Analysis Forecast Production Model: A Mexican Family Firm Proposal

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Abstract

The prediction of the production of food is a very important topic that is attracting more the attention of researchers, scholars and professionals in the field of business and management since it is currently an issue at a global level considering the shortage of food and the exponential increase of the population. Similarly, the development of forecasting models about production are commonly used by different researchers and scholars to create predictions of the production systems, including good, as they normally provide valuable information for both making business decisions and reducing costs. For this reason, the main objective of this empirical research is the proposal of a forecast production model by applying a case study for a family agro-industrial enterprise from Aguascalientes (Mexico) through the implementation of a computer system that improves significantly their planning and commercial system of agro-industrial products (i.e. broccoli).

Keywords
Family firm, regression analysis, forecast, production model.

1. Introduction

Agriculture has been playing an essential role in the production of food since the last decade, for a population that has increased exponentially through the production of more and better food (Hawkes and Ruel, 2006; McDermott et al., 2013). However, despite all the different efforts made by agro-industrial enterprises and small scale farmers to incorporate more available land to produce more crops with a substantial increase in calories to reduce food insecurity, undernourishment and famine present in different developing countries, as it is the case of Mexico, these efforts have not been enough because they have not achieved the expected results, as the number of people with undernourishment and famine is still growing in part due to the high quality standards that some regions of the world establish (Akerele and Musediku, 2017).

From this perspective, it is important to state that researchers, scholars and professionals in the field of business and management, must focus their investigations in policies and programs that allow the development of agro-industrial activities, in a way that food security is significantly increased at local, national and international levels, because agriculture is precisely the essential activity that can increase world food security, the quality of food and a better nutrition of the population (Remans et al., 2011; Carletto et al., 2015). Therefore, the development of agriculture should be prioritize the diversification of production systems and the development of forecast production models, that allow not only to attain food security but also to increase the quality of food products to diminish the problems of undernourishment, obesity and other chronic diseases (Frison, 2007; Keding et al., 2012; McDermott et al., 2013; Qaim et al., 2014).

In this regard, different organizations and some researchers such as The World Bank (2007), the FAO (2013) and Carletto et al. (2015), concluded that agricultural products can influence significantly the quality of the diets (i.e. the consumption of a variety of foods), of people and in the nourishment conditions of the population in general. Consequently, even when there is an agriculture that produces a subsistence farming for a high number of families, most developing countries with an emerging economy, as it is the case of Mexico, must support small scale farmers so a part of their production can be sold and consumed in regional, national and international markets so they can obtain more income for the families that work in agriculture for a living (World Bank, 2007; Jones et al., 2014).

Similarly, the support to small-scale farmers so they can sell part of their agricultural produce has to consider that many women are the head of their families and they work the land. This is why there should be gender equity in the corresponding supports (Malapit et al., 2013), considering also the power and control that women have in the purchase and use of agricultural products as well the management of income to obtain products for the agricultural produce (Jones et al., 2014). For this, analysis forecast production models for agriculture attempt to improve not only the production systems and the value of investment (Sambharya, 2011), but also to improve commercialization activities and market efficiency as well as the investment protection of families (Jensen and Mecking, 1976; Yu, 2008; Huang et al., 2017).

In this trend of ideas, there are few published empirical investigations in the current literature of business sciences and management, that have analyzed the effects produced by the analysis forecast production models of agriculture, and there are even fewer empirical papers that analyze the same effects in family agricultural enterprises in developing countries or with an emerging economy, as it is the case of Mexico (Sibhatu et al., 2015; Akerele and Musediku, 2017). As a result of this, the main contribution of this empirical research is the analysis and discussion of the effects of proposing an analysis forecast production models of agriculture of a Mexican family agricultural enterprise (Frigorizados La Huerta), just as it is recommended by Sibhatu et al. (2015), Akerele and Musediku (2017), as well as Zhang et al. (2017a).

2. Literature review

The demand of agricultural products (food) has enlarged exponentially in the national and international markets in the last decade of this new century. This is why the production of food is catching the attention of researchers, scholars and professionals in the field of business and agriculture (Zhang et al., 2017b). Similarly, fresh agricultural products, including broccoli, have some specific features such as a short lifespan in the shelves, a high market demand, high standards for storage and use of technology for its transport. For this, it is necessary that enterprises have an adequate forecast production model and an efficient model of information, to create a bigger amount of food with more quality (Manning et al., 2006; Jin et al., 2013).

Furthermore, the logistics between producers and clients plays an essential role in order to take the different fresh agricultural products needed by different consumers to their homes, since it does not only add a higher level of quality to agricultural products but it also cuts the risks in supply operations of food (Zhang et al., 2017b). As a result, Yujun et al. (2005) concluded that the need of enterprises, including family ones, to have a monitoring model and decision making of prediction of the production based on a wireless sensor network (WSN), which represents a series of advantages such as an effective control of the production, a low consumption of energy as well as an effective reflection of the production in real time, temperature and quality of food (Xinqing et al., 2015; Xinqing et al., 2016).

In this regard, the prediction models of agricultural production are essential not only to achieve a higher level of business performance, but also to increase the quantity and quality of food products. For this, managers and/or owners of family firms have to rely on professionals that help them in the design and analysis of prediction models, which would improve the management of the family enterprise (Graham et al., 2005; Yu, 2008; He and Tian, 2013; Huang et al., 2017). Thus, managers and/or owners of agro-industrial family firms, will need to have the necessary information for the adequate development of the analysis forecast production model, which could create several benefits for the organization as a whole (Jensen and Mecking, 1976), including a higher quantity and quality of the agricultural products manufactured (Hassell and Jennings, 1986; Duru and Reeb, 2002; Hope, 2003; Hutton, 2005).

Additionally, there is theoretical and empirical evidence in the current literature that shows the presence of a clear distinction between property, control and management of the structure of the family firms in order to avoid conflicts that affect the organization seriously as a whole and to achieve a better profitability, by decreasing significantly the costs of the production of agricultural crops (Shleifer and Vishny, 1997). Consequently, depending on the complexity of the information that the family enterprise has about the production and cultivation of crops, it will determined not only the forecast production model that it develops but also the market efficiency and the management effectiveness of the organization (Sambharya, 2011; Yu, 2008; Huang et al., 2017).

Within this context, it is not surprising that nowadays managers from a variety of agro-industrial enterprises around the world, including some enterprises established in Mexico, work professionally and independently from the owners and consider forecast production models as an essential, and very valuable tool not only to improve significantly their production processes (Graham et al., 2005; Yu, 2008), but also to increase their market participation (Zhang et al., 2017a). That is why this type of enterprises are more willing to invest a specific amount of financial resources to incorporate the agro-technology in their food production processes that enables them to achieve a higher level of performance.

Accordingly, in order to obtain a forecast production model of agricultural crops that predicts more efficiently the level of performance of the production, managers usually try to encourage their workers and employees so they work collaboratively as a team in the analysis of the information, and collect as much information as possible in order to improve the prediction of the crops (Cheong and Thomas, 2011). This type of actions developed by managers normally provide a high level of optimism in the organization, as a whole which allows that the different prediction activities of the goods become more precise and it creates only a small dispersion of the information, compared with agro-industrial enterprises that do not have adequate information (Hassell and Jennings, 1986; Duru and Reeb, 2002; Hope, 2003; Hutton, 2005).

However, it is also important to establish the presence of different managers that do not understand clearly the relevance of having reliable information of the production, that facilitates the forecast of agricultural crops (Shleifer and Vishny, 1997; Claessens and Fan, 2002), especially those companies established in developing countries or with an emerging economy, as it is the case of Mexico. This does not normally happen in developed country as managers often tend to build very sophisticated pyramids of the information about the production of their enterprises, which allows them not only to create a higher level of control of the information, but also in its exchange among different departments or areas of the organization in order to improve their market participation (Huang et al., 2017).

Thus, to reduce as much as possible the error of collecting information for the prediction of agricultural crops, managers will need to have a clear market commitment of their food products to increase significantly, the opportunities to attain better results or benefits of the analysis forecast production model (Zhang et al., 2017a). Therefore, to have a better control of the benefits created by the use of prediction models of agricultural products, managers can increase significantly the level of income of family firms by reducing the lack of transparency of production (Haw et al., 2004; Gopalan and Jayaraman, 2012), as well as the lack of information (Francis et al., 2005), restrict the levels of availability of information and the improvement of data of the reports (Khurana et al., 2013).

In this regard, managers of agro-industrial family firms will have to be very precise on the demand of the quality of the information (both public and from the organization), that will be used for the development of the forecast production model. Otherwise, this can reduce significantly the quality of the analysis and the prediction of the agricultural production (Hope, 2003), as well as the accuracy of the results of the forecast production model (Duru and Reeb, 2002). Likewise, managers of agro-industrial family firms of developing countries, work in a similar way with the quality of the information since this mostly determines not only the quality of the analysis of the information,

but also the establishment of production prices of their crops and the level of business performance (Zhang et al., 2017a).

However, in developing countries and with an emerging economy, as it is the case of Mexico, there is a high percentage of agro-industrial family firms, that work with a high level of concentration of the information in only one person (i.e. the manager and/or owner of the organization), with a low level of quality of the information and with a very uncertain business environment (Classens and Fan, 2002; Zhang et al., 2013, 2017c). Moreover, most managers of this type of family firms usually consider that forecast production model would provide them with a low level of benefits, and do not have a clear understanding of the importance of this type of tools, when compared with managers of family firms in developed countries. Consequently, the first ones do not take advantage of the opportunities or benefits provided by the environment (Johnson et al., 2000; Baek et al., 2006).

In contrast, there are few managers of agro-industrial family firms that work professionally and have a high level of market discipline, which is the same as managers of family enterprises from developed countries, but they generally have more limitations in the commercialization channels of the production of food, which reduces the benefits obtained (Zhang et al., 2013; Huang et al., 2017). Furthermore, this type of managers normally also take too many risks related to their role and with the needs of the market of food (Zhang et al., 2013). This is the result of the strong uncertainty of business that can affect significantly the future of the organization, as well as the results and the analysis forecast production model (Leuz et al., 2003; Graham et al., 2005).

Additionally, this type of managers that are more professional in the performance of their activities try to obtain the biggest quantity available of benefits, that come from the analysis forecast production model of agricultural goods, by reducing as much as possible the risks of the market and the production costs. This allows them to have a better control of the information created in the production process and its communication, to the different areas or functional departments of the organization (Zhang et al., 2017a). Moreover, this type of managers also emphasize the type of information that can be transferred to both the inside and the outside of the very family firm, which reduces the levels of error and facilitates the design and analysis of the forecast production models (Zhang et al., 2017c).

Finally, this type of activities carried by managers of agro-industrial family firms established in developing countries and with an emerging economy, have positive and significant effects in the benefits and the level of economic and financial performance of the organization as a whole (Zhang et al., 2017a). Therefore, the professionalization of managers creates less conflict in the production processes and in the commercialization systems of food products from agro-industrial family firms. At the same time, they create a smaller amount of conflicts with the main shareholders of the organization, mostly because of the excellent results obtained with the implementation of forecast production models of agricultural goods (Filatotchev et al., 2011; Zhang et al., 2013).

3. Methodology

An inference analysis was carried out for the attainment of the two analyses of linear regression of the forecast production models of agricultural crops of the agro-industrial family firm Frigorizados la Huerta, with the meteorological and production data available from the organization. First of all, a linear regression analysis was carried out with the last year of available data in order to have a pre-diagnostic of the production level in 2016. This is why the method was practically based in detecting the meteorological variables that had more influence at the level of agricultural production. In this regard, an alternative linear regression model was calculated for the forecast of the agricultural production in 2016, in order to compare the results obtained with the ones predicted.

The most important independent variables that best define the agricultural performance (Tons/Hectares) were selected to develop the model of linear regression of the forecast production, which will be validated and discussed in future predictions (Chatterjee and Price, 2000). Similarly, the coefficients of the linear regression model were estimated by using the method of minimal squares, since this method rates the regression coefficients through the minimization of the sum of the squares of the deviations of the linear regression model proposed (Peña, 2002; Aranda et al., 2012). The equation of the linear regression model of the forecast production model is the following:

$$\hat{Y} = \alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p \quad (1)$$

Where $\hat{Y}$ is the predicted value and α_0, β_1,…, and β_p are the estimations of the regression parameters. Therefore, the real value of Y IS:

$$Y = \alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p + \varepsilon \quad (2)$$

Where ε is the prediction error of the linear regression model (Montgomery, 2004). In the same way, α_0, β_1,…, β_p describe the expected changes in the prediction variable (Y = dependent variable), as a response to a unitary change made in X_1 when the rest of the independent variables or predictors remain constant (Draper, 1998). This technique is not recommended to predict the dependent variable (Y), when the values of the set of independent variables or predictors (X), are out of the range of the data used to calculate the linear regression equation and for this case it will be necessary to make an extrapolation of the data and the error (Neter et al., 1996).

Likewise, these linear regression model are frequently used to obtain an association and explanation between independent and dependent variables and they are widely used by several researchers, scholars and professionals in the field of engineering and business with very satisfactory results (Sousa et al., 2007). Moreover, the collinearity in the equations of the linear regression models between the independent variables may produce an incorrect identification of the most important predictors so that is why it is necessary to be very careful in this aspect. Therefore, the graphics (i.e. figures) and the linear regression analysis of the forecast production model of agricultural crops of the family firm, was carried out by using the SPSS 22.0 software.

3.1 Sample

For the development of the forecast prediction model of agricultural crops considered only the data of the production of broccoli from the enterprise Frigorizados la Huerta from 2010 to 2016 because around 70% of all the land cultivated for crops (350 hectares) corresponds to this products and, more specifically, the only data that will be taken into account will be the production of broccoli of the last available year (2016). Consequently, the forecast production model that will be analyzed and discussed afterwards will only consider the production of broccoli from 2016, in the four crops that are obtained annually as well as the meteorological variables that have more influence in the level of production, since the information of the concerning variables to the plant and the soil is in the recollection process.

4. Results

In order to analyze the fixed, random and individual effects of the meteorological variables that determine to a greater or lesser extent the level of production of agricultural products (broccoli), it will be estimated through a model of multiple linear regression by applying the comparative test of Hausman, between the production obtained and the individual effect of the variables in the production planned (Green, 1997; Thiele and Weiss, 2003; Akerele and Odeniyi, 2015; Akerele and Musediku, 2017). Therefore, the general specification of the individual effects of the forecast production model of agricultural crops is presented below (Model 2):

$$Y = \alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p + \varepsilon \quad (3)$$

Where Y is the forecast of the broccoli production, α_0 is the constant that is correlated with the explanatory variables X_1, y $\beta_1 \ldots \beta_p$ are the constants that are totally correlated among them and uncorrelated with the error, which allows to identify some type of endogeneity between variables. Thus, the description of the explanatory variables in the linear regression model are presented below with a brief description of their meaning.

X_1 = Irrigation (m^3/Hectare)
X_2 = Average Temperature (ºC)
X_3 = Thermal Sum (ºC)
X_4 = Thermal Time (ºC)
X_5 = Rain (mm)
X_6 = Relative humidity (mm)
X_7 = Average of Global Radiation (Wats/M^2)
X_8 = Average of Evapotranspiration (Wats/M^2)

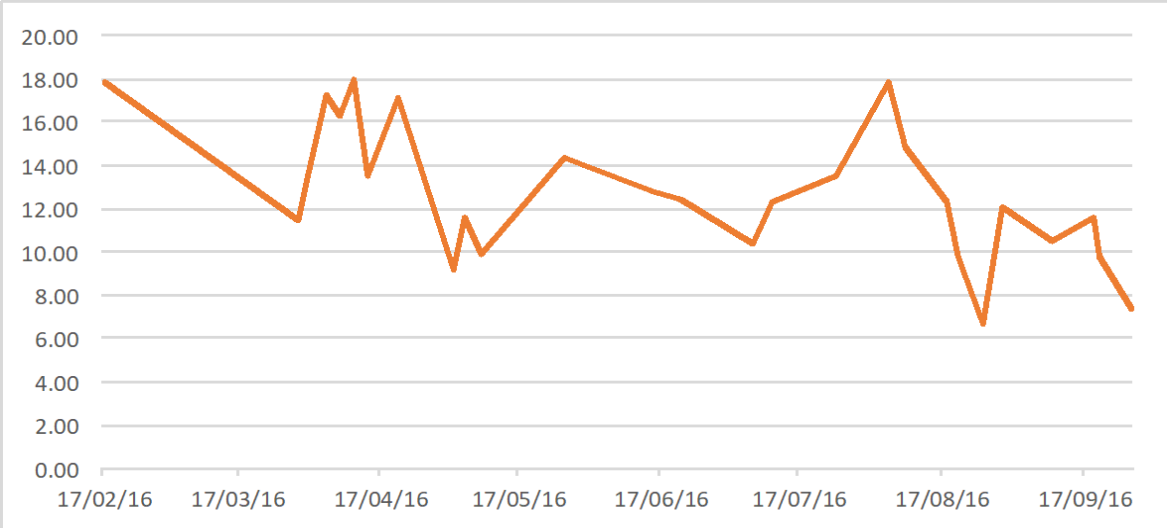

Figure 1. Total performance obtained in 2016

Figure 1 shows the presence of a fluctuating (irregular) production of broccoli because even when at the beginning of the year there was a production of 17.86 tons per cultivated hectare, it decreased drastically in the mid-year obtaining 9.18 tons per hectare, but the largest setback is at the end of the year with a production of only 6.67 tons of broccoli per cultivated hectare. Therefore, these data show the difficulty that the enterprise faces currently in terms of agricultural production, as it is too complicated to analyze a planning of the agro-industrial production and commercialization of broccoli. For this, it is necessary the development and implementation of a forecast production model that facilitates the planning systems of the production of the enterprise.

In this regard, different published investigations in the current literature in the field of enterprises have provided enough empirical evidence not only about the importance of the forecast production models but also about the excellent results that have been obtained. So, in order to attempt to provide a forecast model of the production of broccoli that improves the results of the family business, a linear regression model was created considering the eight variables established previously and obtaining the following results:

$$Y = 59.11 + 0.000X_1 + 2.116X_2 + 0.007X_3 - 0.036X4 - 0.004X_5 - 0.458X_6 + 0.079X_7 - 13.167X_8 \quad (4)$$

Once the values of the line of the equation of the model of linear equation are obtained, the next step is to obtain the graphic of the prediction of the agricultural performance estimated for 2017 considering the same meteorological and broccoli production conditions.

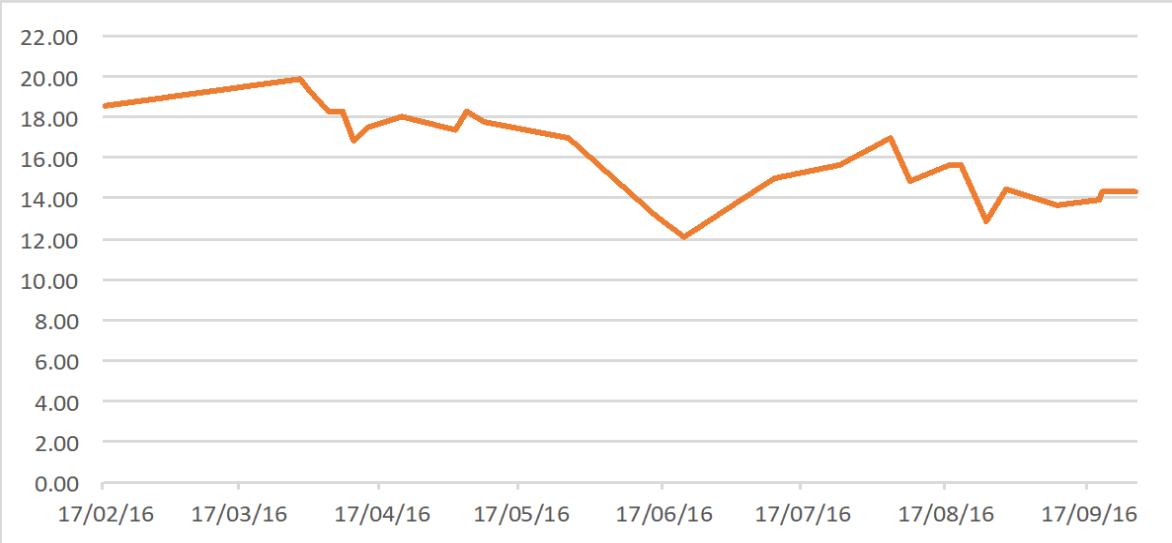

Figure 2. Projected total performance for 2017

As it can be seen in Figure 2, the forecast production model of broccoli for 2017 shows a more regular production and the fluctuations that are shown in such figure are lower than the ones obtained without the model. Therefore, the development of the agricultural forecast production model, obtained through the analysis of linear regression, improves considerably the performance estimated for the family agro-industrial enterprise. Furthermore, these result allow executives the creation of a more effective and efficient planning model since the fluctuations of the production level, as it can be seen in Figure 2, are less accentuated and the performance of broccoli production tend to be higher than the one obtained without the implementation of the forecast model of agricultural production.

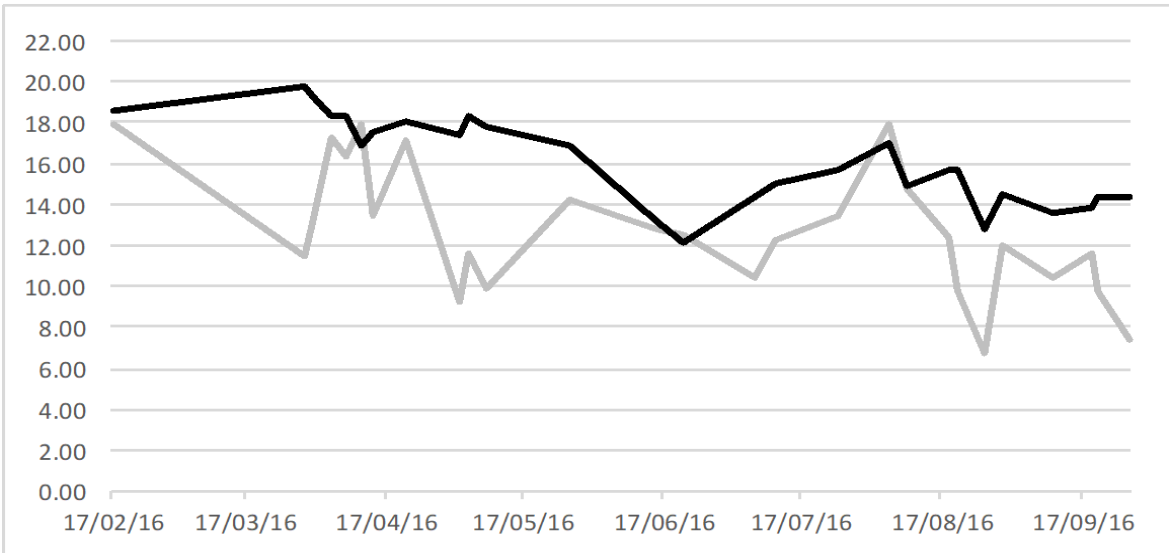

Figure 3. Total performance obtained vs. projected

Figure 3 shows both the production of broccoli during 2016 (the lighter line) and the production estimated for 2017 (the darker line), and it can be observed clearly the existing differences between both production which can provide enough empirical evidence about the importance of forecast models of agricultural production at a business level as well as the several benefits it provides to agro-industrial family enterprises that adopt them and implement them, including an adequate planning which is effective and efficient in the systems of agricultural production, a significant

decrease in the level of uncertainty in the production forecast, a significant improvement in the commercialization system of foods and a better level of sustainable development, among others.

5. Discussion and conclusions

The results obtained in this empirical research can help to conclude in two main aspects. Firstly, the process of agricultural production of the agro-industrial family firms in Mexico has some problems that are important to highlight because, according to the production data obtained and recorded in 2016, there are different production levels in the four seasons of the production of broccoli since the first production of the year tends to go down. The second one has a significant increase and in the third and fourth productions, there are different levels of growth and regression of the production. This creates severe problems not only in the planning process but also in the commercialization system of broccoli.

Secondly, the forecast production model of broccoli for 2014, considering the same prevailing meteorological conditions during 2016, creates better conditions of the production of broccoli by reducing the level of uncertainty and increase significantly the efficiency in the forecast level of the systems of agricultural production. Moreover, the improvement in the efficiency of the forecast production model of broccoli will allow the management of the family enterprise a better decision making process by having a forecast model of agricultural production that, once it has the meteorological information and the data of the plant, it will facilitate the production processes and system as well as the sale of broccoli.

Similarly, these results contain a series of implication for both the management of the family enterprise and the organization as a whole. In the case of the management, one of the most important implications that these results produce is that the agro-industrial activities have to be reassigned to the staff of the enterprise so there are enough employees to collect all the necessary information from both the process of sowing the broccoli and the meteorological conditions that are taking place in the field because the quality of the information is essential for the development of the forecast model of agricultural production. So, the more and the better the information can be obtained from all the variables that participate in the production process of broccoli, the better the development of the forecast model.

Furthermore, the manager of the agro-industrial family firm has to assign a staff member to be in charge directly of the reception, organization and management of the information from the different areas of the company so this employee can enter the data into the forecast production model and manage it. In this regard, if the employee assigned to the management of the forecast model does not have the necessary knowledge and skills for the development of these important activities, then the management will have to look for some training courses or workshops regarding the use and management of information and communication technology, database and interpretation of statistical data.

Additionally, the management of the agro-industrial family firm will have to provide the necessary economic resources to acquire agro-technology of information and communication in order to collect the information (both agricultural and meteorological), through electronic devices so it becomes more efficient and effective. Therefore, the agro-technology obtained by the family enterprise will be essential to feed the forecast model in real time and create the predictions of the production of broccoli, or any other agricultural product, which will facilitate the development of an adequate planning of production as well as the commercialization activities of the agro-industrial products.

In this trend of ideas, the agro-industrial family firm will have the opportunity to have an electronic forecast production system which will be able to produce several competitive advantages regarding their main competitors as they will have information of the production level of foods in real time and at the same moment when the model is fed. In this regard, the family enterprise will have reliable information that can facilitate the development of an adequate planning of the production and sale of broccoli in the market in which the enterprise participates. This will contribute with a significant cut on the response time to the orders placed by their main national and international clients, as well as a decrease in the total costs of the organization.

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References

Akerele, D. and Odeniyi, K.A., Demand for diverse diets: Evidence from Nigeria. *Proceedings of the 89th Annual Conference of the Agricultural Economics Society. University of Warwick, Warwick*, April 5, pp. 13-15, 2015.

Akerele, D. and Musediku, S.A., Can food production diversity influence farm households' dietary diversity? An appraisal from two-dimensional food diversity measures. *International Journal of Social Economics*, vol. 4, no. 12, pp. 1597-1608, 2017.

Aranda, A., Ferreira, G., Mainar-Toledo, M.D., Scarpellini, S. and Llera, S.E., Multiple regression models to predict the annual energy consumption in the Spanish banking sector. *Energy and Building*, vol. 49, no. 1, pp. 380-387, 2012.

Baek, J., Kang, J., and Lee, I., Business groups and tunneling: Evidence from private securities offerings by Korean Chaebols. *Journal of Finance*, vol. 61, no. 5, pp. 2415-2449, 2006.

Carletto, G., Ruel, M., Winters, P., and Zezza, A., Farm-level pathways to improved nutritional status: Introduction to the special issue. *The Journal of Development Studies*, vol. 51, no. 8, pp. 945-957, 2015.

Chatterjee, A.S.H.S. and Price, B., *Regression Analysis by Example*. 3th Edition. New York, John Wiley & Sons, NY., 2000.

Cheong, F. and Thomas, J., Why do EPS forecast error and dispersion not vary with scale? Implications for analyst and managerial behavior. *Journal of Accounting Research*, vol. 49, no. 2, pp. 359-401, 2011.

Claessens, S., and Fan, J., Corporate governance in Asia: A survey. *International Review of Finance*, vol. 3, no. 2, pp. 71-103, pp. 2002.

Draper, H.S.N.R., *Applied regression Analysis*. 3th Edition. John Wiley & Sons, NY., 1998.

Duru, A., and Reeb, D., International diversification and analysts' forecast accuracy and bias. *The Accounting Review*, vol. 77, no. 2, pp. 415-433, 2002.

FAO., *The state of food insecurity in the world 2013: The multiple dimensions of food security*. FAO, Rome, 2013.

Filatotchev, I., Zhang, X., and Piesse, J., Multiple agency perspective, family control and private information abuse in an emerging economy. *Asia Pacific Journal of Management*, vol. 28, no. 1, pp. 69-93, 2011.

Francis, J., Schipper, K., and Vicent, L., Earnings and dividend informativeness when cash flow rights are separated from voting rights. *Journal of Accounting and Economics*, vol. 39, no. 2, pp. 329-360, 2005.

Frison, E., *Agricultural biodiversity and traditional foods: important strategies for achieving freedom from hunger and malnutrition*, 34, SCN News, 2007.

Gopalan, R., and Jayaraman, S., Private control benefits and earnings management: Evidence from insider controlled firms. *Journal of Accounting Research*, vol. 50, no. 1, pp. 117-157, 2012.

Graham, J., Harvey, C., and Rajgopal, S., The economic implications of corporate financial reporting. *Journal of Accounting and Economics*, vol. 40, no. 1/3, pp. 3-73, 2005.

Greene, W.H. (1997). *Econometric analysis*. 3rd Edition. Englewood Cliffs, Prentice-Hall, NJ., 1997.

Hassell, J.M., and Jennings, R.H., Relative forecast accuracy and the timing of earnings forecast announcements. Accounting Review, vol. 61, no. 1, pp. 58-75, 1986.

Haw, I., Bingbing, H., and Wu, W., Ultimate ownership, income management, and legal and extralegal institutions. *Journal of Accounting Research*, vol. 42, no. 2, pp. 433-463, 2004.

Hawkes, C., and Ruel, M.T., Understanding the links between agricultural and health. *Focus*, vol. 13, no. 1, pp. 1-16., 2006.

He, J., and Tian, X. The dark side of analyst coverage: The case of innovation. *Journal of Financial Economics*, vol. 109, no. 3, pp. 856-878, 2013.

Heo, J.S., and Kim, D.S. A new method of ozone forecasting using fuzzy expert and neural networks systems. *Science of the Total Environment*, vol. 325, no. 1, pp. 221-237, 2004.

Hope, O. Accounting policy disclosures and analysts' forecasts. *Contemporary Accounting Research*, vol. 20, no. 2, pp. 295-321, 2003.

Huang, S.X., Pereira, R., and Wang, C., Analysts' coverage and the likelihood of meeting or beating analyst earning forecast. *Contemporary Accounting Research*, vol. 34, no. 2, pp. 871-899, 2017.

Hutton, A., Determinants of managerial earnings guidance prior to regulation fair disclosure and bias in analysts' earning forecasts. *Contemporary Accounting Research*, vol. 22, no. 4, pp. 867-914, 2005.

Jensen, M., and Meckling, W., Theory of the firm: Managerial behavior, agency costs, and ownership structure. *Journal of Financial Economics*, vol. 3, no. 4, pp. 305-360, 1976.

Jim, T., Yahui, W., and Xuemei, F., Monitoring system of cold chain logistics for farm fresh problem. *Journal of Jilin University (Engineering and Technology Edition)*, vol. 43, no. 6, pp. 1707-1711, 2013.

Johnson, S., La Porta, R., Lopez-de-Silanes, F., and Shleifer, A., Tunneling. *American Economic Review*, vol. 90, no. 2, pp. 22-27, 2000.

Jones, A.D., Shrinvas, A., and Bezner-Kerr, R., Farm production diversity is associated with greater household dietary diversity in Malawi: Findings from nationally representative data. *Food Policy*, vol. 46, 1-12, 2014.

Keding, G.B., Msuya, J.M., Maass, B.L., and Krawinkel, M.B., Relating dietary diversity and food variety scores to vegetable production and socio-economic status of women in rural Tanzania. *Food Security*, vol. 4, no. 1, pp. 129-140, 2012.

Khurana, I.K., Raman, K.K., and Wang, D., Weakened outside shareholder rights in dual-class firms and timely loss reporting. *Journal of Contemporary Accounting & Economics*, vol. 9, no. 2, pp. 203-220, 2013.

Leuz, C., Nanda, D., and Wysocki, P.D., Earnings management and investor protection: An international comparison. *Journal of Financial Economics*, vol. 69, no. 3, pp. 505-527, 2003.

Malapit, H.J.L., Kadiyala, S., Quisumbing, A.R., Cunningham, K., and Tyagi, P., *Women's empowerment in agriculture, production diversity, and nutrition: Evidence from Nepal*. IFPRI Discussion Paper. International Food Policy Research Institute. Washington, DC, 2013.

Manning, L., Baines, R.N., Chadd, S.A., Quality assurance models in the food supply chain. *British Food Journal*, vol. 108, no. 2, pp. 91-104, 2006.

McDermott, J., Ait-Aissa, M., Morel, J., and Rapando, N., Agriculture and household nutrition security-development practice and research needs. *Food Security*, vol. 5, no. 5, pp. 667-678, 2013.

Montgomery, G.C.R.D.C., *Probabilidad y Estadística Aplicadas a la Ingeniería*. 2a Edición. Limusa, Mexico, 2004 [in Spanish].

Neter, M.H.K.J., Nachtsheim, C.J., and Wasserman, W., *Applied linear statistical models*. 4th Edition. McGraw-Hill, Chicago, 1996.

Peña, D., *Regresión y diseño de experimentos*. Alianza Universitaria de Textos, Madrid 2002 [in Spanish].

Qaim, M., Andersson, C.I.M., Chage, C.G.K., Kimenju, S.C., Klasen, S., and Rischke, R., *Nutrition effects of the supermarket revolution on urban consumers and smallholder farmers in Kenya*. AAEA Annual Meetings, Minneapolis, MN, July 27-29, 2004.

Remans, R., Flynn, D.F., Declerck, F., Diru, W., Fanzo, J., Gaynor, K., Lambrecht, I., Mudiope, J., Mutuo, P.K., Nikhoma, P., Siriri, D., Sullivan, C., and Palm, C.A., Assessing nutritional diversity of cropping systems in African villages. *PLoS One Journal*, vol. 6, no. 1, pp. 21-35, 2011.

Sambharya, R.B., Security analysts' earnings forecasts as a measure of firm performance: An empirical exploration of its domain. *Management Decision*, vol. 49, no. 7, pp. 1160-1181, 2011.

Shleifer, A., and Vishny, R., A survey of corporate governance. *Journal of Finance*, vol. 52, no. 2, pp. 737-783, 1997.

Sibhatu, K.T., Krishna, V.V., and Qaim, M. Farm production diversity and dietary diversity in developing countries. *Proceedings of the National Academy of Sciences USA (PNAS)*, vol. 112, no. 1, pp. 10657-10662, 2015.

Sousa, S.I.V., Martins, F.G., Alvim-Ferraz, M.C.M., and Pereira, M.C., Multiple linear regression and artificial neural networks based on principal components to predict ozone concentrations. *Environmental Modelling & Software*, vol. 22, no. 1, pp. 97-103, 2007.

Thiele, S., and Weiss, C., Consumer demand for food diversity: Evidence from Germany. *Food Policy*, vol. 28, no. 2, pp. 99-115, 2003.

Thompson, M.L., Reynolds, J., Cox, L.H., Guttorp, P., and Sampson, P.D., A review of statistical methods for the meteorological adjustment of tropospheric ozone. *Atmospheric Environment*, vol. 35, no. 1, pp. 617-630, 2001.

Tinaikar, S., Voluntary disclosure and ownership structure: An analysis of dual class firms. *Journal of Management & Governance*, vol. 18, no. 2, pp. 373-417, 2014.

World Bank. From agricultural to nutrition: Pathways, synergies, and outcomes. The World Bank, Washington, DC, 2007.

Xinqing, X., Qile, H., and Zetian, F., Applying CS and WSN methods for improving efficiency of frozen and chilled aquatic products monitoring systems in cold chain logistics. *Food Control*, vol. 60, no. 1, pp. 656-666, 2016.
Xinqing, X., Xiang, W., and Xiaoshuan, Z., Effects of the quality property of table grapes in cold chain logistics-integrated WSN and AOW. *Applied Sciences*, vol. 5, no. 4, pp. 747-760, 2015.
Yu, F., Analysts' coverage and earnings management. *Journal of Financial Economics*, vol. 88, no. 2, pp. 245-271, 2008.
Yujun, W., Jianjun, W., and Xioamin, Z., Developing and ontology-based cold chain logistics monitoring and decision system. *Journal of Sensor*, vol. 2, no. 4, pp. 1-8, 2015.
Zhang, H., Qiu, B., and Zhang, K., A new risk assessment model for agricultural products cold chain logistics. *Industrial Management & Data Systems*, vol. 117, no. 9, pp. 1800-1816, 2017.
Zhang, X., Wei, J.T., and Wu, H.H., Family firm and analyst forecasts in an emerging economy. *Management Decision*, vol. 55, no. 9, pp. 2018-2037, 2017.

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