Extracting Trusted Pixels from Historical Cropland Data Layer Using Crop Rotation Patterns: A Case Study in Nebraska, USA

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***Abstract*—It is still a challenge to generate the timely crop cover map at large geographic area due to the lack of reliable ground truths at early growing season. This paper introduces an efficient method to extract "trusted pixels" from the historical Cropland Data Layer (CDL) data using crop rotation patterns, which can be used to replace the actual ground truth in the crop mapping and other agricultural applications. A case study in the Nebraska state of USA is demonstrated. The common crop rotation patterns of four major crop types, corn, soybeans, winter wheat, and alfalfa, are compared and analyzed. The experiment results show a considerable number of pixels in CDL following the certain crop sequence during the past decade. Each observed crop type has at least one reliable crop rotation pattern. Based on the reliable crop rotation patterns, a great proportion of pixels can be correctly mapped a year ahead of the release of current-year CDL product. These trusted pixels can be potentially used to label training samples for crop type classification at early growing season.**

***Index Terms*—Crop rotation, Crop Mapping, Land use classification, Cropland Data Layer**

I. Introduction

Ground truth is a crucial component of agricultural land use classification and modeling. An accurate crop cover map is commonly produced based on the reliable ground truth information. For example, Cropland Data Layer (CDL) is an annual product providing a massive amount of field-level (30-meter spatial resolution) land use information with overall 95% accuracy for the entire Contiguous United States (CONUS) [1], which has been used in many studies such as LULC change [2], flood mapping [3]–[5], national-scale cultivated area estimation [6], and crop time series modeling [7]. The procedure of CDL is based on a large number of reliable ground truths and the surveys from the farm agency. However, even though the internal use may be as early as mid to late growing season, the current-year CDL product is usually released for public use in the early of following year. A common issue for the in-season crop mapping is the lack of ground truth at early growing season. Thus an efficient way to gather ground truth information for the in-season agricultural applications is needed.

As a common agricultural practice, crop rotation has been widely used around the world since thousand years ago. The long-term crop rotation can affect crop yield as well as soil quality, such as fertility and soil physical/chemical properties [8]–[11]. Meanwhile, crop rotation information was used to support crop mapping. In [12], an approach for remote sensing-based regional crop rotation mapping was proposed. In [13], a Markov-based model of crop rotation was presented which is able to predict the early crop map without the actual remote sensing imagery. CropRota, a crop rotation modeling framework, was implemented to support agricultural land use assessment and management [14]. Based on the information of cropping sequence, we may find some reliable crop rotation patterns from the historical CDL time series. Then using these patterns to predict the crop type of cropland that follows the regular planting cycles. Once the latest CDL product becomes available, a map for the "trusted pixels" of CDL can be created even before the beginning of a growing season. These pixels can be used to make up the lack of ground truth at early growing season.

This study introduces an innovative method to extract trusted pixels from the historical CDL data based on crop rotation. Several common crop rotation patterns of major crop types in the Nebraska state of USA are investigated and evaluated. The accuracy and amount of trusted pixels for each crop rotation pattern is compared and analyzed. Section II introduces the data, study area, and method of trusted pixel extraction. Section III assesses the common crop rotation patterns in the study area and illustrates the map of trusted pixels. Section IV discusses the experiment results. Conclusions and future works are given in the section V.

II. Methods

A. Study Area

This paper demonstrates a case study in Nebraska, a mid-western state in the United States which lies in the western part of the Corn Belt region. It is one of the top agriculture production state in the United States with agricultural land of 45.2 million acres, which takes 91% of the state's total land area. The crop cover map and the land use information of the study area in 2017 are shown in Figure 1. The statistics show that corn and soybean are two dominant crop types in the Nebraska state. Besides, winter wheat and alfalfa account for 2% of total land area each. Other crop types, such as

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