



Delta-FW70 Fixed-Wing UAV & Intelligent Imaging Processing Designed to Impress

Ag Focused Farmer Approved

Designed to provide professional aerial remote sensing and mapping capabilities in one platform.

It features 4 separate payload bays, capable of holding more than 375 square inches and 6 pounds of payload.

The Delta-FW70 Fixed-Wing UAV is an excellent aerial platform for agriculture UAV operations. The large airframe can accommodate a variety of sensors. HSE can integrate sensors and autopilots to meet a variety of needs. The Delta-FW70 Fixed-Wing UAV is intended for low cost, reliable, repeatable, day to day commercial operation in harsh environments, poor weather, at night, and maritime use. It has the capability of flight times in excess of two hours and range up to 20 miles in poor weather, day or night.

The Delta-FW70 Fixed-Wing UAV has many camera and GPS options for a downward facing camera for surveying, mapping, and agriculture. Aerial imaging is all about the camera, and the Delta-FW70 Fixed-Wing UAV can carry a large full frame mirrored DSLR NIR camera which offers the best in imagery and field of view (FOV). The Delta-FW70 Fixed-Wing UAV is intended for low cost, reliable, repeatable, day to day commercial operation. The key to covering the maximum amount of area in the shortest amount of time is sensor size, not megapixels (MP). Don't be fooled by high MP cameras with small sensors or you will spend up to 5 times longer gathering imagery. You need to gather the images as quickly as possible to maximize profits. No unmanned product at this time gathers imagery faster or better for precision than the Delta-FW70 Fixed-Wing UAV with the recommended camera.

This platform is large in size so that it can carry larger sensors such as mirrored DSLR EO and NIR cameras, LIDAR, SAR, IR and multiple sensors simultaneously. The larger platform is more stable in gusting winds and high crosswinds and thus the imagery is much better without the need for a stabilized gimbal. There is less rocking of the aircraft, fewer blurred photos, and it can fly faster, higher and longer than smaller aircraft. The bottom line is that for a given ground resolution the Delta-FW70 Fixed-Wing UAV is outstanding for obtaining the most usable shots in the shortest amount of time. It is set up to accommodate a variety of autopilots such as the 3DRobotics Pixhawk autopilot system which is capable of operating the most sophisticated UAVs available, so learning to program the autopilot on the Delta-FW70 Fixed-Wing UAV will carry over 100% into other commercial uses because a variety of land, sea and air vehicles use the identical Pixhawk autopilot. The foam core is 2+ lb density EPP which is far superior in impact resistance than lightweight 1 lb. EPS. It survives very harsh environments and most crashes. If damage should occur during a rough landing, repairs are

performed very quickly and easily with Superglue and adhesive tape. Repairs are much, much easier than repairs to fiberglass aircraft.

Flight times of up to one hour can be achieved in certain conditions. Flight times vary with wind speeds, direction of flight path chosen by the pilot, spacing of the flight paths, temperature, the condition of the airplane and its components, etc.

In conclusion, the Delta-FW70 Fixed-Wing UAV is a rugged, easy to repair, inexpensive to operate, commercial/everyday aircraft with full autopilot operation at a very reasonable cost.

INTELLIGENT IMAGING



HSE is a premier provider of aerial image processing services for agricultural service companies using unmanned (UAV, manned, and satellite system imagery. As a complete, turn-key business solution, our team provides data analysis at the rapid pace your clients expect. And with HSE-UAV Ag Imaging, your valuable information is securely stored on our dedicated servers, never on the cloud.

- Detect weather-related damage
- Reduce herbicide and fertilizer usage
- Monitor livestock feedlots and pastures
- Estimate yields using biomass calculations
- Locate invasive species and diseased areas
- Survey irrigation and other structural systems
- Assess environmental impact and wildlife habitat

Our software providers will transform your data into valuable information essential to making good management decisions. Our turn-key, subscription-based service provides more than eye-catching orthomosaics. We offer a complete business solution that compliments your existing precision agriculture products, elevates your brand, and contributes to customer loyalty.

In addition to superior processed imagery, our providers offer interoperability between farm management systems for increased efficiency, allowing you to quickly make important decisions in the field. For added security, the data management services never rely on cloud-based computing systems. In-house server infrastructure houses your data, ensuring complete control over where your information is shared.

Our team of partners will processes aerial data from both manned and unmanned aircraft systems, and satellite services. Pricing is based on volume of data and depth of analysis needed, and we offer both long- and short-term subscription options. Please [contact us](#) for more information.

Canon EOS Rebel SL1

Modified for use in NDVI Imaging
(TBM Aerial Imagery Kit)



The HSE-CAM-AG1 is a Canon EOS SL1 DSLR Camera which is converted to NIR type imagery. The conversion is to HSE specifications for the best conversion to NDVI imagery by the leader in the industry LDP LLC commonly known as maxmax.com. Feel free to peruse the Maxmax.com website. Included with the camera is the Maxmax software to convert to a simple NDVI. We recommend the

call: 309.361.7656

email: info@hse-uav.com

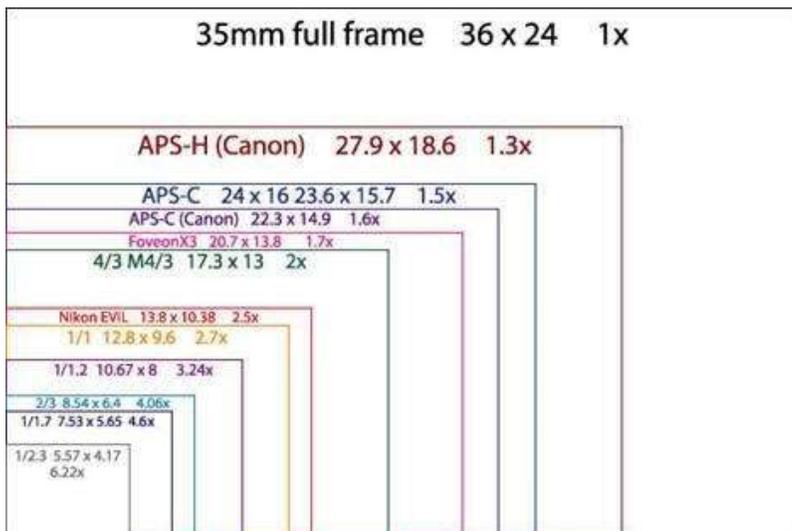
use of aftermarket data processors because there is a lot more to converting the imagery into usable data, but this is good software to get started with to learn the process of NDVI conversion.

Included with the HSE-CAM-AG1 is:

- Canon EOS SL1 DSLR Camera body modified for NIR to NDVI imagery
- Canon EF-S 24mm Pancake Lens
- External Canon GP-E2 GPS Receiver
- Canon Hot Shoe / GPS Extension Cable made by Vello
- Remote Sensing Explorer Software

It is vital that the proper camera and lens be used for quality NDVI conversion. There are several companies which specialize in cameras for NDVI. We have tested many of them at great expense. Some cameras are over \$20,000. There are many different attributes which are critical to obtaining proper imagery which can then be converted for use by many types of softwares for NDVI. The camera is the most important part of the selection process BY FAR. If you purchase a camera which is too slow or with inadequate imagery you will probably purchase the wrong airframe to carry it as well and you will have a total loss on your hands. The camera and lens is proprietary.

1. **Distortion:** It is very important that the lens has very little edge distortion, and the filters are high quality glass which offer low distortion throughout the image.
2. **GPS:** The GPS must be fairly accurate for precision agriculture work, but not sub centimeter accuracy. For volumetrics, then a higher precision GPS is required.
3. **Camera resolution:** The ground resolution changes with altitude, the higher the flight, the lower the resolution. Starting with a very high resolution camera allows higher and faster flights which reduce flight times and thus operating costs. Resolution is all about the sensor size, not the mega pixels. The chart below shows sensor sizes. Spending a little more on a camera is a no-brainer! It will pay itself back in shorter mission times after a few jobs.
4. **Weight:** The weight of the camera is important because this determines the size of the airframe necessary to lift it. Full frame cameras are very large and heavy, and they can be supported with the Delta-FW70. The advantage of the Delta-FW70 is that it is large enough to carry larger cameras, but can also carry smaller cameras as well. It is a very flexible airframe which allows a variety of equipment to be used.
5. **Lens:** The lens of the camera is critical in terms of focal length and to a lesser degree aperture. The focal length determines the altitude that the UAV must fly to obtain a given resolution. After exhaustive study we have determined the best price/performance lens. It has the best blend of performance specifications to allow the fastest airspeeds. It has very low distortion, especially edge distortion which allows for fewer photos to be taken and fewer bad photos which must be discarded.



Sensor Size Comparison: The HSE APS-C (Canon) vs. typical point & shoot camera 1/2.3. Sensor size, not MP is the determining factor for imagery in NDVI applications. APS-C (Canon) sensor is nearly 8 times larger than the 1/2.3 sensor. Don't be fooled by MP! This means that far fewer photos need to be taken using the APS-C (Canon) format than the 1/2.3 sensor. This translates to much shorter flight times and much faster data processing times. Don't spend any more time in the field than is absolutely necessary. Cloud cover and other weather conditions can spoil data, and time is money!

This camera is backed by a 30 day warranty against manufacturer's defects.

NDVI Explained

A simple overview of how drones are used in the farming industry to provide aerial imagery to create NDVI maps to improve crop yields, reduce farming costs, protect the environment and quantify crop damage insurance claims

The FAA recognizes that drones are essential to increasing the productivity of farmlands. Small drones pose a limited risk of injuring people, other aircraft, and property. Thus FAA approval to use drones for farming is coming soon.

Probable FAA policies will revolve around safety, primarily collision avoidance.

- Daylight operation
- LOS (Line of Sight) Operation
- 400' Ceiling
- Various safety devices, pilot and aircraft certifications, training, safety protocols, etc.

Agronomists using drones to assist their recommendations for fertilizer and pesticide application can improve the bottom line to farmers by as much as 15%, and help the environment as well.

The world's farmers must increase yields to feed the world's rapidly growing population. Drones are the latest technological advancement to assist in increasing crop yields while lowering pollution and costs.

Large fields and tall crops are extremely difficult to assess from the ground. Drones provide aerial access at a relatively low cost.

Agronomists operate the drones themselves or hire local drone service providers to fly the fields.

Normalized Difference Vegetation Index (NDVI) is an extremely important tool to determine if crops are stressed. NDVI compares bands of light to accurately determine plant stress. This is state of the art technology. Wikipedia explains NDVI in detail.

Photos directly from the onboard NDVI compatible camera are unusable as is. The photos must undergo special processing.

First, individual photos are stitched together to make one large photo. Online processors are used for this operation due to the high cost and complexity of the hardware and software.

The high quality single image is converted to a NDVI image. NDVI processing software is inexpensive and easy to use though the same online processors who stitched the photos offer this service inexpensively.

The agronomist uses both the normal and the NDVI images with more traditional methods to assess plant stress.

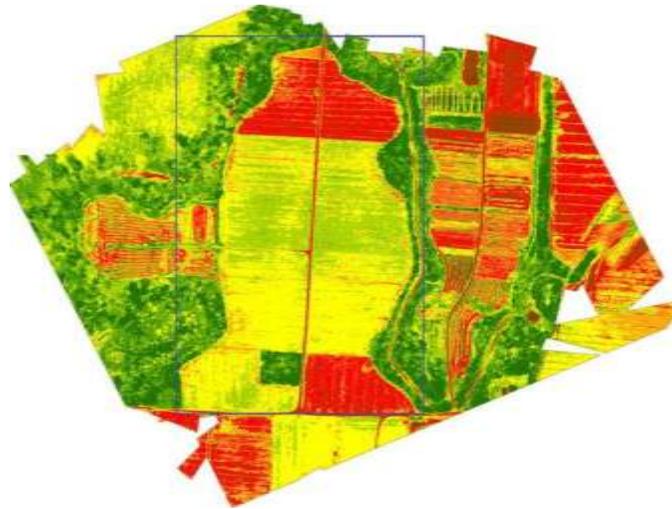
Plant stress can be detected well before it can be seen with the naked eye as well as after obvious damage is apparent.

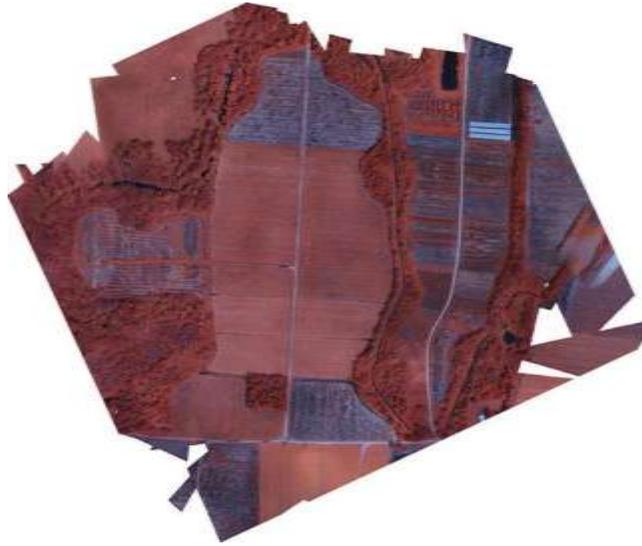
The agronomist then performs "ground truthing" combined with other traditional methods to verify the NDVI data and determine the cause of the stress. Often the agronomist physically walks into the field and looks at the plants where the NDVI has identified problem areas.

The agronomist then makes recommendations to the farmer. If variable rate applicators are used by the farmer, then varying rates of fertilizer and pesticides are recommended which reduce treatment costs, protect the environment by reducing unnecessary over-applications, and increase yields.

The three photos below are all derived from only one camera. Special processing converts the image from the NIR (red) image that is taken by the onboard camera to the "EO" (normal) image as well as the "NDVI" image. Only the EO

(Electro-Optical or "normal") and the NDVI images are used by the agronomist. In the NDVI image the green areas are healthy, the red are not. The area we are concerned with is marked with a blue border. The area is a sod farm. In the NDVI photo the dark green areas around the sod is trees. The large patches of red are areas which were harvested. The red line down the middle is a dirt road. The small red patches of red mixed into the healthy green area are problem areas. The problem is confirmed by looking at the EO photo and by physically walking into the field. There is no grass in the red spots. While you see a low resolution image here, the resolution of the actual photo is high enough to see individual blades of grass! The agronomist saves time because if bare earth, standing water or another obvious problem is identified using the EO image there is no need to walk the field. The sod farmer in this case uses this data to identify excessively large bare spots early on in the growing cycle to replant problem areas and improve yield per acre.





Invasive Species Detection: Canadian Thistle

An NDVI map helped confirm the presence of a Canadian Thistle infestation on this 122 acre corn field. A flat rate herbicide prescription was applied to the entire field.

As shown in the aerial imagery, inspections confirmed that only 0.6 acres required treatment. An herbicide reduction of over 99% would have been possible with a variable rate prescription, decreasing the overall environmental impact and yield loss.



What is the Normalized Difference Vegetation Index (NDVI)?

NDVI maps are useful for detecting plant stress that may be invisible to the human eye. By measuring the spectral characteristics of plants with remote sensors, vigor can be assessed based on the amount of visible light being absorbed in relation to the amount of near-infrared light being reflected by the plant. The healthier the plant, the greater the difference between the two spectral values.

Crop: Corn
Location: NE Kansas
Acreage: 121.82

Environmental Impact

Prescription:	10 gallons/acre (diluted) 6.6 pints/acre (concentrate)
Flat rate area:	121.82 acres
Variable rate area:	(-) 0.60 acres
121.22 acres Herbicide reduction:	1,212.2 gallons (diluted) 100.0 gallons (concentrate)

Cost Savings Impact

Herbicide cost	\$32.27/acre
Flat rate treatment	\$3,931.13
Variable rate & services	(-) \$506.63
Net cost reduction	\$3,424.50

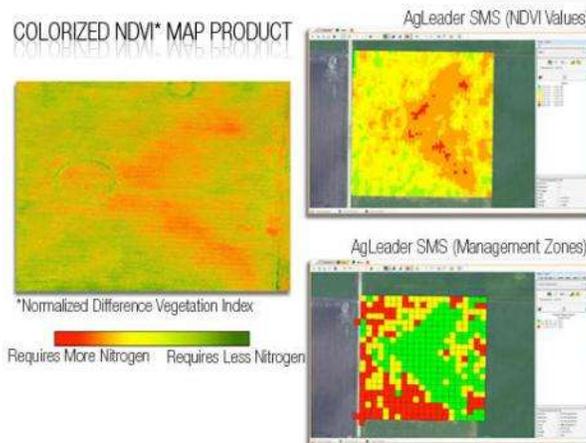
Potential savings / total acreage
 (\$3,424.50 / 121.82) =

INPUT COST SAVINGS:

\$28.11/acre

Farm Management: Flat Rate versus Variable Rate

Data products, created from high-resolution aerial imagery, are compatible with leading farm management systems, allowing producers to create more accurate management zones and increase the productivity of their precision agriculture equipment. The following map was imported into AgLeader SMS to create a variable rate prescription map for a side dress nitrogen applicator. The farmer reduced his nitrogen use significantly, and the yield remained consistent with past years.



Crop: Corn
Location: Minnesota
Acreage: 44

Environmental Impact

Flat Rate Prescription:	15 gal/acre
Variable Rate:	10.6 gal/acre
Nitrogen reduction:	4.4 gal/acre

Cost Savings Impact

Flat rate cost	\$66.00/acre
Variable rate cost	\$46.20/acre
Cost reduction	\$19.80/acre

Cost of flight and processing: \$6.00/acre

INPUT COST SAVINGS:

\$13.80/acre

Delta-FW70 Mapping Package

Including Camera Sensor:



Summary of Package: **\$13,828 USD**

- Delta-FW70 Fixed Wing Ready-To-Fly. Including all hardware, motor, prop, prop hub, ESC, etc.
- Canon EOS Rebel SL1 DSLR Camera converted for NIR Imaging with extras
- 3DR Pixhawk
- Delta-FW70 Aircraft Bag
- TBM AK840 Charger
- (5) LiPo 3S 16,000mAh
- Hitec ePowerbox 50A Switching Power Supply
- Bungee Launcher
- Taranis 9 Ch C2
- Spare Parts: (1) Set of Fins, (1) Delta-FW70 Motor, (4) O-Rings, (1) Foldable Prop, (1) Set of Wing Brackets, (1) 2.5mm Allen Key.
- (Optional) Flight School for Fixed Wing Aircraft \$2495

Options:

- Any camera of your choice which will fit into the airframe. Camera must be shipped to HSE 3 weeks prior to building completion due date.
- Dell semi-ruggedized laptop with outdoor visible screen. Simulator and mission planner software loaded. \$2,485
- Image processing software (such as Agisoft or Pix4D) or optionally you can use online image processing capabilities.
- EZ up tent
- Foldable table and chair
- Portable generator
- Labels for various components, transmitter switches, etc.

Detailed Summary:

Delta-FW70 Airframe Fully Assembled Ready-To-Fly.

Fuselage
Hatches (4)
Hatch floors (3)
Launch hook & mount
3mm CF Stiffener rods
Wings
Elevons
Servos for elevons (2)
Tape for wing leading edges & aileron hinging

CF wing tubes with sheaths
Wing mounting system with locking tabs (2 pairs) and O-rings (4)
Fins (2 pairs)
Pushrods (pair)
Elevon control horns
Electric motor
Propeller and propeller mount
Electronic speed control
Servo extensions
Velcro for hatches, battery mounts, and electronics

- Standard painting. Specialty colors are available at additional cost.
- Pixhawk autopilot with properly set gains. Includes pitot tube, 915Mhz datalink. Other autopilots can be installed at additional cost.
- Taranis 9ch Command and Control RC system completely configured. Other C2 radio systems are available at additional cost.
- Bungee launch system
- Carrying case
- 5 Batteries – 3S 16,000 mah. Up to 40 min flight time for each battery. Higher capacity batteries are available at additional cost.
- High output 1000W DC charger with separate AC to DC power supply
- Building/testing of all equipment including flight testing.
- Canon EOS Rebel SL1 DSLR Camera modified for NDVI. Mirrored Canon DSLR SL-1 Camera 17.9 MP, APS-C format sensor (22.3mm X 14.9mm) converted to NDVI. Includes GPS, GPS extension cable, and 24mm pancake lens.
- Replacement parts:

Wing retaining kit
Vertical fins
Motor
Speed Controller
Propeller
Propeller Hub
Zap CA glue
Adhesive Tape
2.5mm prop allen wrench