# Chapter 10
# The Agricultural Routing Planning in Field Logistics

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## ABSTRACT

*The agricultural sector is facing the need to gain a higher yield on their fields while optimising their operations to stay competitive and satisfy the continuously increasing demand for produce. Cost reductions can be achieved by increasing the effective field size and reducing the operations without gain (e.g., driving longer distance to harvest the field). The agricultural routing planning (ARP) problem represents a specialisation of the travelling salesman problem (TSP) or vehicle routing problem (VRP) with focus on the agricultural operations and considerations of the field and vehicles configurations. In addition, various adaptations of the problem can be found in the literature that define a new problem class with specialised optimisation needs. This chapter introduces the ARP and reviews the past and current research and developments.*

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## INTRODUCTION

The globalisation of the agricultural sector has presented farmers with stronger competition, impacting especially on the market prices of their produce. Advancements in agriculture are generally associated with advanced seeds (Murphy, 2017), use of fertilisers, better resistance against diseases and pests, and water utilisation (Jones et al., 2017). While factors such as these potentially improve the productivity of cultivated areas, they do not address the deployment of humans and machinery for the purposes of harvesting and transporting the produce from the fields to storage areas. Several benefits are derived from optimising the utilisation of humans and machinery, namely, a reduction of time and cost thereby increasing profit. The cost of agricultural machinery is reduced; fewer seasonal workers need to be hired, and less time is required for bringing in the produce. This last factor is critical as the sizes of farms are increasing, yet the time window for harvesting remains the same.

Here, we set the focus on agricultural field logistics. This is related to the optimisation of the vehicle movements necessary to manage the fields including seeding, fertilisation, and harvesting, coordinate multiple vehicles as well as the movement between produce storage, field, and depot. Despite the resemblance with the VRP or TSP, the specific configuration of the problem as well as the utilisation of the vehicles justifies the introduction of a new problem class. Hereafter, we call this kind of agricultural machine planning problem "Agricultural Routing Planning" (ARP). The ARP addresses the movement and route planning of vehicles or machines to undertake several agricultural tasks on the fields. The assumption is that the field is traversed by a series of established tracks (orchards, vineyards, or agricultural fields with symmetrical planted seeds like crops or potatoes) that is accessible to larger agricultural machinery including harvester and possible accompanying agricultural vehicles. The existence of structured tracks supports the human drivers but also allows the operation of auto-steering agricultural machinery using programmable navigational computers and GPS guidance (Barrientos et al., 2011). The routing and planning optimisation is targeting a minimisation of the total distance driven to manage fields, reduce the number of vehicles, and synchronise multiple vehicles. Decisions to make include the selection of vehicles based on capacity and size, selection of areas to operate on, and order of tracks to traverse (Bochtis & Vougioukas, 2008).

Various models and optimisation methods for the ARP can be found in the literature. Multiple authors (Bochtis & Sørensen, 2009; Conesa-Muñoz, Bengochea-Guevara, Andujar, & Ribeiro, 2016; Gracia, Velazquez-Marti, Estornell, Vel Azquez-Martí, & Estornell, 2014; Zhou, Leck Jensen, Sørensen, Busato, & Bothtis, 2014) demonstrate how the agricultural routing planning problem can be described as