

# 1. Agriculture

## Overview

GPS has revolutionized agriculture by allowing precision control of almost all aspects of farming. It provides direct operational benefits such as automated steering, and allows operation at night, in dust and in fog. This results in additional economic and environmental benefits including, for example, precision application of water, seeds, nutrients and pesticides, which saves money by applying only where needed and by avoiding overlapping and unneeded application. The direct economic benefits are estimated at more than US\$ 30 Billion annually.

## Utilization and Benefits

GPS is used extensively in agriculture from initial tillage to final harvesting. Precision at the inch and sub-inch levels can be achieved using corrections from nearby reference sites or from global reference networks delivered by satellite or the internet. Precision farming applications make use of the entire specified bandwidth of the GPS signal to achieve the high precision needed. For example, the injection of a small amount of fertilizer directly over a seed not only lowers the cost of the material used but also minimizes the environmental impact of the runoff of excess fertilizer into downstream watersheds. Estimates of the annual economic benefit in California alone exceed US\$ 2 Billion. Both the huge economic and environmental benefits which can accrue in some special situations is exhibited in an Australian study of “Controlled Traffic Farming” (CTF), in which precisely the same path is followed by the wheels of all farm implements such that no soil compaction occurs where the plants are grown. The benefits documented were: (1) 68% increase in farm gross margin; (2) 67% reduction in farm labor costs; (3) 90% reduction in soil erosion; (4) 93% reduction in nitrogen loss through soil runoff; (5) 52% reduction in CO<sub>2</sub> emissions; (6) 52% reduction in diesel use; and (7) 45% reduction in repair and maintenance costs. In like manner, water usage and pesticides can be minimized by precise control of the application.

## Threats

Although GPS is commonly used in open farm fields, very high precision in many applications is needed even when there is partial blockage of signals such as foliage along tree lined field boundaries. The high precision applications require wide bandwidths and very sensitive receivers to achieve the few inch accuracy needed for many applications. The injection of fertilizer directly over seeds, as mentioned above, is an example. Changes to the GPS radio spectrum environment that affect the reliable reception of GPS signals for uses, such as agriculture, are a threat.

## Recommended Actions

The huge economic benefit to agriculture and other high precision applications use reliable GPS. High precision GPS receivers are designed to take advantage of the full spectrum allocated to GPS, which optimizes the performance and benefits provided to farmers. The GPS radio spectrum environment needs to be protected from interference to ensure these continued benefits to agriculture.

## Summary

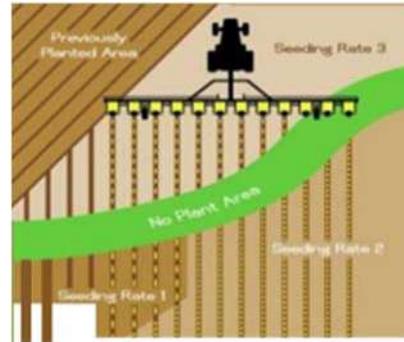
The use of GPS in agriculture has become ubiquitous and of great economic benefit. A number of pictures with brief descriptions are provided in the next two pages to illustrate the broad array of GPS usage in farming. These pictures have been provided courtesy of John Deere, Trimble, and Valmont Industries.

### Uses of GPS in Farming

**Tilling:** Overlap minimization prevents waste of inputs and machine time and allows easy turn-around by skipping swaths for a second pass.



**Planting:** Prescription seeding allows adjusting the seed rate to match the capability of the soil and drainage conditions.



**Application Control:** Precise application of water, nutrients, pesticides, and herbicides saves on costs, increases yield and minimizes the impact to the environment.



**Harvesting:** Precise control of machine during harvest minimizes the number of required machine trips through the field, thus saving time and reducing expense.



**Yield Monitoring:** Provides information for seed and nutrient adjustment for use during the following planting season.



**Relative Control:** Precise control of combined use of vehicles ensures even loads and no need to stop harvesting to unload.



### Other Associated Uses of GPS in Farming



**Crop Scouting:** Dedicated GPS handheld receivers and GPS-enabled smartphone and tablets are ideal for agronomists and farmers to use for agriculture applications. These devices, operating with agriculture field software, can be used for soil sampling, basic mapping and crop scouting tasks. Users can map field acreage, locate soil sample points by grid or zone and scout for pests and other problem areas.



**Soil Mapping Technology:** Using GPS with advanced sensors, intelligent targeting and geo-processing algorithms can produce high-resolution, accurate soil and topographic information. By providing a greater understanding of the physical and chemical characteristics of the soil, including the response of the soil to treatment, the technology enables farmers and agronomists to implement effective solutions adapted to each area within their fields. The mapping information enables critical management decisions regarding irrigation, drainage, nutrients, etc.



**Land Contouring:** GPS-based land forming solutions are used by contractors and farmers to minimize water costs and efficiently distribute water by maintaining grade in the field—enabling farmers to see improvements in yields, water usage and farm productivity. The solutions allow users to design variable-shaped fields and topography based on the best use of existing contours, the water needs of individual crops, and even individual farming practices.



**Correction Services:** GPS corrections provide greater accuracy for use in tilling, planting, application of water, nutrients and pesticides and harvesting. A variety of corrections services are available—from dedicated base stations and local reference station networks to subscription-based services that are delivered via satellite or the internet. These corrections improve the accuracy from a few feet down to a few inches.



**All Weather Operation:** Extended hours of operation at night or even in fog or dust provides additional economic benefits.

***The direct economic benefit of GPS to agriculture is on the order of US\$ 30 Billion annually***