International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-8, Issue-8; Aug, 2021
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.88.9

Modeling and Decision Making Applied to Agriculture

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Received: 19 Jun 2021;
Received in revised form: 20 Jul 2021;
Accepted: 02 Aug 2021;
Available online: 11 Aug 2021

Keywords*— *Decision Making. Modeling. Agricultural. Quali-quanti analysis.

***Abstract*—** *The study analyzed the variables that interfere in the choice of the soil cultivation system, using conventional and/or biodynamic agricultural practices for Vitis vinifera grapes production. The method was an exploratory and descriptive study of quali-quanti analysis. The intentional sample, for convenience and not probabilistic, had 26 vineyards of Vitis vinifera Chardonnay being 19 vineyards of the conventional cultivation system and 07 in transition to the cultivation system using biodynamic agriculture practices. It was concluded that economic variables are the driving force in decision making more than the environmental or social issues in the management of the cropping system, as well as it was noticed the tendency that some properties are looking for new cultivation practices. In the case of biodynamic agriculture, however, it is still tenuous signal that, in this case, the environmental issues could gain a greater value in equalization of alternatives for decision making in vineyard management and especially in soil care.*

I. INTRODUCTION

The present study consists of analyzing the variables that interfere in the choice of the soil cultivation system using conventional and/or biodynamic agricultural practices for the production of wineries.For this, the data under analysis consisted of two bases, namely: a) the reports in the interviews, relating them to cognitive biases and errors arising from the limitation of rationality; and b) technical information during participation in field activities in the vineyards participating in the study. The theoretical framework was supported by the Theory of Limited Rationality [1]; [2]; [3]; [4]and by the Theory of Contingency[5]; [6].

The identification of the variables that influence the tradeoff in the management of the agricultural production unit is of paramount importance, which is justified by the need for the manager to be able to find mechanisms that enable a more satisfactory decision-making or in accordance with the proposed business objectives. Scenarios are often adverse to the proposed business objectives, making the manager need to make choices that best meet the cost-benefit ratio for his property. These are alternatives known as the classic model of rational decision making. Cognitive influences and biases can, however, privilege decisions based on intuition that, at that moment, are sufficient to achieve the expected results. In this case, the situation may be associated with the model based on contingency theory [1]; [3].

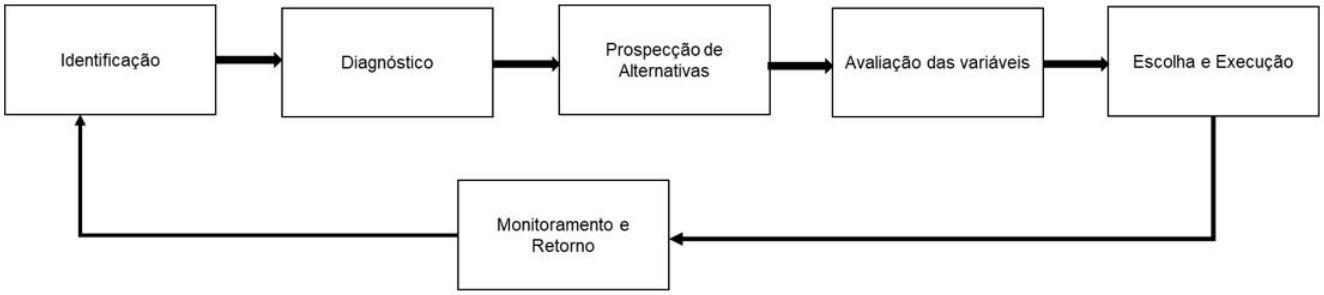

Fig.1: Decision making process

Source: Adapted from Sobral and Peci[7].

The process, whatever the reference model, is a sequence of at least six phases or steps, becoming systemic at the time the decision result is evaluated. The phases or steps can be sequential or present systems internal to the process when, for example, a step presents a limitation or inconsistency due to a previous step, and when the alternatives prospected in the next step do not satisfy the decision maker, this would be the case to redo the diagnosis more often and with more depth. It is important to raise this alternative of internal subsystems to the complete, six-stage system, as it approaches the way in which the organizational decision-making process takes place, especially in the process involving agricultural activity, where the number of intervening variables is, theoretically, infinite.

In this scenario, the decision maker needs to choose those variables that he/she considers relevant at that time and for that situation, dispensing with the others so that he can respect the time he has to make such a decision. The difference between the processes is in the way the information is used. The balance between the information collected and the choices made by managers is what can guarantee an optimal or sub-optimal result in the decision-making process. At the same time, the manager's perceptual, reactive and adaptive capacities can contribute to the decision-making process when making choices in the management of the agricultural unit, including those related to the conduct of agricultural land use in vineyards.

The managerial decision process is influenced by variables that can be classified as internal and external influences to production units. The important thing is to equalize the opportunity cost in view of the trade off of internal variables, which are the following questions: a) what to produce?; b) how to produce?; and the external variables represented by the questions: a) how much to produce?; and b) when to produce? It is observed that the use of a sub-optimal choice can be seen as the result of a rational cost/benefit approach in relation to strategy selection [8].

Tversky and Kahneman[9] draw attention to human limitations in the decision-making process, as both emotions in the face of facts and lack of knowledge can influence the understanding of facts. In this case, the search is for a satisfactory solution rather than an optimal one.

The decision must be seen as a set of aspects that can be controlled and others that cannot. These aspects are identified as internal and external variables that serve as indicators to consider the alternatives to make choices in conducting the soil cultivation unit. These aspects compete with each other, and some of them end up weighing heavily in the decision-making phase. In parallel, the decision process never fails to prospect the possible and probable outcomes related to the choices. This is the step that can be called the “result”. The process and the prospected result, in turn, influence each other, forming, at this level, a system that is also flexible and dynamic. These two systems reinforce the personal aspects of the internal decision of subsystem “I”, as well as their convictions regarding the internal sustainability of subsystem “II”. For Andrade et al[10], in certain situations, decision makers may be acting based on restricted information.

Furthermore, they may be conditioned by the ability of the human mind to process, formulate and solve complex problems. A rational and structured decision, in this case, would lead to the use of specific, systematic and directional biases to make their choices. Therefore, a satisfactory solution ends up being adopted with a high frequency.

Because of this, the problem-question that supports the present study is: how can the evaluation of the variables that interfere in the decision-making process help in choosing the cultivation system in the agricultural unit? For this, the internal and external variables that are part of the opportunity cost and are present in the equalization of alternatives in the decision-making process of any organization will be evaluated, and, theoretically, they are independent of the economic segment or its dimension. Further on, its application to Vitis vinifera production units was verified.

1.1. DECISION MAKING BASED ON THE CONTIGENCE THEORY

The Contingency Theory allows the understanding of organizations in a dynamic environment, requiring an interpretation of external and internal variables to the system, as they are mutually influencing the behavior of organizations in the macro environment.

For Donaldson[11], internal and external variables interact dynamically, which makes it difficult to accurately predict the results of choices, making it necessary to measure risk and the ability to be predisposed to uncertainty. To understand the functional relationship between environmental conditions, Contingency Theory seeks to be effective in identifying environmental conditions and administrative practices so that they are always in harmony [11]. The dynamics of the internal and external environments show that nothing there can be considered absolute, as everything is relative and everything depends.

Thus, the techniques and the environment that cause the influences do not have a cause-and-effect relationship, but rather as a system, because regardless of the cause or effect, the choices are justified by "everything depends" without a methodological sequence, because in the contingency theory, everything will depend, including the adaptive or reactive capacity that cognitive biases can have a preponderant influence on the manager's choices, resulting in new effects and causes that influence the environment that will present adverse or favorable reactions to the objectives and expected results in decision making.

According to Donaldson [11], Structural Contingency Theory developed as a puzzle, in which the insights of various theorists contributed to its empirical support. Burns and Stalker [12] analyzed the mechanical and organic external environment, Woodward [13] approached technology as a contingency factor, Lawrence and Lorsch [14] studied the relationship between structure and environment, Hage [15] and Perrow [16] wrote about technology and structure, and Chandler[17]; [5] analyzed the strategy-structure relationship, providing the background of this theory and offering support from real organizations.

The organizational structure was continuously adapted to its marketing strategy. In Chandler's[17]; [5] perception, the time of decision-making processes in a company's internal environment, such as choices of raw materials and production processes, remains relatively invariable, business decisions have a smaller impact on the business structure due to greater control of variables indoor environmental “what to do”? "And how to do it" When, however, do technology, markets and sources of supply change that external “when to do” variables are considerable? And “how much to do”? The dysfunctions of the structure become more evident and the strategies end up focusing on the architecture of the organizational structure [17]; [5].

The Contingency Theory can help farmers in the relationship with care in the agricultural unit, improving their ability to choose in the face of uncertainties in the external environment and the risks exposed by the internal environment. Beach and Mitchell[18] identify the steps that allow a driver for the decision maker and are related to the following questions: a) what to do? and b) how to do it? These questions allow you to look at the property's internal environment and, with this, not only assess its strengths and weaknesses, but also direct its efforts to achieve the established objectives and purposes.

Other questions that allow a look at the perception and quantification and qualification of the variables that are present in the environment outside the organization are: a) how much to do? and b) when to do it? These inquiries allow analyzing the potential and threats of the external environment, and show alternatives in relation to the market's behavior in a given period of time. For Beach and Mitchell[18], the categories of opportunity cost variables start from a strategy to make choices in the care of the unit's soil with the purpose of reaching its maximum utility in agricultural cropping systems. Collecting information, as well as costs and benefits, provides an attractive framework as it considers task efforts and contingent processing behavior [19].

In this way, the process that allows for the permanent interaction of internal and external aspects lies in the four questions of opportunity cost, which are: What to do? How to make? When to do it? How much to make? Which, somehow, support the interaction of purposes and direct prospects for possible results.

Contingency Theory is very similar to Limited Rationality; the first uses the "everything depends" on "n" variables that, in this case, could result in an "optimal" or sub-optimal decision". The decision role can be seen as the result of a rational cost/benefit approach related to strategy selection [20]. In particular, it assumes the existence of Simon's Limited Rationality[1]on the part of the decision maker. A decision process conditioned to Limited Rationality requires choices with a certain degree of certainty, a certain degree of limitation of information, time, cost and also cognitive capacity, which can often lead to disruptions in the alignment of objectives and purposes, as the The individual believes that limitations are part of the contingency and, at the same time, that, based on his decision, everything will depend on new actions that are not yet possible to perceive.

The decision maker, in this situation, is limited to the time and information available in a state of trade off in which he allows himself to rationalize the usefulness of the choice for the desired results. Therefore, Limited Rationality is constituted by: a) situational limitations, which are a function of the complexity of the situation itself and the set of restrictions; and b) individual limitations, which are a function of the decision maker's ability to perceive and process information. Thus, decision makers try to be rational, however, they hardly manage and act using full rationality, which happens due to factors such as incomplete data and even the inefficiency of technical advice. The decision maker, when opting for an alternative in solving the questions, foregoes others that could be better, if the knowledge of the variables were greater.

For Schneider[21], decision-making in agriculture results from strategies that occur subject to social, cultural, economic and spatial factors. These factors exert constant and variable pressure on the agricultural production unit. Therefore, the decision-making process has a framework that, in exercise, is materialized through the social, cultural and economic relations established between people. Thus, the author considers that, although these are conscious and theoretically rational strategies, this awareness is mediated by a rationality informed by reality that is both the expression of present material relations and those inherited and culturally transmitted.

Therefore, strategies are not causal or teleological, but rather the result of human action in the face of objective contingencies [21]. The author also emphasizes that, among the factors that seek social, economic and cultural reproduction resulting from the relationship between individuals and their families, there are: a) improvements in housing; b) well-being; c) progress in the production unit; and d) the material possibilities of achieving certain goals. With this, it is evident that social reproduction in family farming is the result of a set of factors that can be reinforcing or antagonistic, which vary over time and have flexible relative weights.

1.2. DECISION-MAKING PROCESS, LIMITED RATIONALITY OR INTUITION?

The trade-off, an equalizing issue between present and future results in a decision-making process, can be used to quantify and qualify the alternatives in the choices made in the management of the cultivation system.

Decisions in farm unit management can be formulated as multi-stage decision making. The process is characterized by a sequence of decisions taken to meet business objectives. Choices are linked to periods of time that divide the decision-making process, which can be called stages, representing the moments in which decisions are made.

Decision making is a dynamic process sustained over time [22]; [23] and [24]. Each stage requires a choice of alternatives, so the technical coefficients need to be updated and re-evaluated for the next choices. Faced with this, there is a behavior of adaptation and reaction of farmers.

The trade-off variables in agricultural land use decisions, for Slovic et al[25],affect the heuristic, "risk as feelings". According to this theory, intuitions about risky decisions are linked to previous experience by feelings or affective states (for example, the feeling that if I do not carry out the treatment against pests, it can influence the amount of grapes produced). In the use of decision-maker cognition, Kahneman and Tversky [26] emphasize the heuristics and biases in the decision-making process. They are: a) an intuitive and/or emotional one, with quick response, with little effort, (System 1); and b) another one of "labor mental activities", "complex calculations", "choice and concentration", (System 2) considered rational.

The Theory of Limited Rationality, on the other hand, has the advantage of "providing satisfactory descriptions of actual human behavior" [4].

With it, one must consider the factors that influence decision making, such as: a) past experiences; b) a variety of cognitive biases; c) an escalation of commitment and irrecoverable results; and d) individual differences, including age, income, local beliefs and customs. All these factors influence, to different degrees, the decision-making process and the decisions taken.

Therefore, both intuition and bounded rationality participate or can participate in the trade-off, forming systems that simultaneously self-reinforce. For Simon[2], the selection of information for decision making can be influenced by a series of influences, both from the internal and external environment of the organization. Often the decision maker is limited by his cognitive capacity, and the decision-making process is also limited by this capacity [2].

For Juliusson, Karlsson and Garling[27], past decisions influence the decisions people make in the future. It is expected that when something positive results from a decision, people are more likely to decide in a similar way, given a similar situation. On the other hand, people tend to avoid repeating past mistakes [28]. This is significant as future decisions, made based on past experience, are not necessarily the best decisions.

For Marques et al[29], the influence of information on the decision also depends on the management characteristics of farmers and, more specifically, on their theoretical models, formal or not.

The authors believe that:

> "... the decision maker, when making a decision, expects a certain result, or better: a set of results associated with a set of probabilities and objectives. Therefore, the consequences of a decision, whether to 'do' or 'not to do', can be considered as being 'foreseen'[29].

The decision-making process is complex and requires multiple assessments, with the formulation of variables and biases to parameterize decision-making. This process takes place through decision-making models. Models exert considerable influence on decisions, as individuals decide based on specific mental models, however, they should not be seen as a recipe to be followed, but rather as a tool for understanding complex elements [30].

When multiple complicated decisions come together and interact, variables are difficult to quantify or weigh against each other. Decisions become complex, such as: deciding which type of agricultural practice to adopt for a wine growing system. For this, it is necessary to consider some variables such as: a) type of climate; b) soil; c) vine; d) driving system; e) equipment; f) technology; g) available labor; h) market demand; and others. This involves risks and uncertainties that may be present both in the conventional agricultural system with synthetic and chemical treatments and, in the case of biodynamic agriculture, with its herbal and unconventional treatments using a calendar based on astrology that seeks a balance of the forces of nature. Variables are many and extremely difficult to equalize in a simple way.

A choice on the type of cultivation system that, at the very least, leads to a desired result needs to consider the choices made in conducting the cultivation of vines and, at the same time, the expectations of the production of wines with an identity. It is also desirable to have and consider information on the natural, human and financial resources available and suitable for the type of wine system chosen, which would facilitate the management of the production unit, regardless of the type of production system to be used to assess the capacity for the proper use of the natural resources.

. What the business requires are decisions that, at a minimum, meet the moral requirements with the sustainability of the environment, and that the economic and social results meet the purposes of the actors involved in the production chain. The questions of choice can also be an expression of reaction or just a condition of adaptation of the farmer in face of issues of the macro system of the production chain.

Decision-making, therefore, takes place with action in the choice of alternatives that best suit the characteristics of the business and the profile of the manager who brings, in his/her perceptions, cultural and social factors, economic concerns and concerns with natural resources. With this, it is possible to perceive the need to align perceptual, reactive and adaptive capacities in a harmonious and dynamic way in the management of cultivation of Vitis viniferas.

Gasson[31]shows that the producer's personal characteristics influence his decision-making process. Brandt [32],in his studies on the offer of agricultural products, points out economic, technological, ecological, institutional factors and uncertainties (arising from externalities beyond the farm gate). These factors and the information between them refer to the decision-making circumstances of producers, which are often sources of uncertainty (eg, climate, biological aspects, pests, diseases, etc.) and market conditions.

The uncertainties, subject to causing mismatches in the prediction of results in the agricultural sector, in the decision-making process, such as the accentuated complexity in agrarian systems, have their origin in the chemistry and physiology of the soil as well as in the technologies used, which also reinforces the differentiation of productivity and the role of farmers in the market [33].

Some strategies may be suitable to minimize uncertainties when using an adaptive and reactive profile in the face of complexity and uncertainties, such as, for example, seeking people to exchange experiences and guidance. This person can often be the cooperative's technician, the consultant, a neighbor, experiential courses or technical trips. Seeking help rather than someone to transfer responsibilities and penalties for choices can be desirable behavior for the decision maker.

1.3. DECISION MAKING MANAGEMENT IN THE CULTIVATION UNIT

Decision-making in the management of the cultivation unit requires experience, knowledge, as well as clarity of objectives. For Choo[34],goals have an impact on priorities, choices and the amount of information about the methods and processes by which tasks must be fulfilled, as well as the goals that need to be achieved. In other words: decision making is hardly the result of a structured, sequential and oriented process to solve a given need. In this case, Nutt[35]considers the opinions of people who can intervene in the decision-making process, since their experiences and choices lead to an acceptable decision process.

In the perception of March [36], decision making is an act oriented towards objectives and driven by problems in which the behavior of choice is guided by norms and routines, leading organizations and individuals to act in a procedural and intentionally rational way.. According to Simon [4], there are six basic elements to be considered in the decision-making process: a) decision maker: it is the individual who makes a choice among several action alternatives; b) objectives: what the decision maker wants to achieve with his/her actions; c) preferences: the criteria used to make the choice; d) strategy: the focus of action that is chosen to achieve the objectives according to available resources; e) situation: all aspects of the environment in which the decision maker is inserted and that directly interfere in his/her choice; and f) result: is the immediate effect of a decision strategy. Therefore, there is a systematic or random order, technical or intuitive, that will drive a final choice.

For Carrieri [37], rural producers, as agents of a production system, need to be aware of their agricultural reality and understand their real situation in alignment with the business objectives. Objectives can be rationally defined as centered on profitability, but regardless of the choice of agricultural cropping system. Many of the farmers consider agriculture to be a people-based industry with a family history. These characteristics are present in properties that grow vines in the Serra do Nordeste region in southern Brazil. The history of the vineyards is intertwined with that of the families who live there, being more than a simple business with a profit purpose.

The practice adopted in the execution of agricultural activities in the vineyard very much portrays the relationships of friendship, social interaction between neighbors, family members, and the values and customs of ancestors. Therefore, the trajectory of the people who live there connects with the history of each grape harvest. Thus, decision profiles are based on the global vision of their environment, which means being in agreement with the objectives they intend to achieve. Then, it starts to act and manage its production system, giving it a logic that is aligned with a rationality that is its own and conditioned by a physical, environmental, social, political and economic environment.

Decision-making, in this way, can be based on the influence received from social groups, neighbors, family members. It can be said that it is based on beliefs and/or "facts", or faith and is acquired from various sources, including formal information such as education, experience, peers and cultural environment (eg religion, education). This decision-making profile is close to the behavior of winegrowers who make use of biodynamic agriculture, since they form a system of interpersonal and collaborative relationships for the preparation of compounds and nutrients to take care of the cultivation and soil in their properties.

To do this, it is necessary to understand the component elements of every decision. For Simon [4], "... every decision is composed of two types of elements, called elements of fact and elements of value, respectively". In Jones'[38]view, decisions made by farmers are partly influenced by an expectation of financial profits and partly by family and cognitive factors. In this case, Ocaña, Vecino and Avilés[39]emphasize that the farmer, as a decision maker, is the result of a profile that is defined by the combination of socioeconomic factors (age, income, education, information, associations, management time, the succession process and others) and psychosocial (values, customs, religiosity, beliefs). The decision-making context is one in which the farmer tries to equalize the variables to seek a more relevant and satisfactory solution at a given time and that represents a great opportunity for

the expected results of his vine growing system, such as: relationship with "the that" to plant. Often this choice is limited to crops that have proven to have good yields in the region or that guarantee their subsistence in climatic conditions depending on the soil. Alternatives can also be defined in “how to do it”, and refer to the property's infrastructure. According to Mandelli[40],the cultivation of the vine goes through several stages ranging from sprouting, pruning, phytosanitary treatments, flowering and maturation of the grapes, which enables the organization of field work.

The decision maker also considers situations of externalities that depend on the market's behavior at a given time, which are "when to plant", which indicates the most appropriate period for planting or increasing the cultivation of a given vine, which is classified as a plant perennial, but that requires attention to the climatic conditions in the production regions, and also the question of "how much", which becomes a driver of the amount of area to be allocated for the cultivation of vines. If the ideal is the quantity of kilos of grapes or the degree of sugar or babo of the wine, which Will be responsible for the added value, which will indicate the expected finacial result at the time of the decision driver in the management of the vineyard’ land use.

. The farmer, in many cases, manages to develop the adaptive capacity to face the high levels of uncertainty and risk offered by the environment, elements that, in most cases, are not controllable by the farmers. These and other factors can be internal and/or external to the property, which is an open system [41]. Farmers need to know that a bad decision is as harmful to a vineyard as a contaminated vine graft and/or a type of vine that is not adaptable to the type of soil.

1.

In the case of using intuition for decision making, the individual adopts conceptual representations and the use of logic that make sense to a context, but with processes similar to those of perception, which provides speed, little effort and even the ability to individual engages in multiple tasks while using this system. When this individual uses rationality, the process is slower and demands more effort [1]. This is where, for example, criticism happens, since its ability to identify logics in different contexts makes it capable of doubt, which is nothing more than the ability to think of two or more alternatives of divergent choices, which does not happen in moments when the individual uses intuition [42].

II. MATERIAL AND METHODS

As for the typology, it can be considered that the research was an exploratory and descriptive study of quali-quanti analysis. For Gil [43], exploratory research aims to develop, clarify and modify concepts and ideas. The sample was intentional for convenience and not probabilistic. This type of data collection from a sample is used in exploratory and descriptive studies [44].

The steps of this study were: a) survey of bibliographic data; and b) data collection to analyze the choices in light of the criteria of weighting opportunity costs in researches for the choice of conventional or biodynamic cultivation system regarding the care and treatment of the soil and with the vine in the vineyard. The criterion for choosing the sample was the willingness of Vitis vinifera Chardonnay producers to participate. Obeying this delimitation, 19 vineyards of the conventional cultivation system and 07 in transition to the cultivation system with the use of biodynamic agriculture practices were found, totaling 26 vineyards.

The interviews were conducted individually, with visits to winemakers on their properties from June 6 to 28, 2018. With this, it was possible to carry out a direct and extensive observation. The questionnaire used was structured, made up of questions that help to equalize the trade off, such as questions about opportunity cost. This collection tool was adapted from the validated study in **Dalcin** [45].

Data processing was performed using the Statistical Package for Social Sciences 18 (SPSS) statistical program, with correlation tests to analyze the data obtained in the collection of interviews carried out in the viticulture properties of conventional and biodynamic systems.

III. ANALYSIS AND DISCUSSION

According to the rational choice model of decision making, individuals decide in a mechanistic way, delimited by a guiding objective which, in commercial and productive organizations, is profit. This objective also serves as a thermometer to signal the vitality of the business. However, in all types of enterprises, especially in the agricultural sector, decisions based only on this factor do not guarantee the longevity of natural resources, which are necessary inputs to actually promote profit.

Therefore, most managers started to consider other variables in the decision-making process, such as the ability to intuit and also know that their choices “depend” on contingent situations that lead to the expected results. According to Schneider[21], rural producers are conditioned to social, cultural, economic and spatial factors that exert pressure on their production units.

Inherited expressions are present, such as fears and care in their choices in conducting the crop, for example.

With the results of the research carried out in the field, it was possible to perceive the mechanistic way in the behavior of winegrowers, both those who still use the conventional system for treating their vines and those who opted for an unconventional system of soil care. The results collected in the interviews and direct observations carried out show that the use of biodynamic agriculture practices is still in its infancy. It can be said that those who are migrating to this system of cultivation practices are in a process of adjustment in every way. These adjustments can be seen from the conduct of soil care, as well as in the transformation of the behavior of winegrowers in the approach to the philosophy that underlies biodynamic agriculture, which is anthroposophy.

It can be seen that, so far, in the vineyards that have migrated to the practice of biodynamic agriculture in the production of Vitis vinifera Chardonnay, there has been "an adjustment of agricultural cultivation techniques". This means a concern with the balance of the ecosystem, with fertility and good soil quality. It was possible to notice the concern of the managers of the production units in using less aggressive techniques and treatments to the environment, especially in soil treatments.

Table 1: Correlation of the Economic variable.

Correlations

		QtoP_ Ambiental-Recursos_ Naturais	QtoP_ Econômico_ Recursos_ Financeiros	QtoP_Social _Recursos_ Humanos	QdoP_ Ambiental-Recursos_ Naturais	QdoP_ Econômico_ Recursos_ Financeiros	QdoP_Social _Recursos_ Humanos
OQP_Ambiental-Recursos_Naturais	Pearson Correlation	-,106	-,170	,039	-,067	-,446*	-,077
	Sig. (2-tailed)	,606	,407	,851	,746	,022	,710
	N	26	26	26	26	26	26
OQP_Econômico_ Recursos_ Financeiros	Pearson Correlation	,223	,352	-,332	,117	,000	,308
	Sig. (2-tailed)	,275	,078	,098	,571	1,000	,125
	N	26	26	26	26	26	26
OQP_Social _Recursos_ Humanos	Pearson Correlation	-,234	,084	-,229	-,220	-,506**	,113
	Sig. (2-tailed)	,250	,683	,261	,279	,008	,583
	N	26	26	26	26	26	26
CP_ Ambiental-Recusros_Naturais	Pearson Correlation	,437*	,155	-,184	,048	-,147	,295
	Sig. (2-tailed)	,026	,450	,369	,816	,473	,143
	N	26	26	26	26	26	26
CP_Econômico_ Recusros_ Financeiros	Pearson Correlation	,050	-,028	-,086	,047	,502**	,054
	Sig. (2-tailed)	,809	,890	,675	,820	,009	,793
	N	26	26	26	26	26	26
CP_Social _Recursos_ Humanos	Pearson Correlation	,090	-,328	,303	,028	,302	,032
	Sig. (2-tailed)	,663	,102	,132	,891	,134	,875
	N	26	26	26	26	26	26

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Survey Data (2020).

As shown in the data in Table 1 for the correlation of the Economic variable in the item of financial resources in relation to "how to produce" and "when to produce", the result was a moderate correlation of $R^2 = 0.502$, perfect positive. This means that the decision maker concentrates on evaluating the economic variables at 50.2%, and that he reserves 49.8% for the other variables. The other variables are related to Environmental and Social issues. Therefore, the decision maker's concerns are balanced when assessing the opportunities to make the choice of the agricultural cropping system for a given time and type of crop.

for the manager's equalization in "how to produce", $R^2 = 0.437$ was found, perfect positive. The variables that constitute the Environmental-natural resources issues are in 43.7% correlated with the variable "how much to produce", having also the relevance for the Environmental issue, being one of the important factors to consider in the decision of how to achieve the amount of kilograms of vinifera. The opportunity cost variable of "what to produce", Environmental and Social factor, in relation to the variable "when to produce", Economic

issues, showed a negative correlation with R^2 = -446 and R^2 = -506, variables that imply social issues.

Biodynamic vineyards are characterized by young vines because the soil needs to go through a detoxification process with biodynamic treatments to receive cultivation in accordance with the guidelines of biodynamic agriculture. What was also noticed is that some winegrowers from conventional systems migrated to the use of biodynamic treatment [46].

In this cultivation system, in some cases, there may be a reduction in the planted area, as this system requires greater monitoring of care and greater involvement of the human being, which implies more labor, as well as an area with fewer vines per hectare. As a result, there was a reduction in the production volume in kilograms of grapes from the conventional to the biodynamic. On the other hand, the latter can, in theory, achieve a higher added value in the market, as well as a better quality of fruit characteristics.

According to the winegrowers of the biodynamic cultivation system, "it is a matter of changing their minds and seeking better quality of the fruit" (testimonial of the SCBD 004 vineyard manager), and for the SCBD 005 vineyard manager, "... to produce grapes with biodynamic practices and to preserve the soil pattern, biodiversity, and human health is not a unanimous reality, yet, but with the intention of improving."

Decision-making, regardless of the cultivation system adopted in the agricultural unit, presents risks and can also generate uncertainties due to some flaws in the decision-making process, such as the lack of reliable information and adequate tools that enable a correct assessment resources as well as adequate technical guidance; Add to that the limitations of cognitive ability inherent in human beings, and what you get is a sub-optimal choice for the moment (Limited Rationality). In parallel, the intuitive ability can also lead to choices that converge to a pessimistic or very optimistic scenario, which happens due to past experiences or beliefs or cultural imperatives. In this scenario, the choice is also just satisfactory.

The profile of decisions that the study shows is related to the characteristics of the vineyard model. Thus, for example, regarding the extension of the cultivation areas, it appears that the planting area has, on average, one hectare, many of which are family-oriented properties, and they present a strong valuation of the beliefs and guidance received from their predecessors and the sharing of experiences with neighbors, technicians and suppliers, all of which started to be considered of significant value when establishing the criteria for decision-making.

Deciding, in the face of complex situations in the management of the vineyard unit, requires the winegrower to innovate, even in his way of acting. There needs to be a detachment from beliefs and habits that do not contribute to the desired results, a focus on process innovation, as well as a commitment to issues in which it is necessary to follow procedures that require planning for long-term results and that denote many uncertainties and learning in the face of the new. In this sense, there is a need for adequate technical tools, information, monitoring and learning to enable the improvement of the management process.

Decision making is at the root of any organizational process. It is important to develop effective skills and strategies that allow problem solving, cost-benefit assessment and an examination of possible choices [47]. The decision-making process can be complicated and "overwhelming". As a result, the model that was perceived in the decisions of the sampled winemakers, both daily and long-term, has two sets of variables: internal and external.

The internal variables answer the questions: "what to produce" and "how to produce; the external variables answer: "when to produce" and "how much to produce". These issues are often inter-influenced and are not clearly defined for decision-making, as they are strongly influenced by different external agents or by the local culture or family values. A third process perceived in the interviews was the systematic relationship between what is being called here as internal and external variables. Decision making can be represented by alternatives of producing or not producing and rethinking the investment (adaptation or reaction).

The decision-making process can be facilitated by three decision support routines in order to reach a satisfactory alternative: a) control routine; b) communication; and c) policies [43]. Corroborating, Daft[48] includes the subjective variables of the intuitive field such as experience and common sense, as intuition is not despotic or irrational; it is based on years of practice and direct experience, accelerating the decision-making process. March and Simon[49] make it clear that most decisions, whether individual or organizational, involve the discovery and selection of satisfactory alternatives. Choo[43] explains that, for the most part, these alternatives are motivated by the occurrence of a problem, oriented towards the symptoms or towards an old solution and conjecture: the training, experience and objectives of the decision participants.

Decision makers in the agricultural unit individually seek to be rational through their behavior; however, as it is a complex process, they are subject to

limitations, often in terms of information and training. In this dimension, the farmer needs knowledge and agility in the search for competitiveness and even survival. In agricultural production, the complexity of the processes is accentuated due to the particularities of the activity, such as the influence of climatic variations, soil type, management and care with cultivation. It was possible to notice, in the interviews, that all these elements are present in the decision questions, although with different weights and a little disjointed.

Finally, the analysis of the results shows that the decision-making required the management of a flow of information that allows for a result that is not only satisfactory for a certain time, but rather a choice that leads to the sustainability of the business. It needs to be a choice that generates reliability and allows the farmer to react to adapt or react to an internal or external context. Their choices, in parallel, need to be in line with the longevity of the use of natural resources. Your decisions need to be consistent with maintaining the good quality and fertility of the soil in your vineyards.

The choice of a conventional and/or biodynamic agricultural cropping system goes beyond the capacity of a rational or intuitive choice. It is a choice that “everything depends” (according to Contingency Theory). In this specific case, knowing the physicochemical characteristics of the soil allows the use of a technical tool that will help in decisions on vine planting.

The analysis report allows knowing the soil profile and its nutrients, therefore the type of crop that is best suited to it, such as what, how, how much and when it should be cultivated in a given territory and time, which can greatly help decision on the choice of treatment management and vineyard management system and also indicate the regions with soil profile, climate and natural conditions that are best adapted to certain agricultural cultivation systems.

With the results found, it was noticeable that the winegrowers do not have knowledge or do not take into account the compatibility of soil characteristics and the type of crop that will be introduced in the place, but rather the economic result that has weight equivalent to the sum of all other variables that are part of the complex decision process, and, often, today's decisions can lead to unsatisfactory long-term results and even environmental and human health consequences, due to the choice of care for the soil and systems of cultivation with high intensification of fertilizer treatments.

IV. FINAL CONSIDERATIONS

Information is the limiting factor in decision making. Transparency and speed of data flow contribute to improve the efficiency of all components involved in the process, resulting in better management and, consequently, an efficient use of productive resources. Faced with the challenges of the trade-off, the decision maker needs to access and appropriate the tools and techniques that guarantee him to achieve or approach the desired results for that moment, given the conditions that present themselves in the context.

The relevance of choice valuation must also be intrinsically linked to the decision maker's cognitive capacity. With this, the influences absorbed in a trajectory of activities and coexistence in the environment are present, which may be to equalize decision-making with greater or lesser emotional or intuitive content due to experiences in previous events.

The time factor and environmental conditions for decision making are part of a dynamic and complex context that are not always considered to assess the ability to choose an optimal or sub-optimal decision. The item global knowledge of the problem and the individual's capacity must be related to the business objectives and aligned with its purposes. It means that your capacity for rationality acquires a range of perception in a larger radius, which facilitates access to alternatives that guarantee you, at the very least, choices that maintain the alignment of objectives with the expected results.

Farmers who work with the cultivation of Chardonnay vines, for the most part, decide with restricted information and often do not meet the needs of the company or family. It was found that the choice for an alternative cultivation system, with management and use of alternative techniques, in most of the properties participating in the research, was firstly due to the economic factor, followed by environmental concerns , represented by the care of the soil. This is due to the consequences that the soil of the region shows in technical reports of analysis of soil quality content and soil profile, such as the high accumulated indices of: a) copper due to treatments with “bordeaux syrup”; and b) other chemical additives influencing the vegetative process of the vines [29].

Soil properties influence mineral elements, organic acids, phenolic compounds and aromas, which are factors closely linked to the characteristics of the grapes cultivated in each soil of a region, causing changes in the sensory and chemical properties of the wine, interfering with the result of a good “terroir”.

The difficulties encountered and the concerns in adapting to a less conventional cultivation system, according to the manager of the SBD002 vineyard, "is due to the climatic conditions and the profile of the soil characteristics of the wine-growing regions in the Serra Gaúcha region, which have many variations that do not always favor the cultivation of Vitis vinifera".

Even so, the reduction in the use of chemical treatments in the vineyards has been gradually taking place on the properties participating in the study, until all the care and treatments of cultivation are carried out with the techniques of biodynamic agriculture. On the other hand, conventionally cultivated vineyards are still heavily dependent on the use of chemical products for pest control and cleaning between vine rows.

The relevant question was to analyze the variables that interfere in the choice of the soil cultivation system, with the use of conventional and/or biodynamic agricultural practices for the production of vineyards. The results showed that decisions are influenced by economic variables in the case here demand and value paid by the market, that is, financial profitability. That said, the valuation of economic issues is the driver in decision making, more than environmental or social issues in the management of the cultivation system in vineyards regardless of the system, that is, conventional or biodynamic.

The tendency of some properties is the search for new cultivation practices, in the case of biodynamic agriculture; however, it still faintly signals that environmental issues may gain greater weight in the equalization of alternatives for decision-making and, above all, the concern with climatic conditions and the proper use of the soil.

It should be noted that the study has its limitation in the analysis of only some of the variables that imply the tradeoff of opportunity costs, making it impossible to carry out an analysis with a greater number of variables that may be interfering in decision-making in vineyard management. Another limiting factor is the lack of a database with technical information about the properties and treatments and care for the soil that occurs with the two vine growing systems, also including winegrowers linked to the local Cooperative.

Finally, biodynamic agriculture is still a topic that needs to be studied, treatment tested, although its use began in the 20th century (in 1924), by Steneir (1861-1925), still today requiring new studies and scientific deepening, due to the its application is based on facts, reports and foundations in beliefs, customs and philosophy rather than scientific evidence and techniques recognized and validated, requiring care, as well as signaling possibilities for studies and research.

For future work, it is suggested to carry out a comparison of decision-making in the cultivation system and soil care in vineyards in the south of the country with other Brazilian wine-producing states, in order to validate the variables that interfere in the choices of the manager.

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