Multi-Crop Planning Implemented at the Farmland Level

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Abstract

Nowadays, there is a great urge to present new methodologies in agricultural research. In fact, up to date, many optimization methods were suggested concerned with finding the right crop selection, implementing crop rotation and scheduling precise irrigation. Traditionally, Multi-Crop Planning (MCP) primarily focuses on maximizing the yield and the economic return per unit area by allocating water to different crops according to their water needs (Afshar and Mariño,1989; Onta et al.,1995; Garg and Ali,1998). With time, the studies that are related to MCP have switched to deficit irrigation and its impact on crop yield production (Garga and Dadhich,2014; Kumar and Reddy,2007; Noory et al.,2012)). The objective is regulating deficit irrigation in a way to save water by subjecting crops to periods of moisture stress with minimal effects on yields production. Unfortunately, all these studies optimize agricultural benefits by putting a general cropping plan. But there is no clear framework on how to implement the plan at the local level. As a result, several legitimate questions emerged: 1- What are the types of crops that have to be planted in each farmland within the planned area?; 2- What is the percentage of each crop type to be cultivated in each parcel?; 3- Can any suggested cropping plan on the local level guarantee equity among farmers or stakeholders? As a matter of fact, without setting any rules at the farmland level, the obvious scenario is most of the farmers will select the most profitable crop suggested in the general plan. As a result, the proposed plan will be highly selective without a clear framework and it will not be fully exploited. Our work here presents a Profit Distribution (PD) paradigm to resolve this issue based on a predefined cooperative policy. This method is effective in dealing with the complexity of managing profit among several farmland owners involved in the same agricultural project. In fact, the PD model is motivated by agriculture cooperative approach in profit

distribution. In a sense that, cooperatives provide a method for farmers to join together in an association, through which a group of farmers can acquire a better income (typically financial) than by going alone (Staatz,1987). This approach can be related to a form of economic synergy, where “two or more agents work together to produce a result not obtainable by any of the agents independently”, whereas the profit reimbursement (either through the dividend payout or rebate) is shared only amongst the farmer members. In this work, the maximum profit obtained from the MCP problem is distributed among farmers according to each one share without actual existence of an agriculture cooperative. The objective is to minimize the sum of profit absolute deviation in the course of distributing crops over farmlands or parcels. The outcome of PD formulation is a mixed integer linear programming model whereas its capabilities will be illustrated through its implementation on Bekaa Valley (Lebanon) during the cropping season.

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