New Product Development: Design of Scales in the Banana Sector in Peru

Eduardo Sánchez Ruiz*, Marcos García

Abstract—**The standard models of scales do not satisfy the specific requirements of Peruvian agricultural conditions. Consequently, this generates unnecessary costs and wastes time in the banana production sector. The development process of new products, focused on sustainability, has allowed the generation of added value in terms of labour and creativity by designing prototypes of scales that incorporate solar panels.**

Index Terms— **Prototype, custom design, solar panels, banana sector.**

I. INTRODUCTION

THE banana sector in Peru is one of the sectors with higher production growth rates. In 2011 this achieved an FOB value of US$69.5 million of exported bananas, mainly to countries like Holland, the United States, Belgium, Japan [1] and, at the same time, is one of the sectors with higher demands of international standards [2] [3]. To achieve higher economic performance in worldwide banana production, costs of transportation, personnel, infrastructure and unnecessary storage [4] should be avoided. This involves producers mobilizing production crews in the field, even to remotes areas where banana weighing at the harvesting site is desirable [5].

To access banana harvest areas in Peru, you have to travel on non-asphalt, dusty, rough roads (trails). These are areas with constant rainfall in the summer months and no electrical installations at any time of the year.

Currently, weighing bananas to be exported is done in tanks. This is due to the features of the models of the scales that require electrical power and a safe environment, and are fixed. They also must be free from moisture and dust in order to avoid miscalibration and the rapid deterioration of the scales, as these products [6] generally lack the opportunity for maintenance in Peru.

In the metrological classification of electronic scales, only two parameters are of importance: Tare or maximum load [CM] and the value of digital divide [dd] [7].

A type of common scale uses a sensitive element to deformation and a thin wire whose electrical resistance changes when stretched or compressed. This set is known as a load cell, which is fused together to a column that holds the scale platform [8].

Currently, electronic scales are integrating the latest technology: GPRS communication modules, digital sensors, CAN bus, and automatic weighing, among others [9] [10].

Moreover, for 30 years, research efforts have focussed on understanding the best practices in the development of new products [11]. A number of studies have determined that development practices of new products continue evolving. A wide variety of study designs and methodological approaches have been observed, adapted to the particularities of each sector of activity, and each are becoming more sophisticated. Those that bring the best results use multifunctional equipment [12] [13] [14] [15].

Traditionally, activities for developing new products were focused in developed countries. However, sustainability, environmental responsibility and related trends are part of the business agenda for a growing number of companies worldwide. Understanding how to integrate these concepts in developing new products can be an important part of a successful business [16].

The objective of the article is to apply a methodology for developing new products focused on sustainability, to develop four prototypes of compact, collapsible and lightweight scales with platforms hermetic to dust and water, which integrates advances in technology: the use of solar energy through photovoltaic panels, making this scale prototype a portable and reliable product for its use in agricultural fields.

II. MATERIAL AND METHODOLOGY

Initial considerations of the research are shown in Table I. Understanding assessment levels allows prioritizing and effectively achieving projects, identifying the features and the needs of the project, industrial sectors, and the specific company.

The **project** aims to develop prototypes of autonomous and hermetic scales for use on every weighing stage of the banana sector by using solar energy in the Piura Region.

The **industrial sector** of weighing solutions has few competitors as there are only six companies in the north of Peru that offer products and services of this nature. The banana sector is a little explored niche market. Also, imported products do not cover the requirements of the

Manuscript received July 24th , 2013; revised August 05th , 2013. This work is the result of the project “Desarrollo de cuatro prototipos de balanzas autónomas y herméticas para su utilización en cada etapa del pesaje del sector bananero mediante el uso de energía solar en la región Piura” (“Development of four prototypes of autonomous and hermetic scales for its use in every weighing stage of the banana sector through the use of solar energy in the Piura Region”), financed by the Fondo para la Innovación y Desarrollo para la competitividad (FIDECOM) (“Fund for Innovation and Development for competitiveness”) in Peru.

Eduardo Sánchez Ruiz is with the Universidad de Piura, Piura, Perú (corresponding author to provide phone: + 51-073-284500; e-mail: eduardo.sanchez@udep.pe).

Marcos García is with the Universidad de Piura, Piura, Perú (e-mail: marcos.garcia@udep.pe).

banana sector.

The **company**, “Balanzas Murguia S.A.”, in an effort to satisfy their clients’ weighing solutions, aims to improve their products. This is a vey complex task that requires the research and development of new technologies and mechanisms, along with the necessary collaboration and participation of the Universidad de Piura in the development of the new product.

Table I - Initial considerations of research

Innovation level	Incremental innovation
Risks involved	Technical uncertainties Market uncertainties
Evaluation levels	- Project - Sector - The company
Objective	Develop prototypes of autonomous and hermetic scales for its use at every weighing stage of the banana sector through the use of solar energy in the Piura Region.
Specific objectives	- Database containing technical and functional features for the design of four prototypes of autonomous and hermetic scales for the banana sector. - Four prototype designs of autonomous and hermetic scales for the banana sector. - Four prototypes of autonomous and hermetic scales manufactured for the banana sector.
Approach for the development of new products [16]	1. Team formation and Project planning. 2. Drivers of sustainability for the selected product. 3. Impact assessment. 4. Development of a strategy and design summary of the new product. 5. Generation and selection of ideas. 6. Design and manufacture of prototypes. 7. Evaluation and test market. 8. Product introduction.

The methodology for the development of the new product is based on a practical approach for developing countries proposed by UNEP [16].

In the **team’s formation and the planning of the project** people who will be involved with the project, from both inside and outside of the company, were identified. This is to determine the best use of each of the mechanical and production engineers, production technicians, systems analysts, and project and operations managers.

The drivers of development for the selected product are summarized in that the knowledge to be applied to the development of prototypes is of free use, without restrictions. The technology of the devices or elements, which the product uses, does not restrict its application because the design, development and implementation creates a totally new product, independent of patents and restrictions of the parts.

The **impact assessment** is summarized in the economic and social impact of the agribusiness sector. This is mainly from those small producers or associations that require scales according to their needs, and avoids unnecessary expenses due to lack of appropriate technology. This indirectly strengthens mobile industry development and contributes to the use of clean technology helping to conserve the environment.

The only waste generated by the use of the product is from the batteries. These will be recycled as small batteries and other products of the same nature. Other accessories can be reusable and repairable.

The **development of a strategy and a design summary of the new product** was necessary to study the profiles, needs and requirements of weighing solutions in the banana sector. This was done through structured questionnaires to collect the necessary information to determine the parameters of potential clients of the banana sector. The results of the study are presented in Section III.

In the **generation and selection of ideas**, solutions are presented to improve product sustainability with the identified parameters. The team selects and describes a new concept for the **design and manufacture of prototypes**. The results of the design and manufacture are presented in Section III.

The design of the prototype was made taking into account the technical requirements for the instruments described in two international technical standards: OZML–R76–1:1992 [7] and NMP-003-2009 [17].

In the prototype’s design, the following materials and equipment for the prototype were identified:

1) Display
2) Pedestals
3) Iron plate
4) Steel plate
5) Sensors (electronic card)
6) Solar panel
7) Rechargeable battery

In developing the prototype, the following instruments were used:

1) Welding equipment
2) Grinder Iron cutter
3) Caliper, among others.

To verify the operation of the prototype, the following materials and equipment were used:

1) Load simulator
2) Multi-tester
3) Analytical scale
4) Certified weights
5) Micrometers

III. Results and Tables

The results gathered from six regional organic banana organizations captured the following information:

1) The production system is comprised of 13 activities (see Fig. 1). Weighing is done after packaging by mobile crews in the field, and is assembled/disassembled according to the location of the harvest.
2) The dominant **values** for the **use of scales** for the associations of banana growers are:
   a) **CALIBRATION:** Differences in the weight of boxes of organic bananas cause rework and observations by the controlling entity in the

ISBN: 978-988-19253-1-2
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

boarding area to the container. Also, miscalibration prevents meeting export standards.

b) **PRICE:** The price of standard models of scales fluctuates between $290 and $450. The price issue is sensitive to producers who use on average 10 scales in various work crews that move according to the harvest area. They also have to invest in replacing all of the equipment in less than one year.

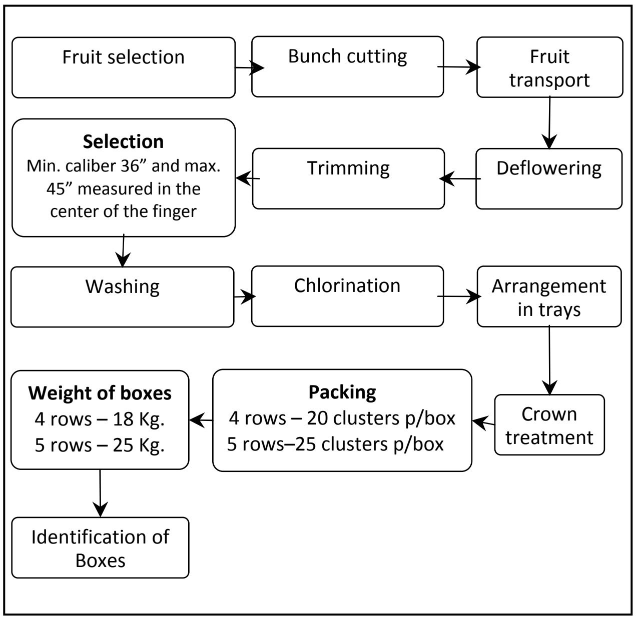

Fig 1 - Current production system

a) **RESISTANCE:** to environmental conditions (sun, rain, dust) and transport conditions involving mobilization of production crews in the field even to remote areas. This feature relates to the quality of scale calibration.

b) **COSTS:** generated by recharging of scales, whose batteries should last from 8 to 10 working hours, or days if areas are difficult to access.

2) The recommendations to be considered for the design of scales were:

a) Hermetic scales.
b) Flexible neck.
c) Protective case for easy transportation to be mobilized by work crews.
d) Digital display.
e) Accessibility of spare parts.
f) Product to consume less power in battery recharges.

The features mentioned made it possible to design and fabricate four prototypes of scales: BAL-005-001-02, BAL-005-001-0, BAL-020-005-01 and BAL-050-010-01 (see Table II and Fig. 2, 3, 4 and 5). The differences in the prototypes are based mainly in their capacity, and in the case of the two 5kg scales, differ in the material of the platform. In summary, the prototypes have the following features: digital, autonomous, hermetic against dust and water, and lightweight (no more than 17kg.).

Load cells, digital display and hybrid charge systems (electric power and/or solar) are used for the operation of the scales, equipped with a mobile solar panel of easy loading and battery lasting up to a maximum of 48 hours.

Among the major components of the prototypes shown, we can mention: (1) the solar panel, (2) the operating console, and (3) the loading platform.

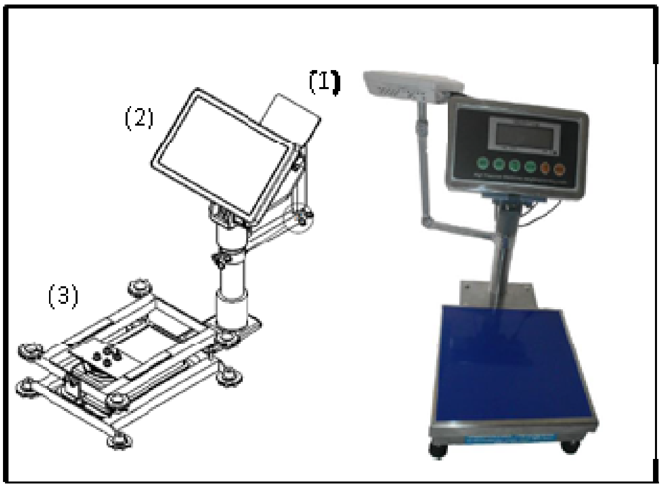

Fig 2 - BAL-005-001-02

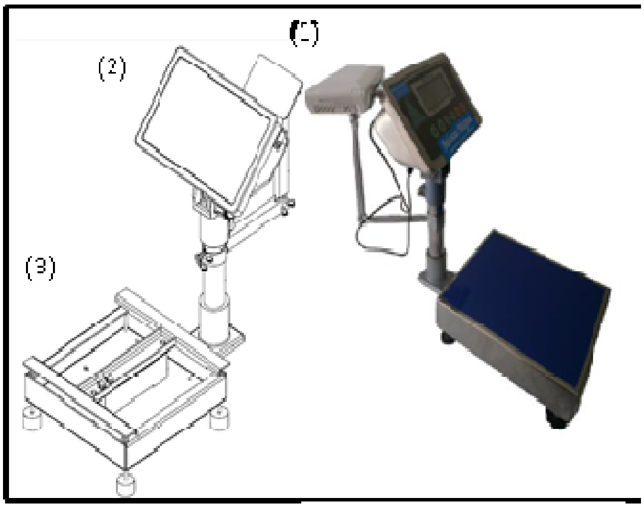

Fig 3 - BAL-005-001-01

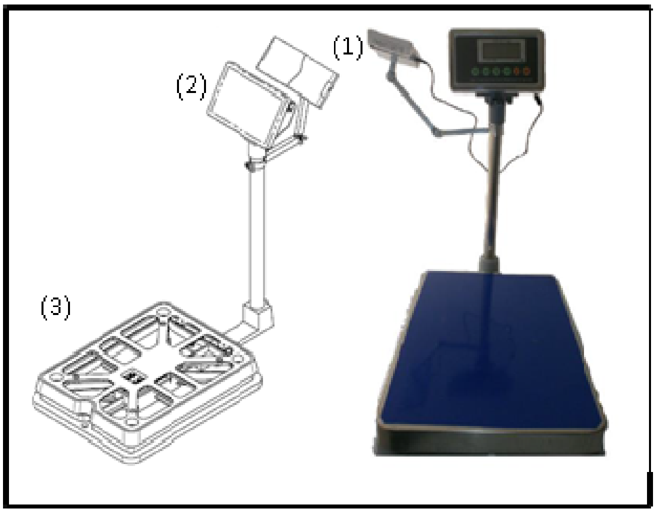

Fig 4 - BAL-020-005-01

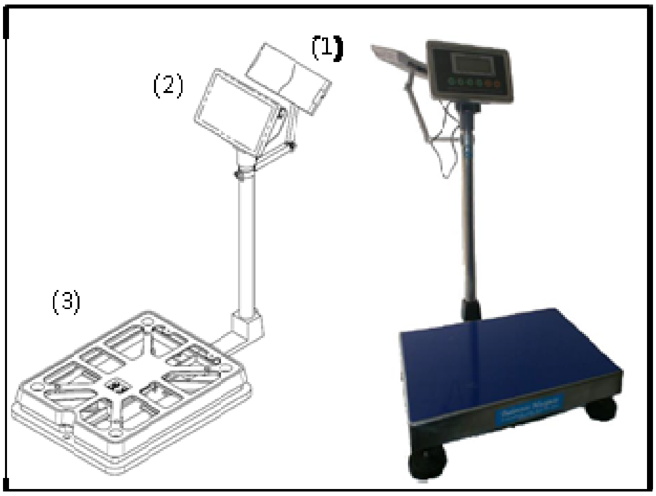

Fig 5 - BAL-050-010-01

In the design of the prototypes, different load cell design is used (see Fig. 6).

In the **evaluation and test marketing**, the reactions of organic banana associations in the region, regarding the sustainability qualities of the product, were highly satisfactory. With this experience, modifications and adaptations to the current process of the company can be done to the **introduction of the product** into the market. At the same time, the company has to prepare a communication and marketing strategy for the new product.

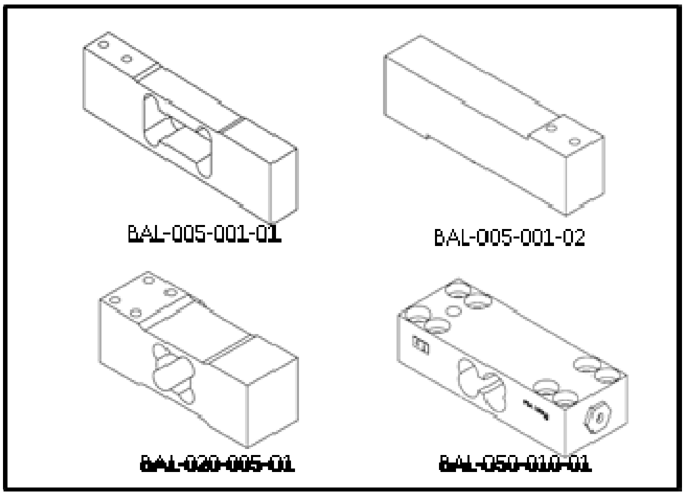

Fig 6 - Load cell

IV. Conclusion

In this paper we presented the application of one of the methods of new product development, focused on sustainability, to develop a scale that integrates solar technology for use in agricultural fields. This sustainable approach improves products and incorporates technical, economic and environmental concerns as key strategic elements for companies in developing economies.

Table II - Technical features of the prototypes

	BAL-050-010-01	BAL-020- 005-01	BAL-005 - 001-01	BAL-005- 001-02
Maximum load [CM]	50 Kg	20Kg	5Kg	5Kg
Value of the digital divide [dd]	10 grams	5 grams	1 gram	1 gram
Units	Kg/lb			
Display	4 digits (7 segments)			
Keyboards	6 keypads, push button type			
Load tension	9V-12V			
Sealing IP	67			
Operating temperature	0 °C – 50°C			
Platform	Cast iron	Aluminium alloy	Stainless steel plate	Stainless steel
Cover	Stainless steel			
Dimensions of cover	49cm x 37cm	39.5cm x 52.1cm	25cm x 30.2cm	25cm x 25cm
Pedestal	Stainless steel			
Pedestal dimension	60 cm	60 cm	21.5 cm	21.5 cm
Display	Stainless steel			
Calibration	Zero and Tare			
Support	4 adjustable rubber feet			

ISBN: 978-988-19253-1-2
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

REFERENCES

[1] Ministerio de Comercio Exterior y Turismo - Perú, «Récord de Exportaciones 2011, (Record Exports 2011)» Ministerio de Comercio Exterior y Turism, Lima, 2012.

[2] Asociación Macroregional de Productores para la Exportación, «Boletín estadístico 2011, (Statistical Bulletin 2011)» AMPEX, Lima, 2012.

[3] B. Bayona, W. Litano y E. Zapata, «Los determinantes de la produccion exportable del banano organico en el valle del Chira, (The determinants of export production of organic bananas in the Chira valley)» Universidad Nacional de Piura, Piura, 2011.

[4] L. Arquero, «Detalles a tener en cuenta para un buen funcionamiento de Balanzas electrónicas, (Details to consider for proper operation of electronic scales)» *Revista del Plan Agropecuario V.102*, pp. 37-39, 2002.

[5] M. Soto, «Situación y avances tecnologicos en la producción bananera mundial, (Status and technological advances in global banana production)» *Revista Brasileira de Fruticultura v.33*, pp. 13-28, 2011.

[6] INIBAP, Producción y Comercialización de Banano Orgánico en la región del Alto Beni, Alto Beni: INIBAP, 2004.

[7] Servicio Nacional de Metrología - INDECOPI, «NMP-003-2009,» INDECOPI, Lima, 2009.

[8] Organisation Internationale de Métrologie Légale, «Nonautomatic weighing instruments,» OIML, Paris, 1992.

[9] N. Quintero y E. Parra, «Prototipo de balanza electrónica con comunicación al PC, aplicada a la realizaciónd e gráficos de control, (Prototype electronic balance with PC communication, and applied to control charts realizaciónd)» Universidad Industrial de Santander, Bucaramanga, 2004.

[10] C. Ouyang, H. Xu, H. Zhang y B. Huang, «Research and design on the new type wheel loader electronic scale,» de *4th International Conference on Manufacturing Science and Engineering*, Dalian, 2013.

[11] R. Dickinson, J. Morton, D. Beggs, G. Anderson, M. Pyman, P. Mansell y C. Blackwood, «An automated walk-over weighing system as a tool for measuring liveweight change in lactating dairy cows,» *Journal of Dairy Science v96*, pp. 4477-4486, 2013.

[12] A. Griffin, «PDMA research on new product development practices: Updating trends and benchmarking best practices,» *Journal of Product Innovation Management*, pp. 429-458, 1997.

[13] M. Montoya-Weiss y R. Calantone, «Determinants of new product performance: A review and meta-analysis,» *The Journal of Product Innovation Management*, pp. 397-417, 1994.

[14] R. Cooper y E. Kleinschmidt, «New products: What separates winners from losers?,» *The Journal of Product Innovation Management*, pp. 169-184, 1987.

[15] R. Cooper y E. Kleinschmidt, «Benchmarking the firm's critical success factors in new product development,» *The Journal of Product Innovation Management*, pp. 374-391, 1995.

[16] R. García y R. Calantone, «A critical look at technological innovation typology and innovativeness terminology: A literature review,» *Journal of Product Innovation Management*, pp. 110-132, 2002.

[17] UNEP, «Diseño para la sostenibilidad,» Programa de las Naciones Unidas para el Medio Ambiente, Lisboa, 2007.