Potential Cropping Benefits of Unmanned Aerial Vehicles (UAVs) Applications

Texas Water Resources Institute TR-477
June 2015

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Ronald D. Lacewell, Paul Harrington
Texas A&M AgriLife Research

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By
Ronald D. Lacewell, Vice Chancellor, Texas A&M AgriLife Federal Relations
Paul Harrington, Student Worker, Texas A&M AgriLife Federal Relations

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Texas Water Resources Institute Technical Report-477
College Station, Texas

June 2015

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There is much ado about the potential for applications of UAVs to take precision agriculture to the next level. The economic value of UAVs to agriculture has been broadly touted with little basis for the estimates. This paper is an attempt to provide background to the potential value of UAVs improving crop and livestock production. Unfortunately, there is not a simple method to estimate this value.

A first consideration of using UAVs is where UAV technology can assist in making decisions about irrigation, use of nutrients, insect and disease control, and similar issues. The area in which the UAVs cannot provide valuable information and impact decisions by producers relates to weather-related losses such as hail, wind, blowing dust, cold, excessive moisture, drought, and such. Therefore, the objective of this paper is to identify losses and expenses where a UAV with appropriate sensors could have a positive impact of reducing losses in yield and quality. Several sources of information are used to develop estimates for Texas and then for the U.S. This effort is based on crops due to lack of availability of livestock information.

Texas Crop Losses

There are many ways to address losses to Texas crops. In this section, the implications for four major crops are reviewed as defined by total losses in 2012 and 2013. In addition, the losses by peril for Texas are presented and from all causes compared to those that might be impacted by application of UAVs.

Corn, Cotton, Sorghum and Wheat

Based on statistics from the USDA, Risk Management Agency (2015), total insured losses are presented in Table 1 for corn, cotton, sorghum, and wheat for 2012 and 2013. These are level of insurance (liability) and losses (indemnity) from all sources. Cotton is without doubt the most vulnerable crop in Texas with liability of near $2.0 billion for 2012 and 2013 and indemnity of $100 and about $800 million for 2012 and 2013, respectively. Overall, total liability was $4 billion for 2012 and was $4 billion for 2013 compared to payments of $0.4 and $1.3 billion. Certainly, just for these four crops, the exposure is dramatic with a large opportunity to reduce payments.

Table 1. Texas level of insurance and losses for 2013 and 2014 in $1,000: corn, cotton, sorghum and wheat[a]

Crop	Liability 2012	Liability 2013	Indemnity 2012	Indemnity 2013
Corn	750,192	993,874	43,897	74,777
Cotton	2,362,737	1,888,076	100,289	800,731
Sorghum	377,924	413,056	95,345	59,299
Wheat	657,578	707,038	165888	364,534
Total	4,148,431	4,002,044	405,419	1,299,343

[a]Source: US Department of Agriculture, Risk Management Agency, accessed 2015

Losses by Peril

To address the source of losses incurred by Texas crops, the U.S. Department of Agriculture, Risk Management Agency has loss information recorded by peril. This information takes the analysis much closer to potential value of UAVs because those perils can be identified where a producer can have an impact. In this case, the losses are presented in Table 2 for insects, plant disease and mycotoxin for 2012 and 2013.

Table 2. Texas crop losses total and by insects, plant disease and mycotoxin: 2012 and 2013[a]

Peril	2012	2013
	------dollars------	
Insects	311,080	232,759
Plant Disease	4,029,697	1,454,367
Mycotoxin (Aflatoxin)	954,252	1,291,550
Total	5,595,029	2,978,676
Total all Peril	1,420,213,883	1,543,877,847
Weather Related	1,414,918,854	1,540,899,171

[a]Source: U.S. Department of Agriculture, 2015.

Across the sources of crop losses where UAVs could help in decisions, the total losses in Texas were $5.3 million and $3.0 million in 2012 and 2013, respectively, based on insurance information from U.S. Department of Agriculture, Risk Management Agency (2015). This suggests if UAVs were able to provide perfect information in a timely manner and avoid all losses, the maximum benefit to Texas crops is $3 million to $5 million annually. Over 99 percent of Texas crop losses are due to unavoidable weather-related events. Keep in mind this is based on crop insurance data, and there is a deductible related to payments as well as crops that may not carry insurance or full liability insurance.

Given the large losses from weather-related events, Texas crop losses across all perils included in the database are presented in Table 3. What is not surprising is the huge losses attributable to drought (nearly a billion dollars), as well as significant losses to hail and wind and, for 2013, the freeze losses (wheat primarily). The total Texas crop losses reported for 2012 were $1.24 billion compared to $1.54 billion for 2013. Again, more than 99 percent of the losses are weather-related, suggesting that application of UAVs would not have an impact.

Table 3. Texas crop losses for 2012 and 2013 across all perils bases on crop insurance information[a]

Peril	2012	2013
	---------------------------$1,000---------------------------------------	
Decline in Price	24,177	6983
Drought	783,838	927,577
Heat	83,114	15,860
Failure Irrig. Supply	47,287	63,680
Failure Irrig. Equip.	1,412	4,336
Unknown	4	-
Hail	113,953	142,637
Excess Moisture/Precip./Rain	23,046	5,929
Frost	513	1,108
Freeze	25,289	116,940
Cold Winter	5	304
Cold Wet Weather	920	475
Insufficient Chilling Hours	108	-
Flood	118	464
GRP, GRIP Crops Only[b]	112,753	76,310
Wind/Excess Wind	86,808	129,396
Hot Wind	107,698	44,155
Cyclone	41	56
Tornado	-	3
Insects	311	233
Plant Disease	4,030	1,454
Mycotoxin (Aflatoxin)	954	1,292
Fire	60	608
Wildlife	1,598	1,744
Earthquake	45	10
Other (Snow, Lightning, Etc.)	1,690	2,848
Other Causes	442	105
Total	**1,420,214**	**1,543,878**

[a]Source: U.S. Department of Agriculture, 2015
[b]Group Revenue Protection

Federal Crop Insurance Indemnity Payments

To supplement the Texas statistics for corn, cotton, sorghum and wheat, the national statistics for those crops are presented in Table 4 along with the total across all crops. When the U.S. is considered, the numbers are huge. Focusing on the indemnity, it was $5.8 billion in 2013 and over $11.8 billion for 2012 for U.S. corn. Cotton indicates that the indemnity was less for 2013 than 2012 but was actually very close to $1.0 billion. Wheat is dramatically different and nearly three times greater in 2013 compared to

2012. The 2013 crop was severely damaged by a late freeze with damages over $2.2 billion. Over all crops included in the database for the U.S., the total indemnity (a measure of loss) was $14.1 billion in 2012 but declined to $9.5 billion in 2013. For a gross estimate of the potential for UAVs in agriculture, a conservative estimate can be interpreted to be $10– 15 billion, except this includes all perils with most weather-related.

Table 4. U.S. level of insurance and losses for 2012 and 2013 in $1,000: corn, cotton, sorghum and wheat[a]

Crop	Liability 2012	Liability 2013	Indemnity 2012	Indemnity 2013
Corn	53,636,549	56,543,952	11,841,640	5,840,500
Cotton[b]	4,831,935	3,780,803	1,096,775	1,004,242
Sorghum	1,064,595	1,307,826	402,386	364,115
Wheat	10,606,791	11,748,018	760,454	2,275,769
Total	70,139,872	73,380,601	14,101,257	9,484,686

[a]Source: U.S. Department of Agriculture, 2015
[b]Not including extra-long staple cotton

Cotton Non-Weather Losses

The discussion above relies heavily on statistics and experience of crop insurance in Texas. There are other sources of information that may provide further insight and suggest that the potential economic benefits of UAVs is greater than indicated by the insurance data. Only one example is provided and it relates to cotton across the U.S. The National Cotton Council has surveyed experts on cotton disease yield losses since 1952 (National Cotton Council, 2015). Beginning in 1965, the survey results have been reported by state. Presented in Table 5 are results of yield losses in cotton for Texas and also for the U.S. due to disease for 2012 and 2013.

The results presented in Table 5 are significantly greater than provided by crop insurance data. For Texas, based on the results of the survey information, it is estimated that Texas incurred a loss of 583,000 bales in 2012 and 395,000 in 2013. Valuing a bale of cotton at $328.80 ($0.60 cent lint per pound and $100 per ton seed with 1.7 pounds of seed per pound of lint), suggests Texas economic losses at $192 million in 2012 and $130 million in 2013. This is a massive difference just for Texas from the $3 million to $5.5 million for all crops based on insurance statistics. Texas leads the nation in cotton disease losses and accounts for 33 percent of U.S. losses in 2012 and 24 percent in 2013. For the U.S. the estimated losses are over ½ billion dollars for cotton. Comparing this to Table 4 however, the annual crop insurance losses for 2012 and 2013 were approximately $1.0 billion, recognizing that the $1.0 billion includes all perils.

Table 5. U.S. and Texas cotton yield losses due to disease: 2012 and 2013[a]

Year	Texas		U.S.	
	Bales/000	Value/$1,000[b]	Bales/000	Value/$1,000[b]
2012	583.5	191,855	1,721.8	566,428
2013	395.1	129,909	1,641.8	539,824

[a]National Cotton Council. National Cotton Council Disease Database: 1952-2013.
[b]The gross value is based on a bale of cotton at $328.80.

Conclusions

It is recognized that the majority of crop losses are due to weather-related events. This suggests that the opportunity for UAV and sensors is to reduce damages rests with damages from insects, disease and mycotoxins; improve quality of produces; and/ or reduce costs. There are numerous factors beyond what is reflected in crop insurance statistics where there may be a benefit to use of UAVs. The cotton losses based on survey data imply much great potential than in the crop insurance statistics. For Texas, the crop insurance data suggest annual losses of $500,000 to $800,000 while the National Cotton Council disease survey indicates losses of $130 million to $192 million, a 100-fold increase. Other factors not included in the numbers above which may influence the potential of UAVs include:

- Water efficiency
- Yield increase potential
- Nutrient management/cost
- Quality of product
- Overall reduction of costs
- Management of disease and insects
- Livestock management
- Reduced exposure to litigation

In evaluating potential for UAV applications on cropland, note that there is approximately 340 million acres used for crop production (U.S. Department of Agriculture, 2015). To apply sensitivity analysis, one should consider annual rate for application of UAVs on an acre of cropland of $5, $10, and $25. This translates to gross revenue to the UAV application if all cropland acres were contracted of $1.7 billion at $5 per acre, $3.4 billion at $10 per acre and $8.5 billion at $25 per acre. Certainly not all acres will be contracted so these are gross overestimates of potential. Furthermore, for a producer, one flyover is not acceptable suggesting the rate per acre must include multiple flyovers by the UAVs and subsequent interpretation of the data generated. The purpose of this exercise is to emphasize that for application of UAVs to cropland in a commercial venture there must be reason to expectations. The value will not be multiple billions of dollars but rather perhaps a few billion dollars. It is recognized there are many applications including timber, road construction, river evaluation, wildlife plus opportunity to conduct monitoring in remote areas. The goal of this paper is to suggest a conservative approach when evaluating the economic impact of UAV technology.

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