USDA Use of Small Unmanned Aircraft Systems (sUAS)

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Cultivation of soil, applications of fertilizers and pesticides, and crop breeding have contributed to record yields in the United States. Globally, areas suitable for agriculture are already under cultivation. The increasing human population will require more food grown on less land.
However, increases in agricultural production often result in increased soil erosion and poor water quality from nutrient and pesticide runoff. Both farmers and the environment benefit from increased agricultural efficiencies.
Precision farming is a set of technologies to manage agricultural inputs based on the variation of growth within a field.

- Key technologies are Global Positioning Systems (GPS) and Geographic Information Systems (GIS)

- Variation in plant growth in a field is based on soil properties: slope, aspect, texture, organic matter, water holding capacity, and so forth.
Precision Farming: Variable Rate Application

- Fertilizers and pesticides cost money
- Apply different amounts of fertilizer based on GPS
- Change rate of fertilization based on plant requirements
- How to determine plant requirements?
Precision Farming: Yield Monitors

- Yield monitors map fields from low- to high-yielding areas.
- High yielding areas require more fertilizer.
- Yield potential in fields is relatively stable from year to year.
- Depending on crop and weather, yields explain 50-75% of variance in fertilizer requirements.
• There are other technologies to help farmers manage nitrogen fertilizers

• “On-the-go” proximal sensors (GreenSeeker and CropCircle) are used for N management.

• Plants illuminated by LEDs, measure NDVI, Yellow-NDVI, or Green-NDVI, even at night.
Most growers of high-end crops already use aerial photographs for monitoring (about 25-35¢/acre). UAS service providers need to provide better information at comparable cost.
Conducting collaborative research at the Hermiston Agricultural Research and Extension Center, Oregon State University
After image acquisition, small scenes are mosaiced to get one large image. Is this necessary when managing a single field?
For nitrogen management, transects across field may be easier for input into GIS.
Precision management of pesticides for controlling Colorado Potato Beetles
Insect damage occurred over a single day
In Japan, UAS are used to apply fertilizers and pesticides. Rice fields are small and muddy so tractors are not appropriate.

Aerial application may not be feasible for production agriculture in the USA, because of large field sizes.
A Low-Volume Spray System on an UAV Helicopter
UAV Aerial Application for Large Crop Fields???

UAVs with 5-30 liter liquid tank capacity with spray rate 1-2 L/ha but AirTractor with 400 gal (1,500 liters) tank capacity with spray rate 5 gal/acre (47 L/ha); That means that UAVs have to reload 50 times to match up the manned aircraft’s aerial coverage.
Combining remote sensing with aerial application could be very important:

- Precision spraying (reduced amount of pesticides)
- Rough terrain (invasive plants)
Irrigation System Management (Thomson and Huang)
UAS has been studied by the US Forest Service for >20 years

Smoke blocks visible light. Fire hot spots are easily seen through smoke using thermal infrared cameras
Placer River Trail Bridge (Alaska) Inspection Using Small Unmanned Aircraft Systems

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1) Use a UAS to collect high resolution natural color stereo pair and video imagery of the Placer River Trail Bridge to evaluate as an alternative or supplemental tool to traditional structure inspection techniques.

2) Evaluate dense Structure from Motion (dSfM) image processing techniques to produce a measurable 3D wireframe bridge model.

3) Compare dSfM point cloud to laser scanner point cloud.
• Images to 3D model: Structure-from-Motion
  – triangulate features across image set
  – Software: Photoscan and SURE

• Small details, big model
Invasive species
Rangeland degradation
Soil erosion
Wildlife habitat

Las Cruces, New Mexico
Information management at USDA

Using sUAS for remote sensing:
- Small pixel size
- Rapid turnaround of information to user
- Low cost

However, information from sUAS is highly context specific
- Wildfire, Insects, N requirements

USDA has many other responsibilities that need long term archives:
- Identify individual species and wildlife habitat
- Inspecting structures

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