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ESCOLA BRASILEIRA DE ADMINISTRAÇÃO PÚBLICA E DE EMPRESAS
MESTRADO EXECUTIVO EM GESTÃO EMPRESARIAL

A TECHNOLOGICAL INNOVATION FOR CAPSICUMS PRODUCTION IN PERU: THE MECHATRONIC ARMS

DISSERTAÇÃO APRESENTADA À ESCOLA BRASILEIRA DE ADMINISTRAÇÃO PÚBLICA E DE EMPRESAS PARA OBTENÇÃO DO GRAU DE MESTRE

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A TECHNOLOGICAL INNOVATION FOR CAPSICUMS PRODUCTION IN PERU: THE MECHATRONIC ARMS

ABSTRACT

Peru agricultural exports have increased in recent years due to (i) free trade agreements with many countries (United States, Canada, European Union, China, Thailand, Singapore, Japan, Chile, among others), (ii) an increasing international demand for healthy products, (iii) country´s economic development and (iv) more private investments in this sector (Velazco 2012).

Also, if we can compare among Peru three main regions (Coast, Andean highlands and the Jungle), It is the Coast (western region) that has a developed agricultural production due to unique weather conditions, private investments, public infrastructure, transport costs and quality of land (Gomez, 2008).

This country development is also related to the production of non-traditional products for export like asparagus, artichokes, capsicums, bananas, grapes, among others; produced by agro industrial companies and small farmers and that are mainly labor intensive (Gomez, 2008 and Velazco, 2012).

This very successful export diversification and self-discovery process was the result of a combination of strong natural comparative advantages (mainly excellent agro climatic conditions) and a significant innovation effort. It meant the introduction and expansion of new products and markets, the entry of new firms, and experimental research and the adoption of new techniques and process technologies developed abroad (in irrigation, crop management, post-harvesting, sanitary control, storage and packing) to produce high-quality, niche (gourmet) and higher value-added products, in line with consumer trends in sophisticated food markets. In products such as asparagus, mango, organic coffee and capsicums, Peru has become a leading world exporter (OECD).

For this reason one of the government main tasks for the next years is to meet urgent agriculture producer's needs in the areas of technological Innovation and business management (MINAG).

In this context, this thesis analyzes the applicability of a new technology – the mechatronic arms – specifically to capsicums production sector in Peru.

We chose Capsicums production sector (paprika, chilli pepper) because is mainly labor intensive and is the sector where my family company (DIROSE SAC) operates.

This innovation consists in a 40 arms mechatronic combine, and it was first created in order to improve the efficiency on the labor intensive phase of harvest for this kind of agriculture products.

It is estimated that a laborer with brief training operating the machine would be equivalent to 40 people that not only would work during daytime, but also on the night shift as well.

Also, using this new technology can allow a company to make additional crops that would increase their yields and annual revenues.

This thesis was developed as a business plan to make this new product available for other agriculture companies that operates in the capsicums production sector in Peru; however, this new technology has the potential to be modified in order to be available to other kind of agriculture products, in Peru and other countries.

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ACKNOWLEDGEMENTS

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1 INTRODCUTION

Peru is one of the region's fastest growing economies and is expected to remain as such in the medium term. Most recent estimates of real GDP growth for 2014 are above the regional average (3.5% vs 1.2% respectively). Inflation has been low within target range in 2013 (2.9%). A still favorable external environment, prudent macroeconomic policy, and deep structural reforms have combined to support this high growth, low inflation scenario in Peru (World Bank).

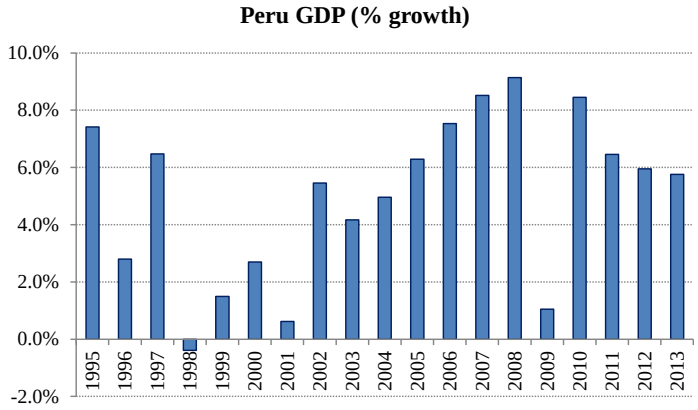


Figure 1: *Peru GDP growth rate*
Source: INEI

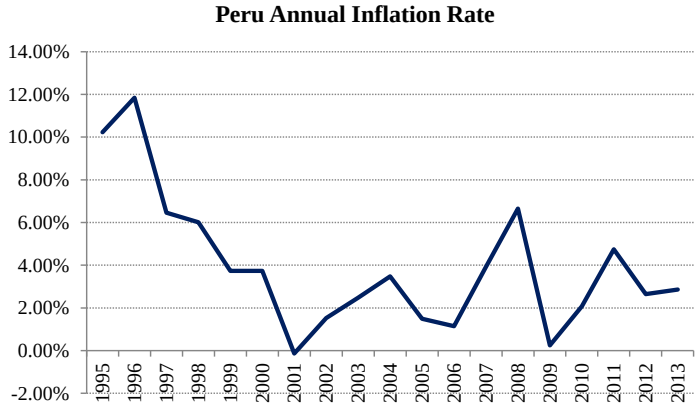


Figure 2: *Peru Annual Inflation rate*
Source: INEI

The effects of strong growth on employment and income have significantly reduced poverty rates and boosted shared prosperity. Between 2005 and 2013, poverty rates were more than halved, from about 45% to 24 % of the population (INEI).

Peru is on the Pacific coast of South America, along which it has 2,400 km of coast. Peru has a surface area of 1,285,216 square kilometers, making it the fourth largest Latin American nation. It is the largest of the Andean countries and borders Colombia and Ecuador in the north, Brazil and Bolivia in the east, and Chile in the south. Peru population of 28MM ranks fifth in the subcontinent and, as in most other South American countries, the population is largely urban (Vera, 2006).

Figure 3: *Peru Map*
Source: Peru government web page

Major geographic regions are the Coastal area (Costa), Andean highlands (Sierra) and the Jungle (Selva). Each area, however, contains special ecological niches and microclimates generated by Pacific Ocean currents, the wide range of Andean altitudes, solar angles and slopes, and the configurations of the vast Amazonian area.

In Peru, and contrary to what happens in most other Latin America countries, agriculture contributed with a small percentage to the gross national product (GDP) (Vera, 2006). Also, land with potential to be used for agriculture activities is very limited.

In this sense, one of Peru biggest challenges is to consolidate the agricultural growth. This objective will require the development of productive factors and the promotion of technological innovation. For this reason one of the government tasks for the following years is to meet urgent agriculture producer's needs in the areas of technological Innovation and business management (MINAG).

It is important to mention that as a result of a limited country's technological innovation policy, the respective indicators (such innovation index, degree of cooperation among technological entities; technological capability, and technological sophistication) of Peru show the lowest levels compared with other Latin American Countries and the United States (Palomino, 2012).

Also, unlike other Latin American countries, and despite a well-established academic tradition, Peru largely missed the opportunity to develop a strong public science and technology (S&T) infrastructure in its university system or public research institutes (PRIs) in the 1960s and 1970s. As a result, its S&T "supply side" has been insufficient. The resource endowments of these institutions and their performance in terms of knowledge generation and diffusion were often extremely weak. Peru continues to suffer from this situation, which is often aggravated by poor governance of PRIs (OECD).

In addition, changes in economic policy over successive political cycles were accompanied by sometimes drastic shifts in the role and orientation of S&T policy, thus hindering the emergence of a strong political consensus on the importance of investment in S&T for sustained and inclusive development and competitiveness. This led to low levels of resources for S&T and allocation conflicts and undermined the emergence of a coherent and articulated innovation system in which actors are more prone to engage in co-operation than to defend vested interests (OECD).

Compared to emerging economies and Latin American countries with similar levels of development or endowments, Peru devotes very few public or private resources to research and development (R&D). In 2004, the last year for which statistics – of uncertain reliability – are available, the R&D intensity of the Peruvian economy (the ratio of R&D expenditures to GDP)

was only 0.15% against 0.90% in Brazil, 0.65% in Chile, 0.43% in Mexico and 0.86% in South Africa.

Peru's weak performance in terms of innovation outputs, as measured by patents or productivity, reflects to some extent the low level of investment in physical and intangible knowledge assets as well as inefficiencies in the innovation system that result in inadequate returns to S&T-related investment. (OECD).

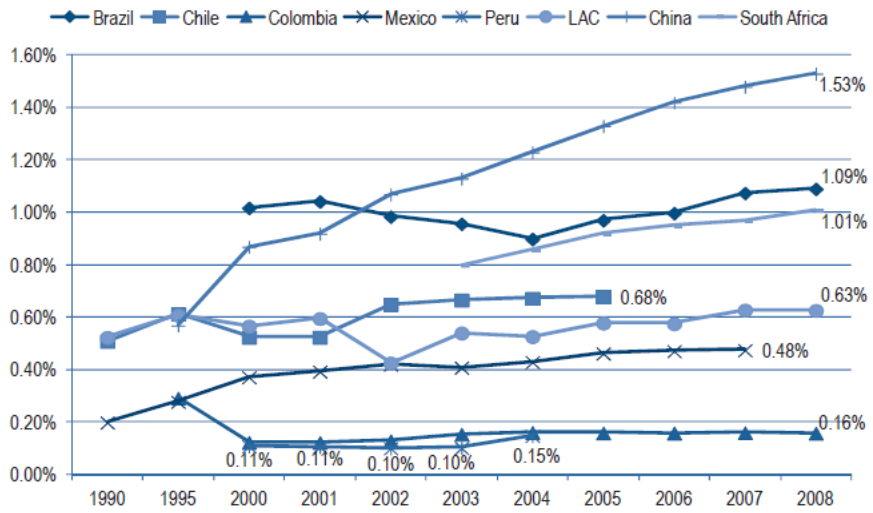


Figure 4: *R&D intensity, Peru and selected countries, 1990-2008*
Source: RICYT; IDB (2010a); OECD Main Science and Technology Indicators (MSTI)

In this context, we present a business plan for a technological innovation for the capsicum production sector in Peru – The mechatronic Arms..

DIROSE is an exporting family company, founded in October 2005, dedicated to the processing and commercialization of capsicum products. Its main products are (i) Sweet Paprika Powder and (ii) Press paprika pods and its exports go mainly to United States and Europe.

Also, managers at DIROSE SAC dedicate part of their time to research and development tasks. One of the recent R&D projects is the development of the mechatronic arms machine.

For this specific project, we hired a team of 5 mechatronic engineers who helped us to develop this new technology in several steps, being the most difficult the development of the software that identifies and separated the product from the plant.

The company has already obtained the respective patent from the government of Peru for this new technology and has tested this innovation in the field obtaining satisfactory results.

We consider this new technology as a great opportunity to improve agricultural companies ‘efficiency in the farm, as well as to improve the contribution of the agriculture sector to country´s GDP.

It is important to mention that for this thesis, I will focus the strategy on capsicum products (paprika, chilli pepper) sector in Peru; however, this new technology has the potential to be modified in order to be available to other kind of agriculture products, in Peru and other countries.

Figure 5: *Main capsicums producer's regions in Peru*
Source: DGCA – MINAG, Proinversión

1.1 OBJECTIVES

The general objective of this thesis is to prepare a business plan in order to support this new technology to big and middle size agricultural companies in Peru.

Also, we expect that from independent farmers segment, at least 25% will have purchased this new technology in the next 5 years.

It is important to mention that the selling proposition not only includes DIROSE support in the use of this new technology, but also the respective warranty services throughout the product life cycle.

1.2 MISSION

DIROSE SAC is a family company that always is looking for better agricultural practices in order to improve country competition and development.

DIROSE priority is the commitment to satisfy the necessities of clients with products of optimal quality.

The company looks for continuous progress in benefit of its clients, workers and the communities in which DIROSE operates.

According to Peru Central Bank, agriculture sector growth was below 1.5% in 2013 and is expected to reach only 1.6% in 2014 (BCRP).

In this sense, DIROSE SAC will have fulfilled its mission when all its clients have achieved growth rates above agriculture sector average rate, using this new technology.

1.3 KEYS TO SUCCESS

Important keys to success are:

- Focus on the target market: Drill down into several agriculture segments.
- High detailed planning and execution process: since it is a new technology, we need to monitor each step of the strategy and develop an efficient selling process.
- Quality services: DIROSE SAC will be not only the seller but also will give support to its clients to manage this new technology throughout the product life cycle.

- Financials must be adequate in order to make this product available to most of Peruvian companies and obtain profits from this new technology.

2 THE COMPANY

DIROSE SAC was founded in October 17th, 2005 by Diego Rosales Sepulveda and Miguel Angel Rosales Sepulveda.

It is an exporting company, dedicated to the processing and commercialization of agricultural products in the domestic and international markets being its main products (i) Sweet Paprika Powder and (ii) Press paprika pods.

Sweet Paprika Powder **Press paprika pods**

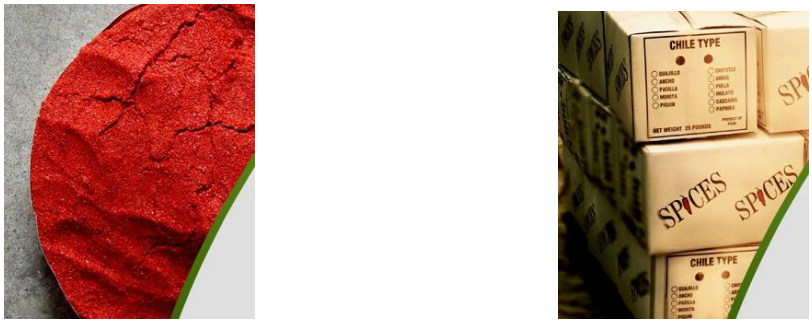


Figure 6: *DIROSE main products*
Source: DIROSE SAC

DIROSE Mission

Contribute to the success of its customers and employees by investing in people and technology and offering the best products in order to enhance the returns for its customers, shareholders and the communities in which DIROSE operates.

DIROSE Vision

To become an exporting company, leader in commercialization of agricultural products that satisfies the necessities and expectations of all its clients, in every market.

DIROSE core values

- Fulfill high standards of quality along the operational process.
- Deliver the products in the conditions previously agreed with the clients.
- Consistency on the supply and quality of the product.
- Maintain personnel with solid moral values.

DIROSE owns 112 hectares of land in the north western region of the country basically used for planting and processing capsicum products.

Figure 7: *DIROSE selection process in Zaña, Chiclayo*
Source: DIROSE SAC

Success and growth of DIROSE S.A.C. in recent years are:

- 500 hectares worth of processing capacity (112 from farm in Zaña, Chiclayo)
- Paprika powder exports mainly to USA, Israel, and Spain
- Current Paprika processing factory in Zaña, Chiclayo.

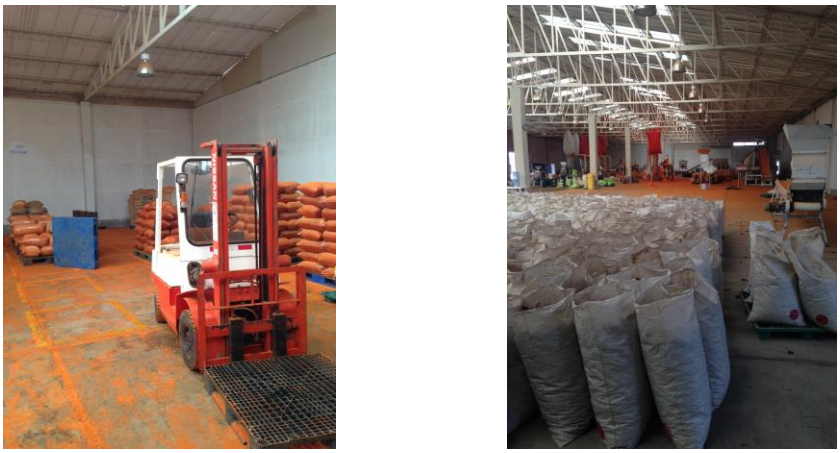


Figure 8: *DIROSE packaging process and facilities*
Source: DIROSE SAC

Strengths **S** • Short term operations with fast returns • 10 years of experience in the capsicums sector • Trained staff • R&D Capabilities	**Weaknesses** **W** • Rented machinery dependence • Lack of value added production process • Company's Financial statements include all R&D projects expenses	Internal Factors
Opportunities **O** • Production can be performed at any time in the year in the country due to Peru´s special weather conditions • Quality improvement opportunities	**Threats** **T** • Natural disasters and changes in weather conditions • Changes in local laws • Pests and diseases • New international requirements for capsicums	External Factors
Positive	Negative	

Table 1: *DIROSE SWOT analysis*

In the SWOT analysis we can see how Peru special weather conditions help DIROSE to produce capsicums at any time in the year. Also the opportunity to improve the quality and produce value added products.

On the other hand, DIROSE is basically a rented machinery dependence company. For this reason the relationship with our providers is very important.

Also, R&D projects expenses are included in our Financial Statements and sometimes it is difficult to analyze only the core business of the company.

Finally, all agro industrial companies are subject to changes in local laws, natural disasters as well as new international requirements for exports.

It is important to mention that one of DIROSE R&D projects was the development of the mechatronic arms machine. This innovation is not the core business of DIROSE but could represent an important cash flow and revenue in the future.

In this thesis, we develop a business plan for the mechatronic arms machine, as a separate special business unit in the company.

2.1 COMPANY OWNERSHIP

DIROSE SAC is a family business and its shareholders equity is around USD1.1 million. Total liabilities and shareholder´s equity is around USD1.6 million.

Current Assets came mainly from Inventories. Liabilities are mainly short term debt.

In the following table we can see DIROSE´s Balance Sheet at the end of 2013.

DIROSE Balance Sheet - 2013			
(in USD)			
Cash & Due / Banks		3,109.29	
Clients		82,555.00	**85,664**
Inventories			
	Raw Material	142,805.71	
	Finished Goods	249,607.14	
	Work in progress	292,939.29	
	Others	108,082.14	**793,434**
Prepaid Expenses		33,782.14	
Taxes		35,342.86	**69,125**
TOTAL Current Assets			**948,224**
Property, Plant & Equipment - Gross		894,061.07	
Accumulated Depreciation		(212,540.00)	
TOTAL Non Current Assets			**681,521**
TOTAL Assets			**1,629,745**
Wages Payable		-	
Suppliers		49,821.43	
Short term debt		481,843.93	
TOTAL Current Liabilities			**531,665**
TOTAL Non Current Liabilities		-	
TOTAL Liabilities			**531,665**
Equity		565,714.29	
Retained Earnings		319,983.21	
Current Earnings		212,738.93	
TOTAL Equity			**1,098,436**
TOTAL Liabilities & Shareholders' Equity			**1,630,102**

Table 2: *DIROSE Balance Sheet - 2013*

There are currently 13 permanent employees and 250 temporary employees in the seed and harvest stages.

Company shares are not listed in Lima stock exchange market.

To develop this new product, we consider joining with a strategic partner and also going to the banking system for financing.

2.2 COMPANY LOCATION AND FACILITIES

DIROSE SAC have two locations:

(i) One in the north western region of Peru (Zaña) – where is the farm and the processing factory.

(ii) The other in Lima – where is the administrative office.

Mechatronic arms were developed in Lima by a group of mechatronic engineers and were tested in Zaña, in DIROSE´s farm.

3 PRODUCT

The product is the 40 mechatronic arms machine, an innovative software technology for the agriculture sector in Peru.

This product was developed by DIROSE SAC in order to reduce agriculture companies' costs in the harvest stage of production.

With this new technology, agriculture companies can change the traditional way to harvest capsicums production into a modern one.

This new technology offers considerable benefits and advantages over traditional manual capsicums harvesting.

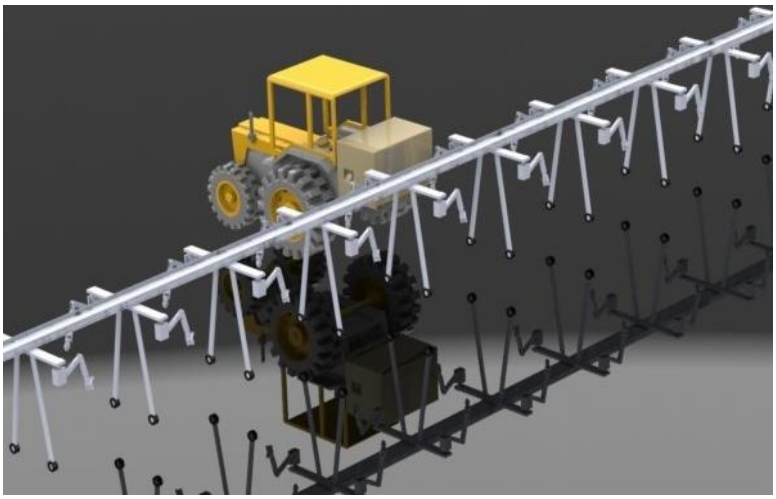


Figure 9: *Mechatronic Arms Machine*
Source: DIROSE SAC

3.1 PRODUCT DISCRIPTION

Basically, the 40 mechatronic arms machine consists in a software that identifies the color and the distance of the product and sends the information to a mechatronic arm in order to pick only the one the program indicates.

Also, each arm was developed with special fingers that can catch the product without destroying neither the plant nor the product.

The hardest part of this project was to develop the intelligent software that can spot and pick the product via an ‘arm’ design.

Each mechatronic arm is made of aluminum and steel that makes them more durable and not heavy.

Arms are flexible and can catch 1 pepper per 3 seconds.

3.2 COMPETITIVE COMPARISION

The mechatronic arm is a high quality, high tech solution that will be offered at a very competitive price.

To set the market price of our product, the company considered the following aspects:

	Amount per Arm in USD	Total Amount in USD
Cost per arm (hardware)	**3,100**	**124,000**
Cost of carrier	**1,575**	**63,000**
Cost of warranty	**1,102.5**	**44,100.5**
Total Cost	**5,777.5**	**231,100.5**
30 % expected revenues over total costs	**1,722.5**	**68,899.5**
Total Price per product	**7,500**	**300,000**

Table 3: *Product market price*
Source: Own elaboration

We assume a 30% of expected revenues over total production costs taking into consideration the price of other kind of combine machines in the Latin American market.

Figure 10: *Example of a combine machine sold in Argentina*
Source: www.agroads.com.ar

It is important to mention that the software used in this new technology was developed in the initial stages and is not considering in the total cost in this table (sunk cost). However we can assume that it is included in our expected revenue rate per product.

Also, in order to compare this new technology with current manual labor costs, we developed a detailed wage analysis.

For this wage analysis we set the following assumptions:

Assumptions	
Exchange rate PEN / USD	**2.8**
Additional wage benefits	**4% (from country data)**
Cost of transportation per month per person	**120 Peruvian soles (PEN)**
Discount rate	**10%**
Country inflation	**2% (Central Bank data)**
Working hours per day per person	**8**
Working hours per day per mechatronic arm	**16**
Mechatronic arms machine lifecycle	**5 years**

Table 4: *Assumptions*

We assume a 10% discount rate taking into consideration a COK of 9.02% (Rf+B*(Rm-Rf)+country Risk = 2.35%+0.79*(5.28%)+2.5% = 9.02%). For this calculation I use Aswath Damodaran web page. He teaches Corporate Finance and Valuation at the Stern School of Business at New York University and his webpage is one of the most important for valuations analysis, at global level.

In this sense, discount rate = COK*(Equity/(debt+equity)) + i*(Debt/(debt+equity))*(1-tax) + Weather conditions risk premium

Discount rate = 9.02%*70% + 3.5%*30%*70% + 3% = 10.05%

The following table shows the monthly wage rate in Peruvian soles per person for the harvest process of production.

Year	Monthly wage rate in Peruvian Soles	% delta
2002	**410**	
2003	**460**	**12.2%**
2004	**460**	**0%**
2005	**460**	**0%**
2006	**500**	**8.7%**
2007	**500**	**0%**
2008	**500**	**0%**
2009	**500**	**0%**
2010	**550**	**10.0%**
2011	**550**	**0%**
2012	**550**	**0%**
2013	**600**	**9.1%**
2014	**600**	**0%**
12 year CAGR 2.5%		

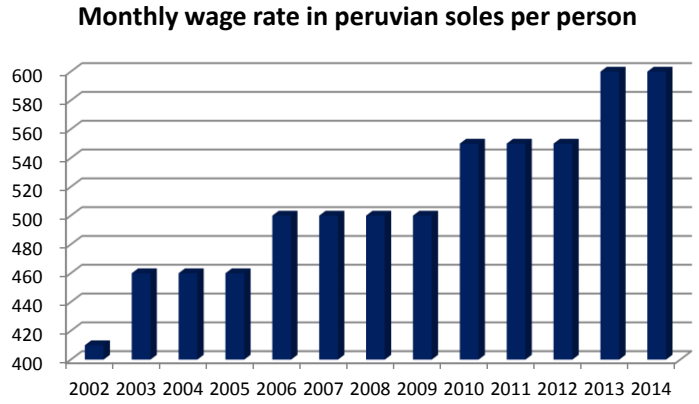


***Table 5**: Monthly wage rate in agriculture sector INAG*
Source: DIROSE harvesting historical costs and M

If we add the monthly transportation costs and the additional wage benefits, we obtain the following total cost of labor:

	Amounts in Peruvian soles	Amounts in dollars
Monthly wage rate per person	**600**	**214**
Transportation	**120**	**43**
Benefits (@ 4%)	**24**	**9**
Total monthly cost per person working 8 hours per day	744	266

Table 6*: Monthly costs per worker in the agriculture sector*
Source: Own elaboration

It is important to mention that country´s legal minimum monthly wage is S/.750 which assumes 6 working days per week and 8 working hours per day (Tusalario.org). However, this minimum monthly wage is applicable only to a dependent employee.

Also, in order to work the same number of hours than one mechatronic arm (16 hours per day), we need to consider two workers per day (each one working 8 hours per day).

	Amounts in Peruvian soles	Amounts in dollars
Total monthly cost per 2 workers, each one working 8 hours per day	1,488	531

So that the total cost per year will be:

	Amounts in Peruvian soles	Amounts in dollars
Total cost per year per 2 workers, each one working 8 hours per day	17, 856	6,377

In 5 years, total cost will be:

	2015	2016	2017	2018	2019
Yearly wage	17,856	17,856	17,856	17,856	17,856
Present value	16,233	14,757	13,415	12,196	11,087
Sum in Soles	67,688				
Sum in USD	24,174				

If each mechatronic arm is equal to 2 persons, working 8 hours per day each one; therefore, 40 mechatronic arms will be equal to:

USD 24,174 x 40 = USD 966,960

We assume 5 years in this exercise because is the expected lifecycle for this new technology and is the maximum number of years for the warranty.

In the following chart, we compare the market price of the Mechatronic arms machine vs manual labor costs.

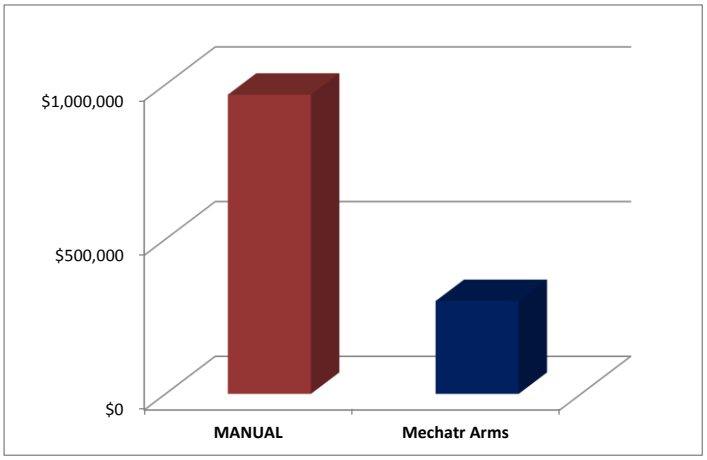


Figure 11: *Mechatronic Arms Machine price vs Manual Labor Costs*
Source: Own elaboration (MANUAL: Traditional Manual Harvest)

Also, if we compare other costs between Manual Harvest and the Mechatronic Arms machine, we can conclude that the use of this new technology can make companies more efficient.

For example a farmer or company who purchases this new technology can save money in other labor costs, including:

(i) Direct costs: Supervisors, Bag handlers and Vacation pay and

(ii) Implied costs: Labor shortages, Opportunity costs and Sanitation issues

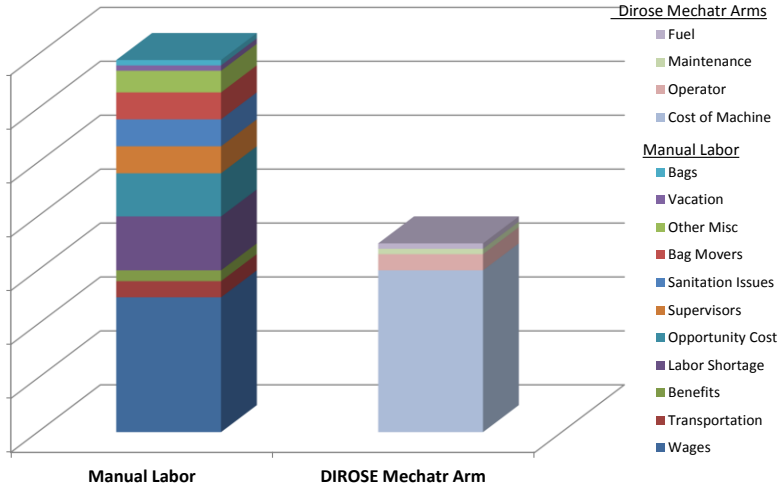


Figure 12: *Manual Labor vs Mechatronic Arms Machine - additional costs*
Source: DIROSE S.A.C.

Finally, there is another similar product used by some paprika companies; however is a product that is not sold in the peruvian market and from which we don't have accurate public pricing information.

This product is the current paprika combine that shakes and sorts the whole paprika plant (destroying it), followed by the separation of the fruit from the plant by laborers inside the machine on a conveyor belt.

This way, this machine destroys the crop on the first harvest and loses at least two additional harvests.

Due to lack of public information of this machine in the peruvian market, this thesis is not going to analyze this other alternative.

Figure 13: *Current Paprika Combine*
Source: www.armstrongchile.cl/products/

3.3 TECHNOLOGY

The Mechatronic Arms is an innovative software technology, is DIROSE's solution for improving capsicums harvesting in Peru.

Version 1.0 – The First Design

Design (Feb 2010)

- Intelligent software can spot and pick the product via an 'arm' design (artificial vision).
- Movement powered by belts and one motor.

Lessons Learned:

- ✓ Speed was slow (1 pepper per 10 seconds).
- ✓ Flexibility in 'arm' was low.

Figure 14: *First Designs*
Source: DIROSE S.A.C.

Version 2.0 – Dynamic Engine Control

Design:

- More durable (made of aluminum and steel).
- More flexible and degrees of freedom (increased joints from 4 to 6).
- Faster speed (1 pepper per 3 seconds).

Figure 15: *Version 2 designs*
Source: DIROSE S.A.C.

In 2010, this innovation was elected by the FONDO DEL PROGRAMA DE CIENCIA Y TECNOLOGÍA DEL PERÚ (FINCyT) to continue the research and development of this new technology, so that in October 2011 the second prototype was finished. Being faster, more dynamic and precise; in addition of controlling several motors simultaneously in a harmonious way.

This part of the project was the most critical, since the control of artificial vision which recognizes distances, colors and shapes had been developed and an articulated, precise and at low cost technology for mass production, had been designed.

The total investment made to reach this current stage was approximately USD$ 450,000

Version 3.0 – the final product

The next step is to build a 40 arms mechatronic machine depending on customer´s needs and the technical conditions that may arise. These arms will be held on a conveyor belt and will have a source of energy generated by a tractor or external generator.

It is important to mention that this machine has been initially conceived as an agricultural implement transported by a farm tractor of the standard mosquito type.

During the length of this stage, enhancements were made in order to reduce costs in accessories and supplies for the arms, as well as to improve current software to get more efficiency.

The cost of this start up stage is estimated to be USD$ 536,989 as is stated in the financial analysis section.

3.4 SERVICE AND SUPPORT

DIROSE SAC has 9 years of industry experience with a team of highly trained engineers.

The company also has an R&D capability to continue improve current technology and get more efficiency.

Part of the selling package of this new technology includes the training in the use and warranty services through machine lifecycle.

3.5 FUTURE PRODUCTS

Future products will come mainly to improve current technology to make it faster and available to other agriculture products in other countries.

Also, this new technology could be applied not only at the agricultural level, but also for other industries that could see other benefits using these robotic arms with an artificial vision.

It is important to mention that this product has been patented in Peru by DIROSE SAC.

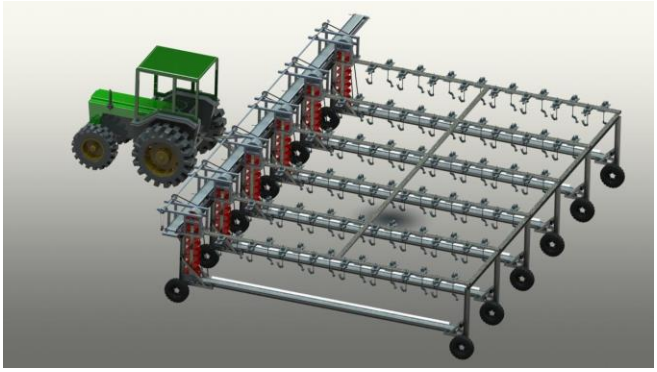


Figure 16: *Example of possible future development*
Source: DIROSE S.A.C.

4 MARKET ANALYSIS

This thesis is focus for capsicum products in Peru. According to Peru Ministry of Agriculture, one of the main products in this sector is Paprika. Paprika represents around 3% of the agriculture exports in Peru being the most important coffee and asparagus.

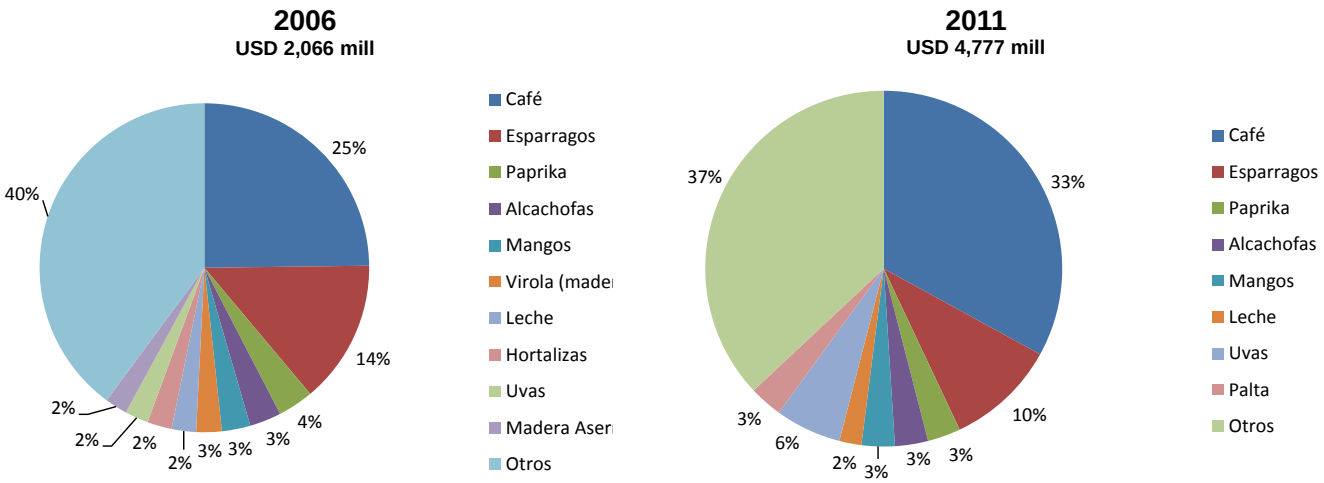


Figure 17: *Agriculture exports distribution 2006 - 2011*
Source: Peru Ministry of Agriculture

One of the main costs of production in the capsicums sector is the harvest stage of production. For this task, there is not an available technology in the country (Kuramoto, 2013) because in the last decade, the area of science, technology and technological innovation in the Peruvian economy has been of low priority for policy makers.

For this reason the only competition in the market for our product is the traditional manual harvest.

Figure 18: *Traditional manual harvest*
Source: contadoresyempresas.com.pe

4.1 MARKET SEGMENTATION

We are going to focus the strategy to companies that operate in Peru and specifically in companies that produce Capsicums.

In this sense, we have the following initial list of potential clients:

Company or producer	Number of hectares for capsicums production
Adagrosac	82
Agrícola Guayacan	62
Agroindustrias AIB	305.9
Antonio Falconi	90
Antonio Mata Cuadros	16
Camp. La Viña- Peot	50
Carloman Cerquera	16
Eduardo Caceres Vizcarra	51
Jorge Cubas	41
Jorge Luis Obando	6
Jorge Quillatupa Ortiz	43
Jorge Santillán Mendoza	6
Juan Soto Del Pino	7
Gabriel Soler Cherres	5
Gandules S.A.C	198
Luis valencia Sebantín	32
Marco A. Flores Tijeros	20
Marco Bellodas Tesen	8
Marino Clavo Mondragón-(Batangrande)	28
Negocios Agrícolas Jayanca S.A	495.15
Familia Mayanga	14

Pomalca	150
Proserla S.A.C	39
Roberto Gallardo	4
Sebastián Oneto Valle	10
Camposol S.A.	500 aprox
ECO – Acuicola Sociedad Anonima Cerrada	300 aprox
Sociedad Agricola Viru S.A.	300 aprox
Danper Trujillo S.A.C.	500 aprox
Ind. Com. Holguin e hijos S.A.	200 aprox
Agricola Pampa Baja	300 aprox

Table 7: *First potential clients list*
Source: mincetur.gob.pe, siicex.gob.pe and DIROSE SAC

4.2 TARGET MARKET SEGMENT STRATEGY

The target market for this product can be divided in three groups:

I.- Big and medium size producers : This is the group of companies or individuals who plant capsicums in extensive land size (referring to more than 100 hectares) and that have the same problems mentioned before at harvest time. In this sense, the opportunity cost of counting with adequate personnel at each harvest stage is too high (many hectares are left unsowed), which could lead them to acquire the new technology.

II. Companies that provide outsourcing of agricultural machinery: This is the group of companies or individuals that provide services to different farmers. They give support from the preparation of the land, fumigation, up to the harvest of certain products. This is the group that could add capsicums harvest to their services. In this group the return on investment can be realized very quickly, because they can harvest from different farmers in various zones of the country taking the maximum advantage of the new technology.

III Wholesale and exporting companies: In this group we not only include companies or individuals who export the finished product, but also companies who sell to local markets or exporters. This group is more interested in the crop.

Also, this new technology can not only be used for capsicums, but also for the following products:

a) All red colored products with similar characteristics.

b) Products with different colors from the green plant with similar characteristics.

c) Other crops such as grapes, avocadoes, mangoes or other kind of fruit which is differentiated by color or shape.

To do this, we will need to make a previous modification in order to adapt the Mechatronic Arm machine to the specific tasks.

5 STRATEGY AND IMPLEMENTATION

5.1 COMPETITIVE EDGE

a) Customizable Design:

- The number of arms on each machine is customizable
- The machine can be designed to harvest other red fruits and vegetables
- Lights can be added to harvest at night

b) Ease Implementation:

- Designed to be attached to the customer's existing tractor
- Designed to only pick red peppers, not un-ripe green peppers
- Allows for multiple capsicums harvests each year

- Mechanical harvesting yields a higher quality pepper

c) Competitive Cost Structure:

- Other solutions and technologies are not available in the market or are too expensive to implement.

5.2 VALUE PROPOSITION

Mechatronic Arms is an innovative, value-added technological solution for Peru's farmers and agricultural industry.

It is a new technology with a competitive pricing and with a specialized support.

Also it is a significant cost savings opportunity for customers over short and long-term process of production.

From a growth potential point of view, DIROSE SAC has the potential to be an R&D center with future technologies to further enhance the harvesting experience for current clients in Peru and around the world.

5.3 SALES STRATEGY

Sales strategy will initially address Peruvian companies. The prospective clients will be supplied with a professional product information package followed up with a direct mail brochure and a phone call.

There will be no initial direct compensation or commission for closed sales. Proceeds from sales will be invested back into developing and expanding the business. As the company begins to increase its initial sales force, commission-based incentive programs will be implemented

5.4 SALES FORECAST

Delta sales will be 5 machines per year with a market price of USD 300,000 per product.

Figure 19: *Sales Forecast*

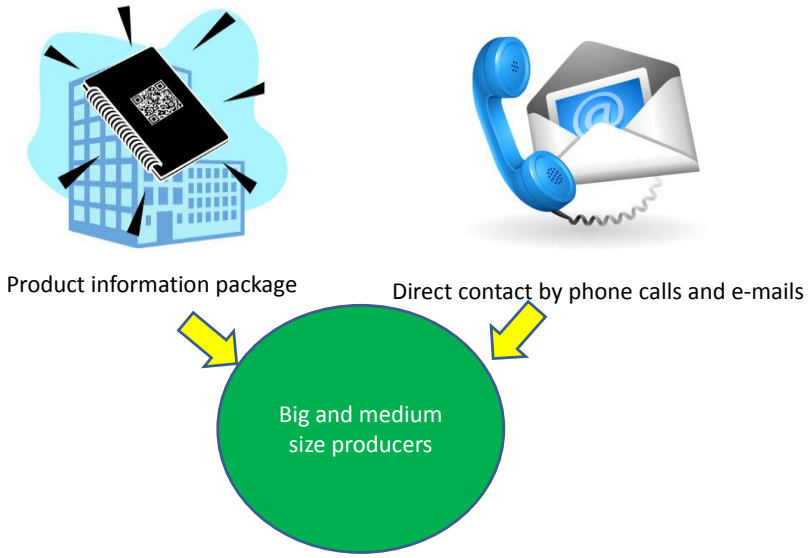
5.5 MILESTONE

- Funding to complete the testing and development phase of the final product: It would take six months. This stage includes the user guide.
- Final Product development by third parties suppliers: We will hire two supervisors for this process. It would take 4 months.
- Patent to the final product: although we already have a patent for the software, we need to renew it next year.
- Promotional materials will be developed: It would take1 month.
- 5 machines sales increase each year.
- After successful implementation, we will begin the development of new machines for other agriculture products.

5.6 MARKETING STRATEGY

For our initial target market, the company will implement one marketing effort. We will create a push factor by effectively convincing the decision-level managers within the organizations that our product provides an ideal solution to their production process.

We will create a product information package that will be explained in person. However initial contact will be by phone. Initial market target will be big and medium capsicum producers.



Also we will incorporate a value added proposition guiding the company in all the process for the implementation of this new technology. This way we will ensure the correct use of the machine and avoid any complain in the meantime.

The product and the brochure will be also available in our web page and orders will be also received through this channel.

We expect a direct relationship between clients and the company before and after the selling process taking into consideration that it is a new technology.

5.7 STRATEGIC ALLIANCES

Suppliers

The relationship between DIROSE SAC and its suppliers will be essential.

We can have the product on time to our clients and be able to make some changes according to clients' necessities if we maintain the good relationship with our suppliers.

It is important to mention that the software of this new technology is already created and the hardware has parts or components that are available in the local and international markets.

We can have many suppliers in order to diversify the risk and ensure the availability of our product in the market.

The Government

Government can be also a strategic partner by funding the use of this kind of technology to some local companies. This way, they can improve the efficiency of the agriculture sector and country´s GDP.

Peruvian government has some programs in order to help local companies to implement new technologies in their production process, especially in the agriculture sector.

In this sense, DIROSE can help other companies to have government funding for the use of this mechatronic arms machine in their production process in order to increase the efficiency of the company and country GDP.

6 MANAGEMENT SUMMARY

Two of our strengths are the low cost structure and flexible personnel needs. Sales people with experience relevant to our target market can be attained as need dictates, but the initial management team will consists of DIROSE SAC founders themselves, with an operational

support from 4 mechatronic engineers and two development supervisors. Also personnel for the warranty phase will be added each year as sales have a positive tendency (customer service and mechanics).

6.1 MANAGEMENT TEAM

Initially, the founders will share in the operational and financial responsibilities of the company. They will be responsible for finding, attaining and managing new clients. Founders will be responsible for making direct sales, marketing, and all other operational tasks involved in making this business successful.

Also, for the final testing phase of this new technology and to develop the machine user guide, DIROSE will need the help of 4 mechatronic engineers.

Finally, for the development of the final product DIROSE will need the help of two supervisors.

6.2 MANAGEMENT TEAM GAPS

It will be necessary to hire new sales associates as we expand into a new market segment. An individual with experience and networking.

After sufficient cash flow has been established, we will hire a team of 4 additional mechatronic engineers to expand our existing machine to be available for other kind of agriculture products.

6.3 PERSONNEL PLAN

In order to free up enough capital to continue operations and possible expansion, our founders will not receive additional salary until the product is well established.

Also, mechatronic engineers will receive a fixed salary for the final testing phase of this new technology.

Starting from the second year, we will employ a Sales Associate who will handle sales transactions. His/her compensation will be a combination of fixed salary and commissions on sales.

7 FINANCIAL PLAN

7.1 IMPORTANT ASSUMPTIONS

For this financial plan we take into consideration the following assumptions:

Assumptions	
Exchange rate PEN / USD	**2.8 (Central Bank Data)**
Additional wage benefits	**4% (Country information)**
Cost of transportation per month per person	**120 Peruvian soles (PEN)**
Discount rate	**10%**
Country inflation	**2% (Central Bank Data)**
Working hours per day per person	**8**
Working hours per day per mechatronic arms machine	**16**
Mechatronic arms machine lifecycle	**5 years**
Sales increase per year	**+5**

Table 8: *Financial Assumptions*

We assume a 10% discount rate taking into consideration a COK of 9.02% (Rf+B*(Rm-Rf)+country Risk = 2.35%+0.79*(5.28%)+2.5% = 9.02%). For this calculation I use Aswath Damodaran web page. He teaches Corporate Finance and Valuation at the Stern School of

Business at New York University and his webpage is one of the most important globally for valuations.

In this sense, discount rate = COK*(Equity/(debt+equity)) + i*(Debt/(debt+equity))*(1-tax) + Weather conditions risk premium

Discount rate = 9.02%*70% + 3.5%*30%*70% + 3% = 10.05%

7.2 INITIAL INVESTMENT

The following two tables present details for the respective initial investment, which is USD 425,730.

Fixed Assets	Amount	Depreciation / Amortization (years)	Notes
Real Estate-Land	NA	NA	Will be rented
Real Estate-Buildings	NA	NA	Will be rented
Computers	7,857	4	For engineers, supervisors and founders. Source: www.falabella.com.pe
Mechatronic Arms (40)	124,000	5	Source: DIROSE SAC
Furniture and Fixtures	4,286	10	Desks, chairs, and shelves. Source: www.falabella.com.pe
High Wheels Tractors	57,000	5	Source: http://www.vende.pe/lima/tractores-en_venta
Carrier	6,000	5	Source: DIROSE SAC
Vehicles	26,000	5	Source: www.todoautos.com.pe
Patents	3,000	10	Already paid
Total Fixed Assets	$ 228,143		

Table 9: *Initial Investment: Fixed Assets*

Operating Capital	Amount	Notes
Pre-Opening Salaries and Wages	94,286	Annual Salary. Source: DIROSE SAC personnel expenses
Benefits	3,771	Benefits: 4%
Rent Land	10,000	Annual Rent. Source: http://www.agroforum.pe/terrenos-y-predios/
Rent factory	24,000	Annual Rent. Source: www.adondevivir.com
Advertising and Promotions	10,000	Own estimation. At the beggining will be only visits to potential clients.
Other Initial Start-Up Costs	55,530	Cushion (15% of total costs)
Total Operating Capital	$ 197,587	

	Amount
Total Required Funds	$ 425,730

Table 10: *Initial Investment - Operating Capital*

7.3 SOURCES OF FUNDING

DIROSE´s proposition is to make 20% of the initial investment. 50% of the initial investment will came from private investors and 30% will be financed through a commercial loan with an interest rate of 3.5% and a 24 months tenor.

Sources of Funding	Percentage	Totals	Loan Rate	Term in Months	Monthly Payments	Notes
Owner's Equity	20.00%	85,146				
Outside Investors	50.00%	212,865				
Commercial Loan	30.00%	127,719	3.50%	24	372.51	Citibank interest rate
Total Sources of Funding	0.00%	**$425,730**			$ 8,940	
Total Funding Needed		**$434,670**				

Table 11: *Sources of funding*

7.4 BREAK EVEN ANALYSIS

Break even amount for this project is USD 231,100.5 and includes the following aspects:

Cost_of_Arms				
Material				
Motors			$	1,800.00
Count_per_arm		6		
Average Cost_per_motor	$	300.00		
Camera	$	50.00	$	50.00
Computer	$	350.00	$	350.00
Sensors	$	50.00	$	50.00
Electronic Parts	$	350.00	$	350.00
Paint	$	60.00	$	60.00
Material	$	100.00	$	100.00
Misc.	$	100.00	$	100.00
Labor				
Electrical_Engineers			$	80.00
Rate/Hr	$	10.00		
Hours		8		
Software_Engineers			$	80.00
Rate/Hr	$	10.00		
Hours		8		
Mechanical_Engineers			$	80.00
Rate/Hr	$	10.00		
Hours		8		
Cost_per_arm			$	3,100.00
Count_of_arms				40
Total_cost_of_arms			**$**	**124,000.00**

Table 12: *Cost or Arms*

Cost_of_Carrier		
Material		
Conveyer_belt	$ 1,000.00	$ 1,000.00
Steel	$ 1,500.00	$ 1,500.00
Paint	$ 400.00	$ 400.00
Generator	$ 700.00	$ 700.00
Labor		
Mechanical_Engineers		$ 2,400.00
Rate/Hr	$ 5.00	
Hours	120	
#_of _mechanics	4	
Total_cost_of_carrier		**$ 6,000.00**
Cost_of_High_Wheels_Tractors		
Main_Tractor		
Second_Hand_Tractor	$ 12,000.00	$ 12,000.00
High_Wheels	$ 5,000.00	$ 5,000.00
Secondary_Tractors		
Count_per_tractor	2	$ 40,000.00
Second_Hand_Tractor	$ 12,000.00	
High_Wheels	$ 5,000.00	
Platform	$ 3,000.00	
Cost_ of_tractors		**$ 57,000.00**
Count_of_carrier and set of tractors		1
Total_cost_of_carrier		**$ 63,000.00**

Table 13: *Cost of Carrier and Tractor*

Warranty_Costs		
Labor		
Customer_service		$ 2,000.00
Rate/Hr	$ 10.00	
Hours	200	
Field_mechanic		$ 2,000.00
Rate/Hr	$ 10.00	
Hours	200	
Technology		
Dedicated_telephones		$ 130.00
Count	1	
Rate/Yr	$ 130.00	
Dedicated_computers		
Count	2	$ 300.00
Cost	$ 150.00	
Equipment		
Field_tools & Trucks	$ 1,500.00	$ 1,500.00
Traveling	$ 2,500.00	$ 2,500.00
Replacement_parts		$ 2,146.00
Count_of_arms	40	
Break_rate	5%	
%_of arm_referb	33%	
Cost_to_referb	$ 1,023.00	
Replacement_metal	$ 100.00	
Annual_cost_of_warranty		$ 10,576.00
Warrenty_life		5
Total_cost_of_warranty		**$ 44,100.50**
Rough cost of warranty per arm		**$ 1,103**

Table 14: *Warranty Costs*

7.5 PROJECTED PROFITS AND LOSSES

The following table presents the projected profits details of DIROSE SAC for this new technology, as a special business unit.

Year / concepts	1	2	3	4	5
Sales	1,500,000.00	3,000,000.00	4,500,000.00	6,000,000.00	7,500,000.00
COGS	1,155,502.48	2,311,004.97	3,466,507.45	4,622,009.94	5,777,512.42
Gross Margin	344,497.52	688,995.03	1,033,492.55	1,377,990.06	1,722,487.58
Sales, Marketing and others	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00
Depreciation	119,792.86	231,992.86	344,192.86	456,392.86	566,628.57
Amortization	300.00	300.00	300.00	300.00	300.00
Rent	34,000.00	34,000.00	34,000.00	34,000.00	34,000.00
Salaries and wages	94,285.71	94,285.71	94,285.71	94,285.71	94,285.71
Additional Benefits	3,771.43	3,771.43	3,771.43	3,771.43	3,771.43
Loan principal payment		127,719.00			
Patent Renewal	3,000.00				
Total expenses	264,550.00	501,469.00	485,950.00	598,150.00	708,385.71
Profit before interest and taxes	79,947.52	187,526.03	547,542.55	779,840.06	1,014,101.87
Loan Interests	4,470.16	4,470.16			
Taxes (15%)	11,321.60	27,458.38	82,131.38	116,976.01	152,115.28

Net Profit	**64,155.76**	**155,597.49**	**465,411.17**	**662,864.05**	**861,986.59**
Gross Margin	**23%**	**23%**	**23%**	**23%**	**23%**
Net Margin	**4%**	**5%**	**10%**	**11%**	**11%**

Table 15: *Projected profits/losses details*

Gross Margin is 23% for each year; however, net margin in the first two years is below 10% due to loan payment (interests and principal) and patent renewal.

7.6 PROJECTED CASH FLOW

Projected cash flow includes the initial investment from DIROSE and private investors. Debt payment is included in the respective year 1 and 2 expenditures.

Year / concepts	0	1	2	3	4	5
Initial Investment	298,011					
Cash from Sales		1,500,000.00	3,000,000.00	4,500,000.00	6,000,000.00	7,500,000.00
Expenditures from operations		1,155,502.48	2,311,004.97	3,466,507.45	4,622,009.94	5,777,512.42
Administrative expenditures		145,057.14	269,776.14	142,057.14	142,057.14	142,057.14
Interests and taxes		15,791.76	31,928.54	82,131.38	116,976.01	152,115.28
Cash Balance	**-298,011**	**183,649**	**387,290**	**809,304**	**1,118,957**	**1,428,315**

Net Present Value	**USD 2,448,193.02**
Payback period	**1.4 years**

Table 16: *Projected Cash Flow*

With this project we obtain a positive net present value which is a good indicator that this investment is viable and profitable.

8 CONCLUSIONS

In the last decade, the area of science, technology and technological innovation in the Peruvian economy has been of low priority for policy makers. The institutional national STI system (SINACYIT) was concentrated on some particular programs and funds oriented basically to foster firms' innovation activities of primary and manufactured sectors without a specific and previously designed innovation strategy.

As a result of this limited STI policy, the STI indicators (such innovation index, degree of cooperation among the STI entities; technological capability, and technological sophistication) of Peru show the lowest levels compared with other Latin American Countries and the United States.

Furthermore, the overall analysis of the STI activities in Peru suggest that urgent need to devote political attention and respectable amount of resources to foster firms innovation as a mean to sustain increasing rates of growth of total factor productivity.

For these reasons, it is very important to have innovative developments in our country such as this mechatronic arms machine that can have a huge impact in the agriculture sector and in country GDP.

As we demonstrated in this thesis, this is a viable technology that can help companies and producers to be more efficient in the harvest process of production.

Also, this new technology is adaptable for other kind of agriculture products and sectors; which makes this innovation more attractive to potential investors.

Risks in the use of this machine can be found in that (i) it is a new technology and could have its limitations, (ii) No data regarding how much maintenance this new machine will need, (iii) If there is a problem with some arms, part of the product cannot be harvested.

This business must be considered a stand-alone business and have its own financial statements. We cannot join this new business with DIROSE export one, because both are totally different from each other and have different costs structures.

Also, for this new business, DIROSE will have only part of the participation, so it is better if a new company can be created in order to avoid any misunderstood.

Finally, this is a peruvian family effort to improve the agriculture sector in Peru. Although, sell this new technology is not part of our core business, we consider this machine can have a huge impact in Peru and other countries not only for the agriculture sector but also to other sectors that need this kind of software in their process of production.

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10 APPENDIXES

Prototype 1 –In the year 2009 and 2010 the first prototype of the robotic arm was designed by DIROSE SAC to test the recognition of artificial vision. It can be watched at: http://www.youtube.com/watch?v=R9QadRXSOmc

Prototype 2: Dynamic Engine Contro. In the year 2010, this innovation was elected by the FONDO DEL PROGRAMA DE CIENCIA Y TECNOLOGÍA DEL PERÚ (FINCyT) for the continuation of research, so much so that in October 2011 the second prototype of the robotic arm was finished, faster, more dynamic and precise; in addition of controlling several motors simultaneously in a harmonious way. It can be watched at: http://www.youtube.com/watch?v=WLqaPb5dKzw. Also video with a demonstration in the field can be watched at: http://www.youtube.com/watch?v=uGztGZdAa0k

Final Product: Final products will consist in the development of mechatronic arms machines with several arms, depending on customer´s needs and the technical conditions that may arise. A Video with a final project model can be watched at: http://www.youtube.com/watch?v=aLXmSXBGkOw

Peruvian government support certificate for the initial stages of this project:

REPUBLICA DEL PERU

PRESIDENCIA DEL CONSEJO DE MINISTROS
ES COPIA FIEL DEL ORIGINAL
MERCEDES L. IBAÑEZ HUAMAN
FEDATARIA

Resolución Directoral

Nº 054-2010-PCM/FINCyT

Lima, 14 de Abril de 2010

VISTO:

El Memorándum N° 020-2010-PCM/PCyT/AC, del Coordinador del Área de Concursos, aprobando el Plan Operativo del Proyecto, el Plan de Adquisiciones y Contrataciones y el Cronograma de Desembolsos de la entidad ejecutora **"DIROSE S.A.C."**; y,

CONSIDERANDO:

Que, se ha suscrito el **Contrato N° 045-FINCyT-PITEI-2010** de Adjudicación de Recursos para la ejecución del proyecto: **"DESARROLLO DE UN PROTOTIPO DE BRAZO ROBÓTICO, USANDO INTELIGENCIA ARTIFICIAL, PARA LA COSECHA DE PÁPRIKA"**, entre FINCyT y la entidad ejecutora **"DIROSE S.A.C."**;

Que, en la Cláusula Quinta, del ítem *Obligaciones del FINCyT*, del precitado contrato se establece la obligación de FINCyT de aprobar el plan operativo y el plan de adquisiciones del proyecto;

Que, mediante Memorándum N° 020-2010-PCM/PCyT/AC, del Coordinador del Área de Concursos autoriza la aprobación del plan operativo, el plan de adquisiciones y el cronograma de desembolsos del proyecto;

De conformidad con la Ley N° 29158 - Ley Orgánica del Poder Ejecutivo; y el Reglamento de Organización y Funciones de la PCM, aprobado mediante Decreto Supremo N° 063-2007-PCM, modificado por Decreto Supremo N° 057-2008-PCM, y en uso de las facultades conferidas mediante Resolución Ministerial N° 144-2007-PCM;

SE RESUELVE:

Artículo Único.- Aprobar el Plan Operativo, el Plan de Adquisiciones y el Cronograma de Desembolsos del proyecto **"DESARROLLO DE UN PROTOTIPO DE BRAZO ROBÓTICO, USANDO INTELIGENCIA ARTIFICIAL, PARA LA COSECHA DE PÁPRIKA"**, ejecutado por **"DIROSE S.A.C."**, documentos que en Anexo forman parte integrante de la presente resolución.

Regístrese y Comuníquese.

ALEJANDRO AFUSO
DIRECTOR EJECUTIVO
Programa de Ciencia y Tecnología