.8
T4	5.0	6.3	6.5	8.5	11.6	21.9	27.8
T5	5.0	6.4	6.8	10.0	14.4	26.2	29.6
T7	5.0	5.6	7.0	8.8	12.8	24.4	30.6

	Diámetro promedio (cm)						
T1	0.48	0.59	0.67	1.12	1.45	2.34	3.00
T2	0.41	0.60	0.7	1.04	1.24	1.94	2.26
T4	0.39	0.58	0.65	0.96	1.26	1.94	2.46
T5	0.49	0.66	0.69	1.25	1.49	2.30	2.45
T7	0.41	0.59	0.66	1.12	1.47	2.28	2.79
	Número de hojas promedio (u)						
T1	3.0	3.50	4.40	6.20	5.20	7.50	6.00
T2	3.3	3.64	4.52	6.04	4.96	6.60	5.48
T4	3.2	3.76	4.40	5.92	4.80	6.80	5.24
T5	3.0	3.72	4.56	6.56	5.52	7.44	5.56
T7	3.2	3.72	4.64	6.60	5.28	7.44	5.80

En la Tabla 5 se presentan las mediciones de las plantas en la octava semana que sirvieron de base para los análisis estadísticos.

Tabla 5. Mediciones de control de las plantas

Trat.	Altura (cm)	Diám. (cm)	Hojas (u)
1	34	3.1	6.2
1	34	2.9	5.2
1	35	3.0	6.4
1	36	3.0	6.2
1	36	3.0	5.4
2	24	2.4	6.2
2	23	2.0	4.2
2	28	2.3	5.4
2	25	2.2	6.2
2	24	2.4	5.4
4	27	2.4	4.4
4	29	2.5	5.4
4	28	2.6	4.4
4	28	2.4	6.4
4	27	2.4	5.6
5	26	2.4	5.4
5	32	2.8	6.4
5	30	2.3	4.0
5	32	2.3	5.8
5	28	2.5	6.2
7	27	2.7	5.4
7	31	2.8	5.4
7	31	2.8	6.2
7	34	3.0	6.6
7	30	2.8	5.4

Figura 1. Primera semana de crecimiento

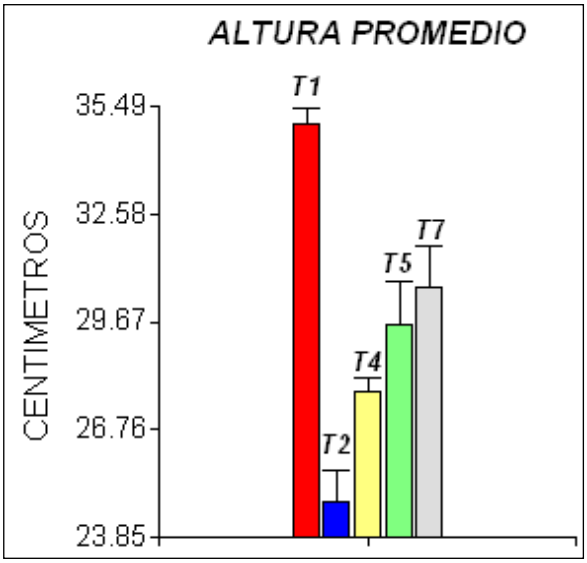
Figura 2. Octava semana de crecimiento

3.1. Altura

Tabla 6. Estadística descriptiva de la altura de las plantas en la 8va semana del ensayo

Variable	n	Media	D.E.	Mín	Máx
T1	5	35.00	1.00	34.00	36.00
T2	5	24.80	1.92	23.00	28.00
T4	5	27.80	0.84	27.00	29.00
T5	5	29.60	2.61	26.00	32.00
T7	5	30.60	2.51	27.00	34.00

Figura 3. Altura promedio de las plantas en las 8va semana del ensayo



Variable	N	R²	R² Aj	CV
ALTURA (cm)	25	0.79	0.75	6.51

Cuadro de Análisis de la Varianza (SC tipo III)

F.V.	SC	gl	CM	F	p-valor
Modelo	282.16	4	70.54	19.06	<0.0001
TRATAMIENTO	282.16	4	70.54	19.06	<0.0001
Error	74.00	20	3.70		
Total	356.16	24			

Test:Duncan Alfa=0.05

Error: 3.7000 gl: 20

TRATAMIENTO	Medias	n			
1.00	35.00	5	A		
7.00	30.60	5		B	
5.00	29.60	5		B	C
4.00	27.80	5			C
2.00	24.80	5			D

Letras distintas indican diferencias significativas(p<= 0.05)

Cuadro 1. Análisis estadístico con el test de Duncan de la variable altura de las plántulas

De la Tabla 6, Figura 3 y Cuadro 1 se observa que:

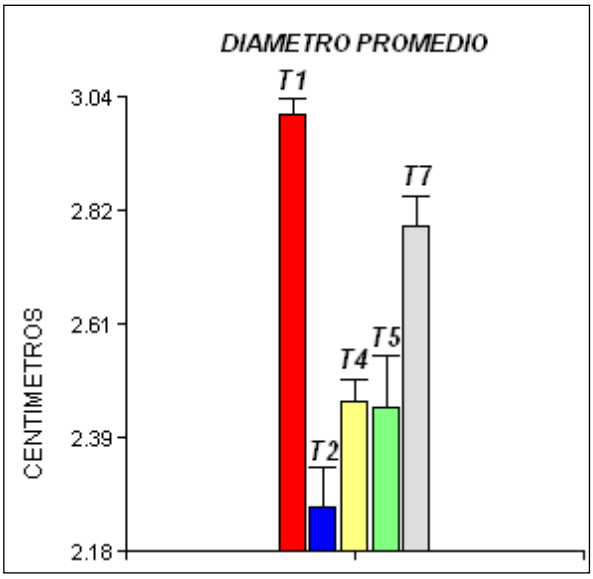
(a) La cantidad de plántulas (5) de cada tratamiento se representa por (n).
(b) La media (altura promedio) por tratamiento de las plántulas de banano que presentó el más alto valor corresponde al tratamiento T1.
(c) La D.E. (desviación estándar) de la altura que hay entre las plantas de cada tratamiento presentó la menor dispersión en el tratamiento T1.
(d) La altura mínima (Mín) y máxima (Máx) de cada tratamiento que presentó mejor resultado es el tratamiento T1 con una altura mínima de 34 cm y máxima de 36 cm entre sus plántulas.
(e) El mejor tratamiento en relación al T7 (control) según el test de Duncan es el T1 con una altura promedio de 35 cm por planta
(f) El peor tratamiento es el T2 con una altura promedio de 24.80 cm por plántula.
(g) El tratamiento T7 (control) presentó una altura promedio de 30.6 cm por plántula siendo superado solo por T1

3.2. Diámetro

Tabla 7. Estadística descriptiva del diámetro de las plantas en la 8va semana del ensayo

Variable	n	Media	D.E.	Mín	Máx
T1	5	3.00	0.07	2.90	3.10
T2	5	2.26	0.17	2.00	2.40
T4	5	2.46	0.09	2.40	2.60
T5	5	2.45	0.21	2.30	2.80
T7	5	2.79	0.13	2.65	3.00

Figura 4. Diámetro promedio de las plantas en las 8va semana del ensayo



Variable	N	R^2	R^2 Aj	CV
DIAMETRO (cm)	25	0.81	0.77	5.53

Cuadro de Análisis de la Varianza (SC tipo III)

F.V.	SC	gl	CM	F	p-valor
Modelo	1.77	4	0.44	21.50	<0.0001
TRATAMIENTO	1.77	4	0.44	21.50	<0.0001
Error	0.41	20	0.02		
Total	2.18	24			

Test:Duncan Alfa=0.05

Error: 0.0205 gl: 20

TRATAMIENTO	Medias	n			
1.00	3.00	5	A		
7.00	2.79	5		B	
4.00	2.46	5			C
5.00	2.45	5			C
2.00	2.26	5			D

Letras distintas indican diferencias significativas(p<= 0.05)

Cuadro 2. Análisis estadístico con el test de Duncan de la variable Diámetro de las plántulas

De la Tabla 7, Figura 4 y Cuadro 2 se observa que:

(a) La cantidad de plántulas (5) de cada tratamiento se representa por (n).
(b) La media (diámetro promedio) que presentó el más alto valor corresponde al tratamiento T1.
(c) La D.E. (desviación estándar) del diámetro mostró la menor dispersión en el tratamiento T1.
(d) El diámetro mínimo (Mín) y máximo (Máx) que presentó mejor resultado corresponde al tratamiento T1 con un diámetro mínima de 2.9 cm y un diámetro máximo de 3.10 cm.
(e) El mejor tratamiento en relación al T7 (control) según el test de Duncan es el tratamiento T1 con un diámetro promedio de 3 cm por plántula.
(f) El peor tratamiento es el T2 con una diámetro promedio de 2.26 cm por plántula.
(g) El tratamiento T7 (control) presentó un diámetro promedio de 2.79 cm por planta siendo superado solo por T1.

4. Conclusiones

Los análisis estadísticos señalan que el mayor crecimiento, expresado tanto en altura como diámetro de las plántulas, correspondió al abonado exclusivamente con 400 g de *Azolla* por plántula, es decir, al tratamiento T1.

El mayor promedio de hojas por plántula se evidenció asimismo en el tratamiento T1.

El uso exclusivo de *Azolla* como abono activa, al parecer, una serie de ciclos biogeoquímicos que potencian el cultivo del banano.

Este, se considera un estudio preliminar, y es deseable que se realicen otros, por ejemplo con poblaciones de mayor número de plántulas. También se debería estudiar la química y microbiología del suelo relacionada a la aplicación del *Azolla*. Muchos compuestos comerciales vigorizadores del crecimiento de las plantas están fabricados con soluciones de aminoácidos y el *Azolla* contiene una buena cantidad de ellos [10]. En estudios de Awodum [11] se aprecia claramente que el *Azolla* aumenta la materia orgánica y la porosidad del suelo, lo mismo que biodispone de fósforo, potasio, calcio, magnesio y sodio a esta matriz.

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Annex 12

Doctoral Thesis: Guayas Ecosystem (Ecuador): Resources, Environment and Sustainability in Tropical Knowledge perspective

Mariano Montaño Armijos
Universidad Miguel Hernández de Elche
April 2011

Summary

Guayas Ecosystem is the Ecuador's representative tropical area that includes the Gulf of Guayaquil and related watersheds (Figure 1). This place, for its exceptional planetary location, biodiversity and productivity, is destined to become the unique natural laboratory of humanity to build tropical knowledge, science and technology, what is in early development, and constitutes urgent need for tropical countries society. This issue, moreover, opens renewed paths to trigger institutional and business actions in Ecuador and friendly countries.

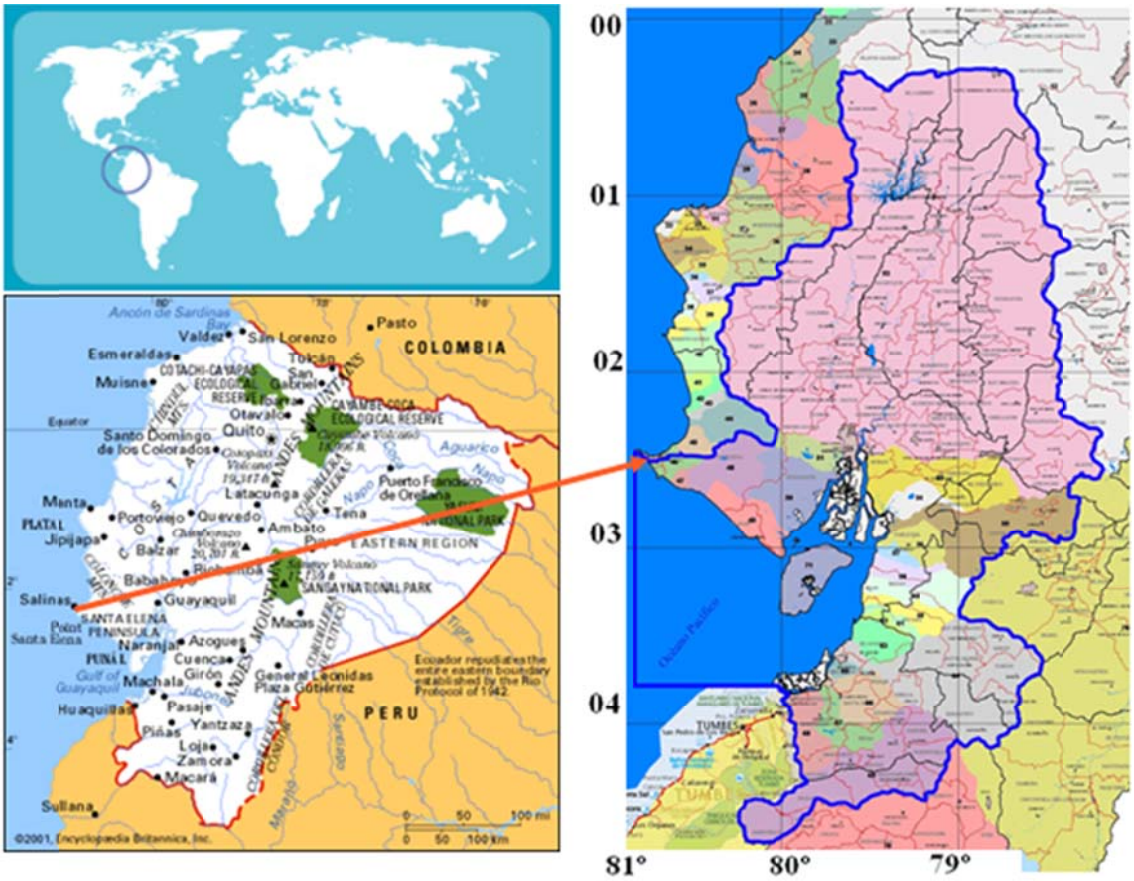

Figure 1. Guayas Ecosystem (bordered in blue)

Main part of the development of Ecuador is founded on Guayas Ecosystem through agriculture, livestock and aquaculture, fishing, mining, navigation, tourism and towns. The products of this ecosystem to more than satisfy domestic consumption cover up with diversity the global market. In this regard, it is urgent to garner knowledge to manage the ecosystem, integrating resources, environment and sustainability, which can become a model for national and international action.

The variety of natural resources and Guayas Ecosystem productivity represent basic elements of the socio-economic system development, although the extraction, processing and utilization of products, generate inevitable waste that return and deteriorate the ecosystem. In this sense, here is the main challenge of today's civilization, which is to promote a harmonious formula of economic development, social equity and environmental sustainability.

This Ph.D. thesis aims, as one of its main objectives, to position the Guayas Ecosystem in the consciousness of Ecuador and the world, as an exclusive place for tropical knowledge generation and to offer tropical enviromental services on a global scale.

The articles included and discussed in the doctoral thesis represent a comprehensive framework of key issues concerning the Guayas Ecosystem. These works start with basic concepts about environment and sustainability in Guayas Ecosystem (Montaño and Sanfeliu, 2008), on the other hand, emphasize oceanographic resources, estuarine and mangrove forests (Twilley et al., 1998) which leave room for the shrimp industry (Montaño and Navarro, 1996). These studies highlighted the quality of coastal ecosystems and water facing of ecological and economic constraints to proper management of mangroves and shrimp ponds (Twilley et al., 1999).

Working for about 15 years on Guayas Ecosystem and for 10 on specific projects, it is discovered a binding element of human and nature events: nitrogen (N). This element, biologically fixed through the *Azolla* superorganism (Carrapico, 2010) in rice ecosystem will generate new paradigms in the farming system, food, health, economic and environmental aspects of the country.

Guayas Ecosystem is a place, an opportunity, a way of working, a way of thinking and living. It is the natural laboratory that humanity has in order to create tropical knowledge, almost nonexistent but highly necessary.

Some knowledge generated in the Guayas Ecosystem are already available to the community and relate primarily to the *Azolla*, nitrogen and indicators of sustainability, that may represent broad initial objectives of work to be done.

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Anexo 13

CONVENIO No. 037 -DAJ-JC - 2011

CONVENIO MARCO DE COOPERACIÓN INTERINSTITUCIONAL ENTRE LA ASOCIACIÓN DE MUNICIPALIDADES ECUATORIANAS Y LA ESCUELA SUPERIOR POLITECNICA DEL LITORAL

La Asociación de Municipalidades Ecuatorianas, "AME", a la que en adelante se podrá hacer referencia por su nombre, por su sigla o como **"LA ASOCIACIÓN"**, legalmente representada por el Dr. Víctor Paúl Granda López, en calidad de Presidente del Comité Ejecutivo, por una parte; y, por otra, la Escuela Superior Politécnica del Litoral a la que en lo posterior se le denominará por su nombre o por su sigla, **"ESPOL"**, representada por el Phd. Moisés Tacle Galárraga, en su calidad de Rector, debidamente autorizados, convienen en celebrar el presente Convenio Marco de Cooperación Técnica Interinstitucional de conformidad con las siguientes cláusulas:

PRIMERA: ANTECEDENTES.-

a) La Asociación de Municipalidades Ecuatorianas, es una institución autónoma de derecho público, con personería jurídica establecida por el Código Orgánico de Organización Territorial, Autonomía y Descentralización, cuyos fines se encuentran establecidos en dicho cuerpo legal y en los Estatutos que la rigen, relacionados con la representación oficial de los Gobiernos Autónomos Descentralizados Municipales. Impulsa la defensa de la autonomía, el fortalecimiento de la gestión y gobernabilidad local, a través de procesos de cooperación, asistencia, capacitación y asesoría especializada, en coordinación con sus oficinas técnicas regionales en todo el país.

b) La Escuela Superior Politécnica del Litoral es una institución de educación superior, persona jurídica de derecho público, sin fines de lucro, autónoma en lo académico, administrativo, financiero y orgánico, tiene la facultad de buscar la verdad en los distintos ámbitos. Se rige por las disposiciones de la Constitución de la República, la Ley Orgánica de Educación Superior y su Reglamento General, por el Decreto Ejecutivo No. 1664 del 29 de octubre de 1958 mediante el cual se creó la ESPOL, por su Estatuto y Reglamentos.

c) La Escuela Superior Politécnica del Litoral, entre uno de sus objetivos prioritarios propende a la búsqueda de la verdad, el desarrollo cultural, el dominio del conocimiento científico y tecnológico, expresado a través de la investigación, la docencia y la vinculación con la colectividad, mediante la ejecución de programas de investigación en los campos de la ciencia, la tecnología, las artes, etc, realizando actividades netamente de trabajo académico con los diferentes sectores de la sociedad para

programas de apoyo a la comunidad a través de consultorías, asesorías, investigaciones, estudios, capacitación u otros medios.

d) La AME y la ESPOL tienen por mutuo interés apoyarse en la gestión de programas y proyectos de servicio a la comunidad, desarrollo económico, asistencia técnica y capacitación que permitan, de una parte, el desarrollo de habilidades y destrezas profesionales de los educandos; y, de otra, el fortalecimiento institucional de los gobiernos locales y el mejoramiento de vida de la población.

e) El Dr. Mario Montaño, catedrático de la ESPOL ha desarrollado un paquete tecnológico aplicable al cultivo del cacao que incluye un fertilizante natural destinado a revolucionar al paradigma agrícola nacional y mundial.

f) Que dicho paquete tecnológico ha sido debidamente comprobado y aplicado en el agro con resultados exitosos en los cultivos de arroz y banano.

g) Que instituciones como el Banco Mundial, PROMSA y la Secretaria Nacional Técnica de Ciencia y Tecnología, SENACYT, han colaborado apoyando a la investigación de dicho paquete tecnológico.

h) Que el desarrollo de este abono natural basado en un helecho acuático, fertiliza el arroz y su excedente se lo utiliza en los cultivos del cacao; de ahí que, los municipios arroceros podrán beneficiarse de este proyecto y de estas corrientes científicas.

SEGUNDA: OBJETO DEL CONVENIO.-

Con los antecedentes expuestos, las partes acuerdan celebrar el presente Convenio Marco de Cooperación Interinstitucional, cuyo objeto es apoyar el proyecto para el desarrollo del cacao, en los municipios con vocación agrícola solucionando los problemas de la comunidad y fortalecer la economía local. Para cuyo fin se realizará una reunión de alcaldes de aquellos municipios con vocación agrícola y arroceros a fin de presentar el proyecto tecnológico, el mismo que se hará con la presencia de técnicos municipales y un expositor chileno. Promover el desarrollo del proyecto tecnológico aplicado a través de un fertilizante natural y estas corrientes científicas.

TERCERA: OBLIGACIONES DE LAS PARTES.-

Con los antecedentes expuestos, la ESPOL y la AME, asumen los compromisos y las obligaciones mediante el cual las partes se comprometen, respectivamente, a lo siguiente:

I.- La Escuela Superior Politécnica del Litoral por intermedio del Decano de la Facultad de que designe el Rector, se compromete a:

a) Difundir el paquete tecnológico entre los municipios con vocación agrícola.

b) Organizar en coordinación con la AME los estudios, los eventos de capacitación, análisis, y otras actividades académicas que sea menester para el cumplimiento del objeto de este convenio. Todos los trabajos serán realizados bajo la responsabilidad profesional del personal docente de la ESPOL.

c) Propiciar la participación de docentes universitarios o estudiantes, conforme a su disponibilidad, en calidad de instructores, facilitadores, investigadores, recolectores o sistematizadores de información, según corresponda, en los eventos de capacitación o en los programas de asistencia técnica que la AME oferta a los gobiernos municipales con vocación agrícola.

II.- La Asociación de Municipalidades Ecuatorianas, se obliga a:

a) Facilitar cupos a los docentes y estudiantes en todos los eventos de capacitación

b) Facilitar y promover pasantías de los docentes y estudiantes de la ESPOL en los municipios beneficiarios del proyecto previa autorización de estos.

c) Coordinar las acciones y demandas de los municipios para la difusión del paquete tecnológico desarrollado por la ESPOL.

d) Solicitar con anticipación debida los estudios, proyectos programados y la capacitación que requiriere para la realización de las actividades y de los procesos de investigación.

CUARTA: PROCEDIMIENTO DE EJECUCION DE LAS OBLIGACIONES.-

Para efectos de la ejecución y cumplimiento de las obligaciones señaladas en este convenio, la parte interesada remitirá a la otra su requerimiento indicando específicamente el ámbito, actividades, lugar, personal que deberá involucrarse y las condiciones que asumirá la peticionaria en el proyecto o acción de asistencia técnica, capacitación, investigación, que pretende ejecutar, para lo cual se firmarán convenios específicos.

QUINTA: COORDINACIÓN.-

La coordinación, gestión, seguimiento, monitoreo y evaluación del presente Convenio estará a cargo del Coordinador Técnico de la ESPOL y la persona que designe la AME, en el plazo de 15 días a partir de la suscripción de este instrumento, delegación que será comunicada por escrito a la ESPOL y que pasará a formar parte del convenio, como documento anexo.

SEXTA: RÉGIMEN FINANCIERO.-

El presente Convenio Marco por sí solo no genera obligaciones financieras recíprocas para las partes, las cuales de generarse deberán instrumentarse independientemente, conforme la correspondiente disponibilidad presupuestaria y de asignación de recursos de cada entidad.

SEPTIMA: RÉGIMEN LABORAL.-

Por la naturaleza del presente Convenio ni la AME ni la ESPOL adquieren relación laboral ni de dependencia, respecto del personal de la otra entidad que trabaje en la ejecución del mismo.

OCTAVA: USO DE LA INFORMACIÓN Y CRÉDITOS INSTITUCIONALES.-

Todo el material comunicacional, de promoción, difusión o capacitación utilizado para el desarrollo de las actividades relacionadas con la ejecución del Convenio, serán aprobados de manera conjunta y difundidos previa aprobación de las partes suscriptoras. Dichos materiales incluirán los créditos institucionales de las partes conforme corresponda, de acuerdo a sus políticas de imagen institucional.

Podrá hacer uso de los materiales anteriormente mencionados, cualquier entidad particular, siempre y cuando cuente con la autorización de las instituciones relacionadas con la ejecución del presente Convenio.

NOVENA: VIGENCIA.-

Este Convenio Marco tendrá un plazo de duración de dos años contados a partir de la fecha de su celebración, plazo que podrá renovarse de mutuo acuerdo en función del cabal cumplimiento de las obligaciones de las partes, con una anticipación de por lo menos treinta días a la fecha prevista para la conclusión del plazo.

DECIMA: COMUNICACIONES.-

Cualquier aviso relativo a la ejecución del Convenio deberá hacerse por escrito y deberá ser remitido a la institución correspondiente, a la dirección señalada como domicilio en el presente instrumento.

DÉCIMA PRIMERA: TERMINACIÓN DEL CONVENIO.-

Este Convenio Marco puede darse por terminado por las siguientes causas:

a) Por cumplimiento del plazo del Convenio;

b) Por mutuo acuerdo de las partes, siempre que no se afecte a terceros;

c) Por sentencia ejecutoriada que declare la terminación o nulidad del Convenio, a pedido de cualquiera de las partes;

d) Por fuerza mayor o caso fortuito que hagan imposible la ejecución del Convenio; en este supuesto se deberá proceder con la terminación de mutuo acuerdo; y,

e) Por declaración de terminación unilateral debido al incumplimiento del Convenio, o por no convenir la ejecución del presente a los intereses de una o ambas Instituciones. Esta declaración deberá ser comunicada a la contraparte por escrito y con una anticipación de por lo menos treinta días a la fecha prevista para la terminación anticipada, notificación que operará de forma automática una vez transcurrido dicho plazo.

En todo caso, concluida la vigencia del Convenio Marco, las partes se encuentran en la obligación de realizar una evaluación mutua de su cumplimiento y proceder a la suscripción de un acta de terminación, en la que se dejará constancia de las obligaciones generadas como consecuencia del convenio que quedaren pendientes de solución, así como las alternativas y responsables de su seguimiento hasta su culminación.

DÉCIMA SEGUNDA: MODIFICACIONES.-

De considerarlo pertinente las partes podrán proponer cualquier modificación de las estipulaciones del presente Convenio. Las modificaciones que se acuerden se estipularán por escrito y se introducirán como adéndum a este documento.

DÉCIMA TERCERA: SOLUCION DE CONTROVERSIAS.-

En caso de que surgiere un conflicto o controversia, las partes se someten libre y voluntariamente al proceso de mediación establecido en la Ley de Arbitraje y Mediación publicada en el Registro Oficial No. 145 del 04 de septiembre de 1997. Sin embargo, para el caso en el cual la divergencia no pueda ser resuelta por mutuo acuerdo entre ellas, las partes determinaran que las controversias se someterán, a la resolución en derecho de los jueces árbitros de la ciudad de Quito de conformidad con las disposiciones de la Ley de Arbitraje y Mediación.

El número de árbitros será de tres, que serán designados de común acuerdo entre las partes. Todo proceso será confidencial y se resolverá en derecho. Mediante esta cláusula las partes renuncian expresamente a la jurisdicción ordinaria. Las partes estipulan acudir al Centro de Mediación de la Procuraduría General del Estado.

DÉCIMA CUARTA: DOMICILIO.-

Para efectos de comunicaciones o notificaciones, las partes señalan como su domicilio, las siguientes direcciones:

- **Escuela Superior Politécnica del Litoral - Guayaquil -** Ecuador Campus Gustavo Galindo, Km. 30.5 Via Perimetral, teléfono: 2 269269 www.espol.edu.ec

- **Asociación de Municipalidades Ecuatorianas:** Agustín Guerrero E5-24 y José María Ayora Teléfono: 246-9367. www.ame.gob.ec, Quito.- Ecuador.

En caso de cambio de domicilio es obligación de la parte que lo genere, el informar por escrito a la contraparte institucional, la nueva dirección que deberá tenerse en cuenta para tales efectos.

DÉCIMA QUINTA: DOCUMENTOS HABILITANTES.-

Forman parte integrante del Convenio, los siguientes documentos:

a) Copia certificada del nombramiento como representante legal de la ESPOL.
b) Copia certificada del nombramiento del Dr. Paúl Granda López, como Presidente de la AME.

DÉCIMA SEXTA: ACEPTACION.-

Para constancia, en fe de aceptación y compromiso, de todas y cada una de las cláusulas de este Convenio, proceden a suscribirlo en dos ejemplares de igual tenor y valor, en la ciudad de Quito, Distrito Metropolitano, a 05 JUL 2011

Dr. Víctor Paúl Granda López
Presidente de la Asociación de Municipalidades Ecuatorianas

Phd. Moisés Tacle Galárraga
Rector de la Escuela Superior Politécnica del Litoral

Los Municipios son la Patria

2008 Global Development Marketplace
Project: 5381 Converting Rice Field into Green Fertilizer Factories

Project Budget Disbursements Summary (Final configuration)

Disbursement	First DM Disbursement	Second DM Disbursement	Third DM Disbursement
Funding Period	**8-Jl-09; 7-Sp-10**	**8-Sp-10; 28-Ap-11**	**29-Ap-11; 7-Jl-11**
Sources of Funds			
1. DM Grant	98 376.00	59 025.60	39 350.40
2. Other Funds:			
(a) Revenue generated from project			
(b) Other Donors			
Total Project Funds	98 376.00	59 025.60	39 350.40
Budget for DM Funds			
I. Use of DM Grant Funds			
A. Works	5 000.00	3 000.00	2 000.00
B. Goods (Materials and Equipment)	17 926.00	10 755.60	2 210.52
C. Services:			
(1) Personnel Costs	33 574.00	20 144.40	15 109.60
(2) Consultants	5 800.00	0.00	1 406.88
(3) Training and Workshop Facilities	15 882.00	13 009.20	8 672.80
(4) Travel	13 995.00	8 397.00	7 471.00
(5) General Administration/Overhead	6 199.00	3 719.40	2 479.60
D. Other (please specify)			
Subtotal: Use of DM Grant Funds	98 376.00	59 025.60	39 350.40
II. Use of Other Funds (revenue generated + other donors)			
Total Use of Funds	98 376.00	59 025.60	39 350.40

Date of approval of the budget amendment 15/02/2011

2008 Global Development Marketplace
Project: 5381 Converting Rice Field into Green Fertilizer Factories
1st Disburment Financial Report
Current Reporting Period
Funding Period: 8-July-2009; 7-September-2010

		Received	Planned (as recorded in previous progress report)	Difference (Received - Planned)	Expected to Receive for next Reporting Period
Sources of Funds					
1. DM Grant		98 376.00	98 376.00	0.00	59 025.60
2. Other Funds:					
(a) Revenue generated from project					
(b) Other Donors					
Total Project Funds		98 376.00	98 376.00	0.00	59 025.60
	Expensed	**Committed as of 07-jun-2010 date**	**Budgeted (as recorded in previous progress report)**	**Difference = (Expensed + Commitment - Budgeted)**	**Budget for next Reporting Period (*)**
Budget and Expenses					
I. Use of DM Grant Funds					
A. Works	5 000.00	0.00	5 000.00	0.00	3 000.00
B. Goods (Materials and Equipment)	11 262.88	6 663.12	17 926.00	0.00	10 755.60
C. Services:					
(1) Personnel Costs	25 134.00	8 440.00	33 574.00	0.00	20 144.40
(2) Consultants	3 584.00	2 216.00	5 800.00	0.00	0.00
(3) Training and Workshop Facilities	15 662.00	220.00	15 882.00	0.00	13 009.20
(4) Travel	10 449.52	3 545.48	13 995.00	0.00	8 397.00
(5) General Administration/Overhead	5 429.17	769.83	6 199.00	0.00	3 719.40
D. Other (please specify)					
Subtotal: Use of DM Grant Funds	76 521.57	21 854.43	98 376.00	0.00	59 025.60
II. Use of Other Funds (revenue generated + other donors)					
Total Use of Funds	76 521.57	21 854.43	98 376.00	0.00	59 025.60

Account Balance: Project Funds Received (total from all sources) minus Total Use of Funds (expensed and committed)
21 854.43

(*) Note: Total budget for the next reporting period should be equal to the sum of the account balance from the current reporting period plus the expected reciept of funds

Executed budget in the period (%) **77.78**

2008 Global Development Marketplace
Project: 5381 Converting Rice Field into Green Fertilizer Factories
2nd Disbursement Financial Report
Current Reporting Period
Funding Period: 8-September-2010; 28-April-2011

	Received	Planned (as recorded in previous progress report)	Difference (Received - Planned)	Expected to Receive for next Reporting Period
Sources of Funds				
1. DM Grant	59 025.60	59 025.60	0.00	39 350.40
2. Other Funds:				
(a) Revenue generated from project				
(b) Other Donors				
Total Project Funds	59 025.60	59 025.60	0.00	39 350.40

	Expensed	Committed as of Jan 07, 2011 date	Budgeted (as recorded in previous progress report)	Difference = (Expensed + Commitment - Budgeted)	Budget for next Reporting Period (*)
Budget and Expenses					
I. Use of DM Grant Funds					
A. Works	3 000.00	0.00	3 000.00	0.00	2 000.00
B. Goods (Materials and Equipment)	5 221.79	5 533.81	10 755.60	0.00	7 170.40
C. Services:					
(1) Personnel Costs	18 062.00	2 082.40	20 144.40	0.00	13 429.60
(2) Consultants	0.00	0.00	0.00	0.00	0.00
(3) Training and Workshop Facilities	9 695.00	3 314.20	13 009.20	0.00	8 672.80
(4) Travel (**)	8 594.83	0.00	8 397.00	197.83	5 598.00
(5) General Administration/Overhead	3 417.57	301.83	3 719.40	0.00	2 479.60
D. Other (please specify)		.			
Subtotal: Use of DM Grant Funds	47 991.19	11 232.24	59 025.60	197.83	39 350.40
II. Use of Other Funds (revenue generated + other donors)					
Total Use of Funds	47 991.19	11 232.24	59 025.60	197.83	39 350.40

Account Balance: Project Funds Received (total from all sources) minus Total Use of Funds (expensed and committed)

11 034.41

(*) Note: Total budget for the next reporting period should be equal to the sum of the account balance from the current reporting period plus the expected reciept of funds
(**) The travel overdraft will be regularized with the 3rd disbursement.

Executed budget up Jan 07, 2011 (%) **81.31**

2008 Global Development Marketplace
Project: 5381 Converting Rice Field into Green Fertilizer Factories
3rd Disbursement Financial Report
Current Reporting Period
Funding Period: 29-April-2011; 7-July-2011

	Received	Planned to expend	Difference (Received - Planned)
Sources of Funds			
1. DM Grant	39 350.40	39 350.40	0.00
2. Other Funds:			
(a) Revenue generated from project			
(b) Other Donors			
Total Project Funds	39 350.40	39 350.40	0.00

	Expensed	Committed as of July 07, 2011 date	Budgeted	Difference = (Expensed + Commitment - Budgeted)
Budget and Expenses				
I. Use of DM Grant Funds				
A. Works	2 000.00	0.00	2 000.00	0.00
B. Goods (Materials and Equipment)	2 210.52	0.00	2 210.52	0.00
C. Services:				
(1) Personnel Costs	15 109.60	0.00	15 109.60	0.00
(2) Consultants	1 406.88	0.00	1 406.88	0.00
(3) Training and Workshop Facilities	8 672.80	0.00	8 672.80	0.00
(4) Travel	7 471.00	0.00	7 471.00	0.00
(5) General Administration/Overhead	2 479.60	0.00	2 479.60	0.00
D. Other (please specify)		.		
Subtotal: Use of DM Grant Funds	39 350.40	0.00	39 350.40	0.00
II. Use of Other Funds (revenue generated + other donors)				
Total Use of Funds	39 350.40	0.00	39 350.40	0.00

Account Balance: Project Funds Received (total from all sources) minus Total Use of Funds (expensed and committed)

0.00

Executed budget up July 07, 2011 (%) **100.00**

2008 Global Development Marketplace
Project: 5381 Converting Rice Field into Green Fertilizer Factories

Summary execution of the project budget

	First DM Disbursement 8-Jl-2009; 7-Sp-2010			Second DM Disbursement 8-Sp-2010; 28-Ap-2011			Third DM Disbursement 29-Ap-2011; 7-Jl-2011		
	Budgeted	Expensed	Committed	Budgeted	Expensed	Committed	Budgeted	Expensed	Committed
Sources of Funds									
1. DM Grant	98 376.00			59 025.60			39 350.40		
2. Other Funds:									
(a) Revenue generated from project									
(b) Other Donors									
Total Project Funds	98 376.00			59 025.60			39 350.40		
Budget for DM Funds									
I. Use of DM Grant Funds									
A. Works	5 000.00	5 000.00	0.00	3 000.00	3 000.00	0.00	2 000.00	2 000.00	0.00
B. Goods (Materials and Equipment)	17 926.00	11 262.88	6 663.12	10 755.60	5 221.79	5 533.81	7 170.40	2 210.52	4 959.88
C. Services:									
(1) Personnel Costs	33 574.00	25 134.00	8 440.00	20 144.40	18 062.00	2 082.40	13 429.60	15 109.60	1 680.00
(2) Consultants	5 800.00	3 584.00	2 216.00	0.00	0.00	0.00	0.00	1 406.88	1 406.88
(3) Training and Workshop Facilities	15 882.00	15 662.00	220.00	13 009.20	9 695.00	3 314.20	8 672.80	8 672.80	0.00
(4) Travel	13 995.00	10 449.52	3 545.48	8 397.00	8 594.83	197.83	5 598.00	7 471.00	1 873.00
(5) General Administration/Overhead	6 199.00	5 429.17	769.83	3 719.40	3 417.57	301.83	2 479.60	2 479.60	0.00
D. Other (please specify)									
Subtotal: Use of DM Grant Funds	98 376.00	76 521.57	21 854.43	59 025.60	47 991.19	11 034.41	39 350.40	39 350.40	0.00
II. Use of Other Funds (revenue generated + other donors)									
Total Use of Funds	98 376.00	76 521.57	21 854.43	59 025.60	47 991.19	11 034.41	39 350.40	39 350.40	0.00