

Collaborative Agricultural Production using the Game Theory

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1 Context

Game theory is a branch of mathematics that studies strategic decision-making in interrelated situations. It assumes rational actors in a defined scenario; however, variations in social, cultural, and behavioral factors include the dynamic nature of the context [1]. It has been applied to various fields such as economics, politics, war and recently, agricultural production. Very little has been written in the agriculture or agro-economics sector about game theory or its applications, yet the practice of agri-production in relation with market demand and supply clearly involves multiple social situations with both cooperative and non-cooperative behaviors [2]. In the agricultural sector, where competition is fierce, farmers seek to maximize their yields in order to expect maximum profit. However, the law of the market does not always align with the ambitions of producers for a better net profit, especially when the market is invaded by overproduction. Thus, it is crucial to find a balance between cooperation and competition to achieve the best economic results. To determine the optimal quantity to produce in a collaborative production environment, game theory could provide a useful answer. Agricultural market modelling makes it possible to analyze how the quantity produced influences market prices, depending on the number of producers present [3]. When the number of producers is limited, a Nash equilibrium game is formed, where each producer chooses a quantity to maximize his own profits while considering the quantities produced by others [4]. On the other hand, when the number of producers is high, producers can opt for collaborative production aimed at collectively maximizing their profits by producing a predetermined quantity [5].

2 Research Objectives

The main objective of this thesis is to develop a novel technique based on the game theory that optimizes in a collaborative way the agri-production of individual growers, with the aim to maximize the profitability of every farmer, considering market data and environmental variables. To be specific, we will first model the market demand-supply processes of agri-commodities by exploring the market data in interaction with the agri-production volumes at the farm level. This modelling will aim at studying the impact of every unit of overproduction on the market price and farmer's net profitability. Secondly, we investigate embedding the game theory in collaboratively producing optimal volumes that meet market demand while ensuring better farmers' profits. Third, we evaluate the added value of collaborative agri-production in enhancing farmers' net profitability and stability of market supply.

3 Admission Criteria

The PhD position is available at Ai movement, the International Center for Artificial Intelligence of Morocco of UM6P in collaboration with the AgriTech Center of Excellence of UM6P. Applicants with excellent academic credentials must be holders of a Master's, an engineering, or an equivalent recognized degree with good skills in applied mathematics, in relation to machine learning and optimization. Past experiences in relation with agro-economics modelling are a bonus. The candidate should also be excellent in programming (Python, Java or C++), should have soft skills of problem solving, autonomy, and be fluent in English and French languages. Letters of recommendation are welcome.

References

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