

CASE

Power from swine manure for industry's internal use (Sadia, Concordia, Brazil)

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Supporting case for Business Model 5

Location:	Concórdia, Brazil
Waste input type:	Swine manure
Value offer:	Energy (Biogas to electricity and thermal energy) carbon credit and bio-fertilizer
Organization type:	Private
Status of organization:	Operational since 2003
Scale of businesses:	Large
Major partners:	Swine farmers, Brazilian Development Bank (Amazon Fund), United Nations (Carbon market), Bio-digester vendors, Espírito Santo University (for measurements of biogas)

Executive summary

Sadia is one of the world's leading producers of chilled and frozen foods with approximately 10,000 integrated poultry and pork farms, which supply raw material to its industrial plants. In order to abate the environmental impacts associated with its swine production farms and to institute sustainability into the pork meat supply chain, Sadia designed and implemented the Program for Sustainable Swine Production (3S Program) in 2003. The 3S Program provides swine producers with bio-digesters and is designed to reduce GHG emissions from the more than 3,500 swine producers in Sadia's supply chain and to qualify the emission reductions as a Clean Development Mechanism (CDM) project. Sadia installs the bio-digesters on its swine producers on a B&T (Build and Transfer) basis. The program seeks to bring sustainability to the company's supply chain by providing additional revenue from carbon credits and better working conditions for swine producers, while reducing the environmental impact associated with swine production. The biogas generated at the swine farms is used on-site and thus significantly saving operational costs for the swine farms. The program contributes to improving the local environmental condition by improving quality of water and reducing soil pollution and foul odors. Moreover, the 3S Program is expected to help disseminate environmental education among swine producers and the surrounding community. Through the design and implementation of the 3S Program, Sadia has incorporated environmental sustainability into its revenue design.

KEY PERFORMANCE INDICATORS (AS OF 2012)

Land:	The bio-digesters installed at the individual swine farms					
Capital investments:	For the whole 3S Program USD 28 million					
Labor:	Provided by the individual swine farms					
O&M cost:	Provided by the individual swine farms					
Output:	Biogas for onsite use; In 2006 290,000 tons of CO ₂ -eq carbon credit sold and 2.5 million tons CO ₂ -eq under agreement					
Potential social and/or environmental impact:	CO ₂ offset, improved working conditions of swine farms, improvement in local environmental condition, improvements in water quality and reduction of soil pollution and foul doors.					
Financial viability indicators	Payback period:	5 to 10 years*	Post-tax IRR:	N.A.	Gross margin:	N.A.

*Depending on the value of Certified Emissions Reductions Certificates (CERs)

Context and background

Sadia, established in 1944, is one of the world's leading producers of chilled and frozen foods in Brazil. It is one of the country's main exporters of meat-based products. As of 2008, Sadia had about 20 industrial plants that together produced over 2.3 million tons of food, including chicken, turkey, pork and beef, pasta, margarine, desserts and other products. Recognizing the increasing influence of social and environmental issues associated with swine production systems in its supply chain, Sadia designed and implemented the 3S Program in 2003. Developed and managed by the Sadia Sustainability Institute, the 3S Program seeks to institute sustainability into the pork meat supply chain by improving animal waste management while providing additional revenue to individual farmers from carbon credits.

The 3S Program provides more than 3,500 swine producers with bio-digesters and is designed to reduce GHG emissions from the swine producers and to qualify the emission reductions as a CDM project. With the program, at least three million litres of swine excrement will be processed daily, a volume equal to 5% of the total swine waste volume produced in Brazil. The voluntary program began at three of Sadia's own swine farms, functioning as prototypes to be extended to its outsourced producers.

Market environment

A significant number of swine facilities in Sadia's chain did not have an environmental permit. Environmental licenses were expensive and not all farmers were aware of their importance or how to obtain them. Most of the manure produced was disposed in groundwater, streams and rivers without adequate treatment, and as a result, nearby communities were affected by water and soil pollution, as well as by the unpleasant odor. Through the implementation of bio-digesters under the 3S Program, swine farmers are able to manage and treat swine manure and reduce GHG emissions. Swine farmers have the opportunity to diversify their income generating activities and increase their farm profits through revenues from selling carbon credits and from reduced energy costs as gases captured from the bio-digester are used by the farms. By reducing costs and creating the possibility for diversifying income sources, Sadia hopes to encourage the small producers to stay in the business.

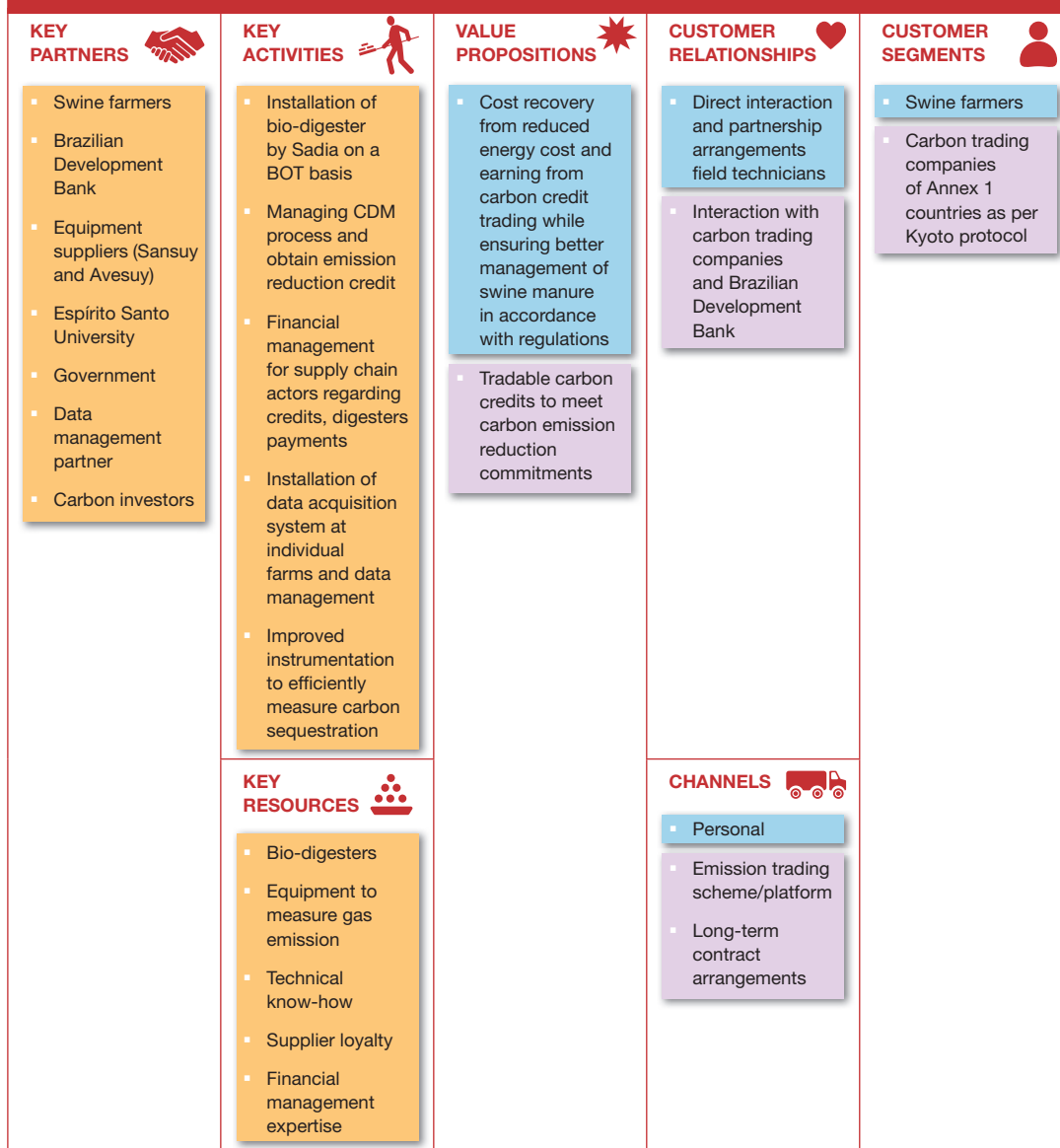
Sadia expected that about 50% of the producers would want to participate in the 3S Program. By early 2007, 96% had signed a contract indicating willingness to participate in the program. The other 4% were large swine farms that are already prepared or were preparing to individually operate in the carbon credit market. The program is implemented in 30% of facilities. In May 2006, Sadia and

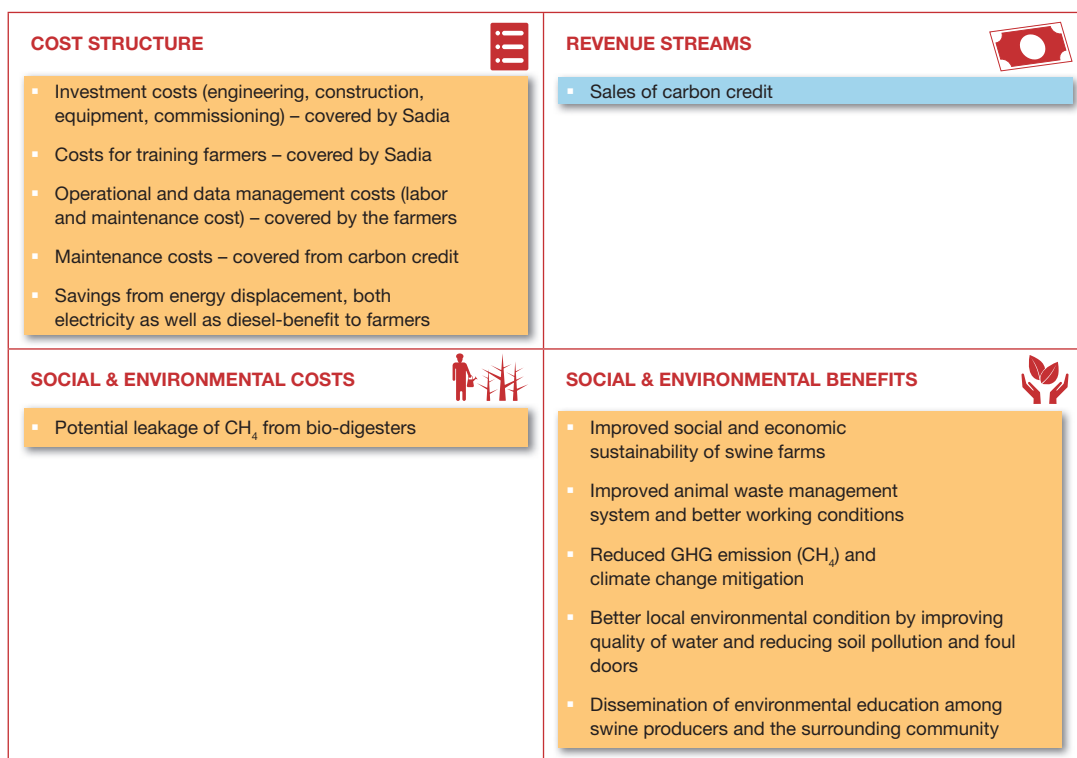
the Sadia Institute sold the first carbon credits generated by the 3S Program. Sadia sold 290,000 tons from its own farms of which 50,000 tons were sold at 11 €/ton, and the rest were based on the European Allowance Market Index. The European Carbon Fund also bought approximately 2.5 million tons of carbon from the institute to be sequestered by the swine farms.

Macro-economic environment

Brazil is one of the major producers and exporters of pork accounting for 10% of the world pork production and exports with annual sales of over USD 1 billion. However, the intensive swine production industry resulted in significant environmental impact as a result of the higher amounts of

FIGURE 56. SADIA BUSINESS MODEL CANVAS





waste generated in these operations. Swine manure has the potential to impact soil, air and water resources requiring proper management, treatment and disposal.

In a mechanism of the Kyoto Protocol, projects in developing countries that mitigate GHG emissions can apply for certificates of emission reduction, most commonly known as carbon credits. These are certificates emitted by an internationally recognized institution, e.g. the UNFCCC, which attests that a certain amount of GHG (usually measured as a ton of CO₂) has been mitigated. Once obtained, these certificates can be traded on the market and exchanged for money. The sale of carbon credits could be enough, according to Sadia's studies, to cover the cost of the bio-digesters. However, applying for the certificates was a rather difficult and expensive process. Brazil has a target to reduce its overall GHG emissions by 36.1% to 38.9% below 1990 levels in 2020. Brazil has been leading in terms of the numbers of CDM project activities after China and India.

Business model

Sadia installs the bio-digesters at its swine producers on a Build and Transfer basis (Figure 56). The participation of swine producers in the program is voluntary. One of the success factors of implementing the 3S Program is the fact that Sadia Institute was able to obtain funds from the Brazilian Development Bank, thus enabling small and medium swine producers to take part in the program. This is a good example of innovative financing mechanism in the waste reuse business. The financing arrangement is that Sadia Institute owns all the equipment installed in the farmers' facilities for the purpose of the 3S Program and is responsible for managing the CDM benefits. The institute trades carbon credits on the carbon trading market. The amount obtained is then shared with farmers, according to each potential emission reduction, after deduction of the investment made in the bio-digesters and in the program implementation and operation costs. In approximately five years, when the farmers finish

paying the Institute for it, the bio-digesters and all related equipment will change hands and be owned by the farmers. The program benefits both parties. Sadia is able to increase supplier loyalty and secure supply in the light of environmental regulation. Farmers benefit from improved management of swine manure. Moreover, in addition to creating revenues from carbon credit trading, farmers are able to benefit from cost recovery due to reduced operational costs from using energy produced from the bio-digester and also the by-product from the fermentation process can be used as crop fertilizer or as food for fish breeding.

Value chain and position

Sadia created a non-profit entity called the Sadia Sustainability Institute, an independent non-profit organization in December 2004, to manage the 3S Program and to negotiate the carbon credits (Figure 57). The institute is responsible for managing the 3S Program including unifying the swine producers and building enough carbon credits to create a CDM project. The Sadia Institute (SI) borrowed R\$ 65.5 million (USD 36.11 million) from the Brazilian Developmental Bank (BNDES) for starting the implementation of the program. Sadia was the guarantor of the SI's loan for implementing the 3S Program.

The institute first identified the swine producers that could be potential participants. The role of the Sadia Institute is to provide the swine producers with information to procure the bio-digesters, identify the infrastructure needed at each facility and overall administration of the program. Two suppliers (Sansuy and Avesuy) were selected to provide the bio-digesters. Sadia also partnered with Espírito Santo University to develop new measuring equipment for measuring the gas emissions i.e. quantity of methane sequestered and amount of CO₂ produced. Once the bio-digesters are installed, the farmers are responsible for the operation of the bio-digester in their respective farms. The emission reductions qualify for the Kyoto Protocol's CDM program, under which Sadia Institute sells the carbon credits. The resulting surplus would be used to improve the social and environmental conditions of the participating farmers. Farmers pay back for the bio-digester from the carbon credit benefits on an installment basis.

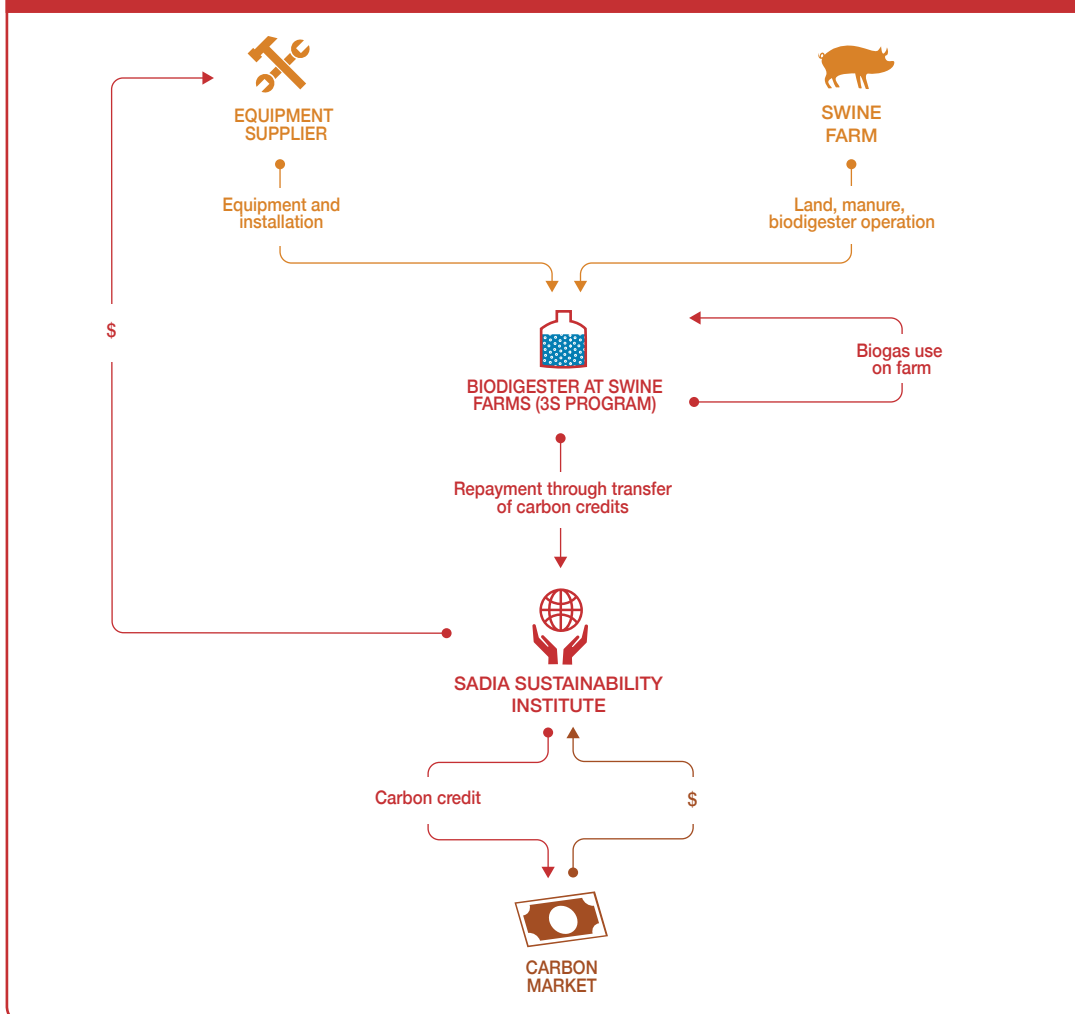
After validation of the biogas equipment by Sadia's engineers using the United Nations Framework Convention on Climate Change (UNFCCC) standards, the farmers will be able to use the biogas. However, if biogas is utilized, no CERs will be claimed for potentially displacing fossil fuels or grid electricity. The treated wastewater and mineralized sludge of the open-air lagoon is used for irrigation of surrounding crops.

Institutional environment

There are no national, state or local requirements providing for GHG emissions of agro-industrial operations (swine production) in Brazil. The state legislation on swine waste in Brazilian states determines that animal waste must have 120 days of retention in a non-permeable open-air lagoon for reduction of the organic load.

Since the 3S Program is registered as a CDM project, both the UNFCCC Kyoto protocol requirements and host country requirements apply. Along with the program implementation, auditing and verification of the program is expected. Such auditing is to be performed every semester by a designated operational entity, an independent auditor accredited by the CDM Executive Board, as determined by the UNFCCC.

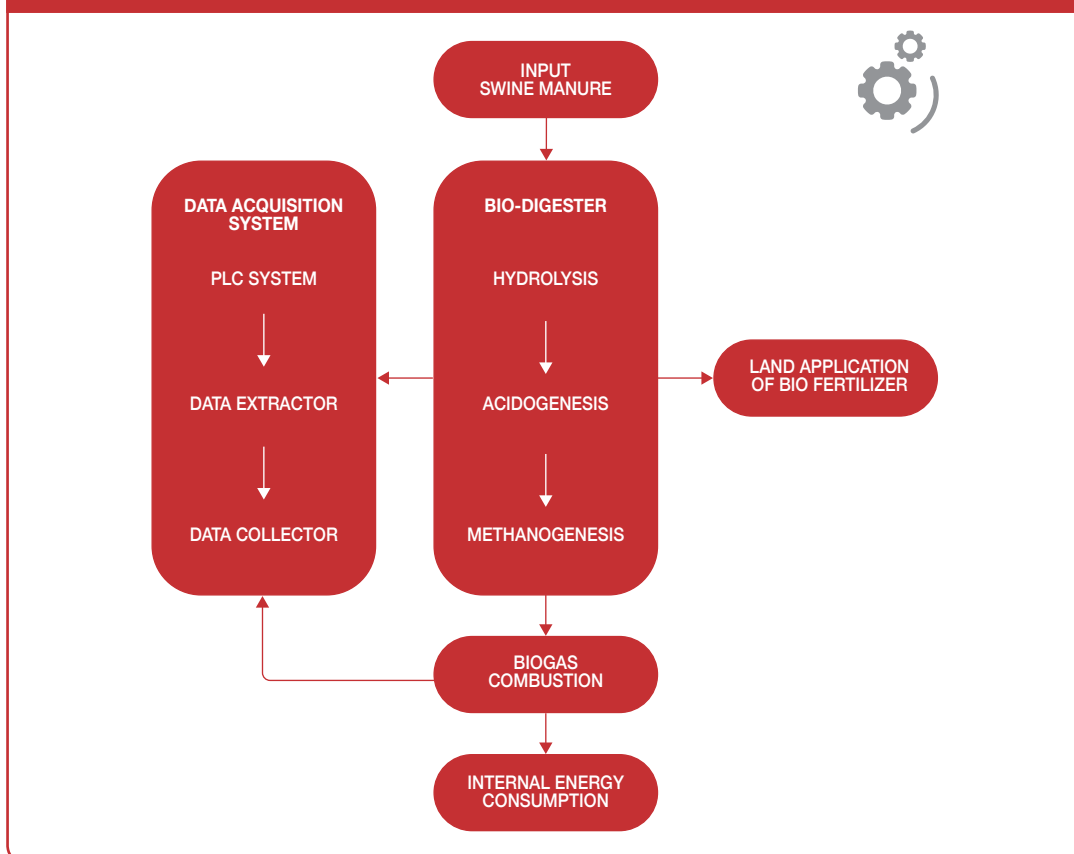
FIGURE 57. SADIA'S 3S PROGRAM VALUE CHAIN



Technology and processes

For all farms included in the 3S Program, the installed equipment follows identical standards. The technology comprises a bio-digester, a combustion system and an open-air lagoon in which to store the treated manure (Figure 58). A process for identifying each farm and data acquisition system is also installed at individual farm. A data system was developed by a software company to ensure that the information about each farm cannot be altered, manipulated or double-counted. This system works with a device called PLC (Programmable Logical Controller) that is installed in each enclosed flare system. It is responsible for the data sources (pressure, temperature, flow, farmer, maintenance and other variables) of the project and where the information is processed. This program operates the system automatically and provides all needed data for each farm. Several technologies are available for manure management in swine farms. However, the selection of a feasible technology should take into account not only technical and economic challenges but also particular farm characteristics. These include the number of housed animals, the available agricultural land for manure application and the opportunities for energy and organic fertilizer production for trading or local consumption.

FIGURE 58. SADIA'S BIO-DIGESTER PROCESS



Funding and financial outlook

The Amazon Fund, created in 2008, fosters a low-carbon economy by reducing GHG emissions, and that contributes decisively to improving not only the standard of living and preservation, but also the recovery and the rational use of its natural resources. The Amazon Fund is administered by the Brazilian Development Bank (BNDES) and aims to provide financing services for projects, which aim at the reduction of GHG emissions. This incentivizes companies, such as Sadia, to pursue CDM project activities.

The Sadia Institute (SI) borrowed money from a financial institution (R\$ 60 million) from BNDES (UNDP, 2007), approximately USD 33 million) for purchasing and installing the bio-digesters and the combustion system in the outsourced farms. SI owns all the equipment installed in the farmers' facilities for the purpose of the 3S Program. In approximately five years, when the producers finish paying the institute for it, the bio-digesters and all related equipment will change hands and be owned by the swine farmers. The institute negotiates carbon credits with the operational entity under the CDM. The institute takes a percentage of the revenue from the offsets to cover operational expenses, and the remainder is allocated to the producer. Before seeing any income from the credits, the producer pays for the bio-digester; the payment is estimated to take five years of installments.

The process of certification of the carbon credits was rather complex involving several steps and actors. The volume of gas burned as well as the temperature, pressure and other measurements are registered in a computer, which would be constantly monitored by Sadia's field work technicians.

Socio-economic, health and environmental impact

The 3S Program initiated by Sadia provides additional revenue and improved working conditions for Sadia's swine producers, while reducing the environmental impact associated with swine production. The biogas generated can be used as energy in the farm, thus significantly saving operational costs. In addition, new business opportunities are created for the farmers, who can use the by-product from the fermentation process as food for fish breeding or as crop fertilizer and thus improve soil quality. The program contributes to improving the local environmental condition by improving quality of water and reducing soil pollution and foul odors. In addition, the 3S Program is expected to help disseminate environmental education among swine producers and the surrounding community.

Scalability and replicability considerations

The 3S Program was designed and implemented to reduce GHG emissions from swine producers in Sadia's supply chain and to qualify the emission reductions as a CDM project. This program can be used as a demonstration for other supply chains to replicate the program by incorporating environmental sustainability in their revenue design. In order for this program to be replicated in other developing countries with intensive livestock production, government support for projects, which aim at reducing GHG emissions coupled with innovative financing mechanism, is required.

The key drivers for the success of this business are:

- Innovative financing mechanism.
- Availability of financing organizations.
- Partnership among the different actors within the value chain.
- Foreseeing and eliminating regulatory problems relating to production permission in Sadia's swine supply chain.

SI plans to extend the program within its supply chain, including those suppliers that are not swine producers (for example, poultry and beef). SI plans to develop a "Sustainable Site Platform" in which it will give training for new agricultural commodities to be produced by its suppliers to diversify and increase their income. The platform aims to educate the producers on financial and management issues and thus creating entrepreneurs that are better prepared for the market.

Summary assessment – SWOT analysis

The key strength of Sadia is the application of innovative financing mechanism to implement the 3S Program and thus fostering strong partnership with its swine farmers (Figure 59). Availability of financing organizations such as the Amazon Fund which provide financing services for projects which aim at the reduction of GHG emissions and government support for CDM are the key opportunities for the business to further expand its 3S Program. However, sustainability of the 3S Program highly depends on carbon credit sales, the prices of which are volatile.

FIGURE 59. SWOT ANALYSIS FOR SADIA

	HELPFUL TO ACHIEVING THE OBJECTIVES	HARMFUL TO ACHIEVING THE OBJECTIVES
INTERNAL ORIGIN ATTRIBUTES OF THE ENTERPRISE	STRENGTHS <ul style="list-style-type: none"> ▪ Innovative financing mechanism ▪ Strong partnership with swine farmers ▪ Ensures following environmental regulation in supply chain ▪ Intensive swine farming (abundance of swine manure) ▪ Diversified income for farmers ▪ Natural process of dry fermentation ▪ The technicians' credibility and respect 	WEAKNESSES <ul style="list-style-type: none"> ▪ Highly dependent on carbon credit sales ▪ Farmer's lack of technical know-how to operate bio-digesters ▪ High technology cost ▪ High operation and maintenance costs ▪ A challenge to include the small producers to find a gauge to measure the gas emissions ▪ Consolidate a large number of carbon sequestrating facilities (bio-digesters)
EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	OPPORTUNITIES <ul style="list-style-type: none"> ▪ Availability of financing organizations ▪ Government support for CDM ▪ Carbon credit market opportunities ▪ High value bio-fertilizer for additional revenue ▪ High quality renewable fuel, biogas has several proven end-use applications ▪ Country's participation in the CDM projects 	THREATS <ul style="list-style-type: none"> ▪ Volatile carbon credit prices ▪ Possible leakage of CH₄ may significantly reduce the carbon credit earnings ▪ Delay in administrative proceedings ▪ Environmental laws are not enforced ▪ Financial challenge the sale realized after the plant is commissioned ▪ Consolidate a large number of carbon sequestrating facilities (bio-digesters)

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Case descriptions are based on primary and secondary data provided by case operators, insiders, or other stakeholders, and reflect our best knowledge at the time of the assessments (2013/2014). As business operations are dynamic, data can be subject to change.