AgBioForum, 16(3): 187-193. ©2014 AgBioForum.

On the Economics of Crop Rotations to Inhibit Corn Rootworm Resistance Development

Michele C. Marra, Nicholas E. Piggott, and Barry K. Goodwin
North Carolina State University

Corn rootworm resistance to one of the corn rootworm traits has been found in a few isolated places in the Corn Belt. Several crop rotations have been proposed by industry officials and academics to attempt to eliminate or delay this resistance. Three of these rotation schemes are evaluated in this article as to their relative monetary returns, as well as other, non-monetary attributes of the rotations. It is found that a rotation containing Roundup Ready 2 Yield® soybeans and Genuity® SmartStax® corn is the most profitable and has other attributes, such as less variable yields and an absence of externalities related to insecticides that may be valuable to growers. A rotation with Roundup Ready corn with no control for insects at two insertion points would be the least preferred by growers. A mixed corn rotation using both Genuity SmartStax and Agrisure® 3122 insect-resistance-traited corn and Roundup Ready corn with insecticides applied would be the second-most preferred rotation. Even so, mandated rotations impose additional costs on growers as well as regulators; and, particularly in an environment of rapidly changing technology in crop production as we see today, a mandated, set rotation would be strongly resisted by growers and would be sub-optimal from a cost standpoint.

Key words: biotechnology, corn rootworm resistance, crop rotation.

Introduction

The first corn hybrids that expressed a transgenic trait to control for corn rootworm (CRW) infestations in corn were marketed in 2003 under the trade name YieldGard® RW (expressing the gene Cry3Bb1) by Monsanto Company. In the next few years, both Dow-Pioneer (expressing the gene Cry34/35Ab1) and Syngenta Corporation (expressing the gene mCry3A) marketed their own corn seeds with different transgenes for controlling CRW. Today, corn seeds with more than one of the above-mentioned genes for controlling CRW are commercially available. The most widely planted of these are the SmartStax® (SS) hybrids, which have eight stacked traits; these can be planted with a 5% refuge in corn-producing areas instead of the 20% refuge required of the initial, single-traited hybrids. SmartStax and Agrisure® 3122 hybrids have also been approved for a 5% "refuge in a bag," where the non-CRW-resistant seed is mixed in each bag of seed, eliminating the need for a structured refuge. The net benefits of the SS hybrids are documented in Marra, Piggott, and Goodwin (2010), and the CRW-traited corn in general in Marra, Piggott, and Goodwin (2012); Hurley, Mitchell, and Rice (2004); and Alston, Hyde, Marra, and Mitchell (2003).

The effectiveness of the CRW-resistant corn in controlling CRW larvae has been significant. This, along with higher, recent corn prices, has resulted in some farmers in high productivity corn areas, such as the Corn Belt, to plant the CRW-resistant hybrids continuously (in particular, hybrids containing the Cry3Bb1 gene alone) for a number of years. The first report of western CRW resistance development to the hybrids containing the Cry3Bb1 gene alone appeared in 2011 (Gassmann, Petzold-Maxwell, Kewesham, & Dunbar, 2011). This has led to concern among some entomologists that the effectiveness of any traited hybrid containing the Cry3Bb1 gene, including the pyramided hybrids, might decrease over time. This concern was expressed in a letter to the US Environmental Protection Agency (EPA) Office of Pesticide Programs in March 2012, signed by 22 corn entomologists (Porter et al., 2012). In it, they cite several contributing factors to the observed resistance development, including the use of CRW-resistant hybrids, with or without additional insecticides in areas where they are not justified economically; corn containing the same CRW resistance gene year after year in some locations; violation of the refuge requirements for the CRW-resistant hybrids; and limited options for employing other forms of pest management. They go on to say that effective resistance management will require an integrated approach that does not rely on a single tactic. To this end, several rotational structures have been

Table 1. SmartStax insect-resistant corn and RR2Y soybean rotation.

Year	1	2	3	4	5	6	7	8
Crop and type	Soybeans	Insect-resistant corn	Insect-resistant corn	Soybeans	Insect-resistant corn	Soybeans	Insect-resistant corn	Insect-resistant corn
Brand	RR2Y	GenSS	GenSS	RR2Y	GenSS	RR2Y	GenSS	GenSS
Yield [a] (bu/ac)	55.5	179.8	182.7	55.5	179.8	55.5	179.8	182.7
Price [b] ($/bu)	$12.90	$4.75	$4.75	$12.90	$4.75	$12.90	$4.75	$4.75
Total revenue	$715.41	$854.05	$867.83	$715.41	$854.05	$715.41	$854.05	$867.83
Seed price [a]	$57.33	$115.76	$115.76	$57.33	$115.76	$57.33	$115.76	$115.76
Direct costs [c]	$177.00	$362.00	$377.00	$177.00	$362.00	$177.00	$362.00	$377.00
Power costs [c]	$83.00	$92.00	$92.00	$83.00	$92.00	$83.00	$92.00	$92.00
Total variable costs	$317.33	$569.76	$584.76	$317.33	$569.76	$317.33	$569.76	$584.76
Return over variable costs								
Overhead costs [c]	$48.00	$56.00	$56.00	$48.00	$56.00	$48.00	$56.00	$56.00
Total costs	$365.33	$625.76	$640.76	$365.33	$625.76	$365.33	$625.76	$640.76
Return above costs shown	**$350.08**	**$228.29**	**$227.07**	**$350.08**	**$228.29**	**$350.08**	**$228.29**	**$227.07**
Total value	**$2,189.23**							
Discounted value (@5%)	**$1,780.66**							
Assumptions used in calculations:								
Commodity prices								
Corn price ($/bu)	$4.75		Soybean price ($/bu)	$12.90				
Seed prices								
RR2Y ($/ac)	$57.33		Genuity SmartStax ($/ac)	$115.76				
RR ($/ac)	$86.43		Agrisure 3122 ($/ac)	$100.90				

[a] Source: T. Vaughn, Monsanto (personal communication, June 2013); [b] Source: CME (2013); [c] Source: Schnitkey (2013)

recommended by various entomologists in both the public sector and industry. The purpose of this article is to compare three of the most prominently recommended rotations from an economic standpoint so that, eventually, the cost side of the equation can be incorporated and compared to the potential benefits of delaying or eliminating resistance development to the CRW-resistant corn in the decision calculus as to which would best serve the objective of economically and environmentally preferred remedies to the resistance problem. As far as we know, no calculation of the benefits has been made as yet, however, and that calculation is beyond the scope of this study. An additional aim is to present and discuss the economic aspects of mandated rotations from a market perspective.

Profit-based Evaluation of Recommended Rotations

Enterprise budgets were constructed for each of the three rotations considered here (Tables 1-3). The crop yield data are based on 2011 and 2012 commercial field-trial data in the major corn- and soybean-growing states in terms of acreage planted in 2012 (US Department of Agriculture [USDA], National Agricultural Statistics Service [NASS], 2013).[1] The crop and input prices assumed in the budgets are listed at the bottom of each of the tables. Expected corn and soybean prices are quotes for December 2013 corn and November 2013 soybeans listed on the Chicago Mercantile Exchange (CME) website as of August 20, 2013. Seed and insecticide prices for the 2013 crop year were obtained from Monsanto Company (T. Vaughn, Monsanto, personal communication, June 2013). Other variable costs including labor, fuel, herbicides, fertilizer, etc., and overhead costs were obtained from Schnitkey (2013), using Illinois as representative of the areas where CRW resistance build-up has been observed. It was further assumed that technology and germplasm are constant and that the expected 2013 input and output prices are stable over the eight-year period of the rotations.[2]

1. *Corn states included Iowa, Illinois, Indiana, and Minnesota. Soybean states included Iowa, Illinois, Indiana, Minnesota, and Missouri.*

Table 2. Mixed insect-resistant and non-insect-resistant corn and soybean rotation.

Year	1	2	3	4	5	6	7	8
Crop and type	Soybeans	Non-insect-resistant corn w/ no insecticides	Non-insect-resistant corn w/ insecticides	Insect-resistant corn	Insect-resistant corn	Soybeans	Non-insect-resistant corn w/ no insecticides	Non-insect-resistant corn w/ insecticides
Brand	RR2Y	RR	RR+ Force	GenSS	Agrisure 3122	RR2Y Soy	RR	RR+ Force
Yield [a] (bu/ac)	55.5	89.9	177.7	179.8	168.6	55.5	89.9	177.7
Price [b] ($/bu)	$12.90	$4.75	$4.75	$4.75	$4.75	$12.90	$4.75	$4.75
Total revenue	$715.41	$427.03	$844.08	$854.05	$800.85	$715.41	$427.03	$844.08
Seed price [a]	$57.33	$86.43	$86.43	$115.76	$100.90	$57.33	$86.43	$86.43
Direct costs [c]	$177.00	$362.00	$384.00	$377.00	$377.00	$177.00	$362.00	$384.00
Power costs [c]	$83.00	$92.00	$92.00	$92.00	$92.00	$83.00	$92.00	$92.00
Total variable costs	$317.33	$540.43	$562.43	$584.76	$569.90	$317.33	$540.43	$562.43
Return over variable costs								
Overhead costs [c]	$48.00	$56.00	$56.00	$56.00	$56.00	$48.00	$56.00	$56.00
Total costs	$365.33	$596.43	$618.43	$640.76	$625.90	$365.33	$596.43	$618.43
Return above costs shown	**$350.08**	**-$169.41**	**$225.65**	**$213.29**	**$174.95**	**$350.08**	**-$169.41**	**$225.65**
Total value				**$1,200.88**				
Discounted value (@5%)				**$980.79**				
Assumptions used in calculations:								
Commodity prices								
Corn price ($/bu)		$4.75		Soybean price ($/bu)				$12.90
Seed prices								
RR2Y ($/ac)		$57.33		Genuity SmartStax ($/ac)				$115.76
RR ($/ac)		$86.43		Agrisure 3122 ($/ac)				$100.90
Insecticide prices								
Aztec ($/ac)		$21.00		Force ($/ac)				$22.00

[a] Source: T. Vaughn, Monsanto (personal communication, June 2013); [b] Source: CME (2013); [c] Source: Schnitkey (2013)

The SS and Roundup Ready 2 Yield® (RR2Y) rotation budget (Table 1) shows the highest return to growers of the three budgets considered, with a total undiscounted value over eight years of $2,189.23. It is assumed that no insecticides are applied in this rotation. The lowest return is exhibited by the mixed corn and soybean rotation (Table 2)—$1,200.88 over the eight-year period. The main reason why this rotation produced the lowest return is the insertion of Roundup Ready (RR) corn with no control for insects in Years 2 and 7. In the Corn Belt, where CRW is prevalent, we assume the yield loss due to no insect control is 50% of the Genuity® SS yield (Alston et al., 2003). Although not controlling for CRW for a season probably effectively delays CRW resistance build-up, these two insertion points produce a loss of almost $170 per acre each. It is difficult to imagine that growers would be willing to produce at a loss 25% of the time. This rotation would require extensive and expensive monitoring if it were mandated. Table 3 presents the enterprise budgets for the mixed insect-resistant and non-insect-resistant corn rotation. The total value from this rotation over the eight years is $1,648.61, which is in between the values of the other two rotations. Although there are no years in which a crop is produced at a loss in this rotation, the four years in which RR corn is produced using insecticides result in a lower return when compared to the SS corn, although those returns are more than the returns to

2. *This assumption is, admittedly, simplistic. However, using futures price quotes for one and two years out leaves us with the dilemma of what to assume for the years beyond. Furthermore, the out-year futures price quotes are subject to major revision, as well.*

Table 3. Continuous corn rotation with insect-resistant and non-insect-resistant hybrids.

Year	1	2	3	4	5	6	7	8
Crop and type	Insect-resistant corn	Insect-resistant corn	Non-insect-resistant corn	Non-insect-resistant corn	Insect-resistant corn	Insect-resistant corn	Non-insect-resistant corn	Non-insect-resistant corn
Brand	GenSS	GenSS	RR+ Force	RR+ Force	Agrisure 3122	Agrisure 3122	RR+ Aztec	RR+ Aztec
Yield [a] (bu/ac)	182.7	182.7	177.7	177.7	168.6	168.6	177.7	177.7
Price [b] ($/bu)	$4.75	$4.75	$4.75	$4.75	$4.75	$4.75	$4.75	$4.75
Total revenue	$867.83	$867.83	$844.08	$844.08	$800.85	$800.85	$844.08	$844.08
Seed price [a]	$115.76	$115.76	$86.43	$86.43	$100.90	$100.90	$86.43	$86.43
Direct costs [c]	$377.00	$377.00	$399.00	$399.00	$377.00	$377.00	$398.00	$398.00
Power costs [c]	$92.00	$92.00	$92.00	$92.00	$92.00	$92.00	$92.00	$92.00
Total variable costs	$584.76	$584.76	$577.43	$577.43	$569.90	$569.90	$576.43	$576.43
Return over variable costs								
Overhead costs [c]	$56.00	$56.00	$56.00	$56.00	$56.00	$56.00	$56.00	$56.00
Total costs	$640.76	$640.76	$633.43	$633.43	$625.90	$625.90	$632.43	$632.43
Return above costs shown	**$227.07**	**$227.07**	**$210.65**	**$210.65**	**$174.95**	**$174.95**	**$211.65**	**$211.65**
Total value				**$1,648.61**				
Discounted value (@5%)				**$1,338.76**				
Assumptions used in calculations:								
Commodity prices								
Corn price ($/bu)		$4.75		Soybean price ($/bu)				$12.90
Seed prices								
RR2Y ($/ac)		$57.33		Genuity SmartStax ($/ac)				$115.76
RR ($/ac)		$86.43		Agrisure 3122 ($/ac)				$100.90
Insecticide prices								
Aztec ($/ac)		$21.00		Force ($/ac)				$22.00

[a] Source: T. Vaughn, Monsanto (personal communication, June 2013); [b] Source: CME (2013); [c] Source: Schnitkey (2013)

the Agrisure 3122 corn. Note that the RR2Y soybean insertion points yield the highest return above costs shown compared with any type of corn hybrids produced.

In sum, the enterprise budgets and rotations that are shown here all result in positive total and discounted values, although the values vary greatly across rotations. The total returns range from $2,189.23/acre to $1,200.88/acre. The mixed corn and soybean rotation produces the most variable annual returns of the three, ranging from $350.08/acre for the RR2Y soybean insertion points to a loss of $169.42/acre for the RR corn not controlled for insects. The discounted values range from $1,780.66 for the SS and RR2Y rotation budget to $980.79 for the mixed corn and soybean budget. It seems clear, based on total and discounted returns, that the mixed corn and soybean rotation would not be adopted by many growers, if any. But farmers' adoption decisions usually do not depend solely on monetary considerations, as discussed in the next section.

Other Economic Considerations

Other factors that may come into play in deciding what rotation plan to choose (if any) if a farmer is a utility maximizer are discussed in the following sub-sections.

Risk

One important component of a farmer's utility from an enterprise is the riskiness of the enterprise compared with alternatives. For example, it has been established that farmers are willing to pay more for a less risky (less variable yield) outcome (Alston et al., 2003; Marra et al., 2010; Piggott & Marra, 2007). Therefore, risk-averse farmers would choose the rotation that is perceived to have the least variable outcomes, all else equal. With respect to the three rotation schemes evaluated here, the risk aspects of the SS hybrids have been demonstrated to be more highly valued by farmers than the non-insect-traited corn. The risk aspects of the Agrisure 3122 hybrids have not been evaluated publicly as yet, but they should be similar to the SS hybrids because they both have the 5% refuge-in-a-bag option and at least two modes of action for controlling CRW (*Farm Industry News*, 2012). Therefore, from a risk standpoint, the SS and RR2Y rotation should have the best risk characteristics because it does not involve planting the non-rootworm-resistant corn. Farmers have placed a value of between $1.00 and $5.00 per acre on the reduced yield risk associated with the CRW-resistant hybrids (Alston et al., 2003; Marra et al., 2010). As it turns out, the mixed corn and soybean rotation has the lowest total value and the highest variability of annual returns, so it would be the least preferred rotation on both counts.

Human and Environmental Safety

Farmers have also shown that they place a value on the additional human and environmental safety provided by the CRW-resistant hybrids. This additional safety is mostly attributable to the lower use of insecticides with these hybrids, with their concomitant externalities. The EPA labels of the two insecticides proposed to be used in the second two rotation schemes (Force® and Aztec®) indicate that there is some human and environmental safety risk associated with their use (Bayer CropScience, 2013; Syngenta Crop Protection, LLC, 2013). Both insecticide labels indicate the products are restricted-use pesticides due to toxicity to aquatic invertebrates and contain precautionary statements about hazards to humans and domestic animals. Corn farmers in the Midwest have placed a value of $1.00-$4.00/acre for the enhanced human and environmental safety provided by the CRW-resistant corn hybrids (Alston et al., 2003).

The Challenges of Mandating Rotations in a Perfectly Competitive Market

The motivation for regulators to mandate a rotation scheme is to delay or prevent resistance of the CRW technology, and this certainly has merit. The producer's primary motivation for rotation is to maximize long-run profit, as it is well established that the economic returns over several periods tend to be higher for producers who practice this agronomic strategy. This is not to say that producers are not concerned about delaying resistance of the CRW technology; indeed, they could be very concerned. Because every producer has their own set of farm and farmer characteristics and, even though producers are competing in a perfectly competitive market place, it is still the case that each producer will have a different optimal solution with respect to how many acres to allocate to a crop and what technology to employ. It is for this reason that a regulator must be involved and *mandate* a particular rotation if it is to be implemented as part of the producer's decision on how many acres to allocate to a particular crop and what technology to adopt each period. That is, the mandate becomes a constraint in the optimization problem of each producer that must be met and taken into account in deriving their optimal solution as to what and how many acres of a crop to plant and the technology employed in a particular year.[3] Making the rotation mandatory also comes with the cost of auditing to ensure compliance by, in essence, placing a constraint on the producer's optimization problem that is binding. Below, we discuss some of the challenges and costs involved in moving forward with a strategy of mandating rotations and the potential costs and distortions it might cause in the marketplace.

If, for example, the previous year's soybean crop had been adversely impacted by soybean rust and ending stocks for the crop year had been depleted, we would expect soybean prices to be higher relative to corn than what they typically are in an attempt to bid corn acres into soybean acres. That is, a producer might choose to deviate from their planned corn-corn-soybean rotation after just planting soybeans the previous year, by again planting soybeans because the additional profit that higher soybean prices offer is greater that benefits of rotating back to corn given the current circumstances. This would represent a perfectly rational economic decision in response to a signal from the market that more soybeans needs to be planted in the upcoming year due to the previous year's shortfall. However, if this producer was mandated to rotate the soybeans with corn, this optimal choice to plant soybeans again is not avail-

3. *The proposed mandated rotation can be viewed as an example of the Le Chatelier principle at work. In economics, the Le Chatelier principle refers to the differences in the responses of decision variables, which in turn impact the optimal solution, to changes in parameters when additional constraints are imposed on the system (Samuelson, 1947). Additional constraints, if binding, reduce the optimal outcome, thus leading to less desirable results. The upshot is the optimal solution or level of decision variables that maximize utility will always achieve a lower level of utility as compared to the less constrained system.*

able to them. The producer could ignore the mandate and risk the chance of not being audited and penalized or they could comply with the mandate and fail to take advantage of the new higher price signal. Clearly, the mandate, although well intended, places a cost on the producer, in the form of the forgone additional revenue that could have been earned by planting soybeans as well as a potential distortion in the soybean agricultural economy by preventing the producer from reacting to the market signal of higher prices. The greater the number of producers impacted, the greater the potential market distortion.

It might be an economically optimal decision for the current period and beyond to adopt a new technology; however, in the presence of a mandate of a crop-rotation strategy, an alternative technology might be required, and so the producer must again choose between ignoring the mandate and risk the chance of being audited and penalized or they could comply with the mandate and fail to act economically optimally. Clearly, the mandate, although well intended, places a cost on the producer in the form of the forgone additional returns from employing the newer technology as well as a potential distortion in the technology advancement by preventing the producer from reacting to the market signal of higher returns being achieved from this new technology. The challenge to the regulator is to make available in the rotation the most recent technologies. This presents a logistical and regulatory nightmare, but failure to do so would discourage technology developers from being innovative.

It is almost certainly the case that no matter what the mandate entails, and how well-intended the mandate is, it will be binding for some producers. The producer is then left with the choice of forgoing additional returns and complying with the mandate or taking the chance of being audited and making the optimal economic choice. As is always the case with evaluating the economics of regulations, it begs the question for regulators and poses a dilemma: do the costs to the producers and regulators amount to less than the benefits from the mandate being enforced? For the case at hand, the question would be whether the value that could be attributed to a mandated rotation for delaying resistance of the particular CRW-resistant technology is greater than the value of the forgone utility in not pursuing more optimal choices for each of the producers in each of the periods the mandate was in force.

Conclusion

Three rotations that have been proposed by various groups to combat resistance build-up to the CRW-resistant traits are evaluated as to their relative profitability and other, non-monetary considerations. The rotation based upon SS and RR2Y corn and soybean technologies, respectively, is shown to be the most profitable of the three and probably would be the most palatable of the three for producers. The mixed corn and soybean rotation would likely be the least preferred by producers, given it is the least profitable with the most variable annual returns, including years where there are losses. The mixed insect-resistant and non-insect-resistant corn rotation has higher profitability and lower variability of returns when compared with the mixed corn and soybean rotation, but it requires the use of external pesticides with their concomitant risks and externalities and still provides lower total returns when compared with the SS and RR2Y rotation.

In addition, changing technology makes the rotation schemes impossible to enforce without substantial costs. Given the new corn technologies in the research pipelines of the various seed companies, it appears certain that a producer would be giving up a lot if a set rotation were mandated and would probably think twice before adopting it, given the current incentive structure. Getting growers to comply with a set rotation mandate in times of rapidly changing technology and, possibly, relative market prices would be a difficult, complicated, and expensive task for regulators.

References

Alston, J.M., Hyde, J., Marra, M.C., & Mitchell, P.D. (2003). An ex-ante analysis of the benefits from the adoption of corn rootworm resistant, transgenic corn technology. *AgBioForum*, *5*(3), 71-84. Available on the World Wide Web: http://www.agbioforum.org.

Bayer CropScience. (2013). *Aztec® 2.1% granular insecticide* (Product guide). Research Triangle Park, NC: Author. Available on the World Wide Web: http://ws.greenbook.net/Docs/Label/L39443.pdf.

Chicago Mercantile Exchange (CME). (2013, August 20). *Agricultural commodities products: Soybeans and corn quotes as of August 20, 2013* [data]. Chicago, IL: Author. Available on the World Wide Web: http://www.cmegroup.com/trading/agricultural/.

Farm Industry News. (2012, July 3). Two new refuge-in-a-bag corn products. *Farm Industry News*. Available on the World Wide Web: http://farmindustrynews.com/corn-hybrids/two-new-refuge-bag-corn-products-available-syngenta.

Gassmann, A.J., Petzold-Maxwell, J.L., Kewesham, R.S., & Dunbar, M.W. (2011). Field-evolved resistance to Bt maize by western corn rootworm. *PLoS One*, *6*, e22629.

Hurley, T.M., Mitchell, P.D., & Rice, M.E. (2004). Risk and the value of Bt corn. *American Journal of Agricultural Economics*, *86*(2), 345-358.

Marra, M.C., Piggott, N.E., & Goodwin, B.K. (2010). The anticipated value of SmartStax for US corn growers. *AgBioForum*, *1*, 1-12. Available on the World Wide Web: http://www.agbioforum.org.

Marra, M.C., Piggott, N.E., & Goodwin, B.K. (2012). The impact of corn rootworm protected biotechnology traits in the United States. *AgBioForum*, *15*(2), 217-230. Available on the World Wide Web: http://www.agbioforum.org.

Piggott, N.E., & Marra, M.C. (2007). The net gain to cotton farmers of a natural refuge plan for Bollgard II® cotton. *AgBioForum*, *10*(1), 1-10. Available on the World Wide Web: http://www.agbioforum.org.

Porter, P., Cullen, E., Sappington, T., Schaafsma, A., Pueppke, S., Andow, D., et al. (2012, March 5). *Joint letter to Dr. Steven Bradbury, Office of Pesticide Programs, US Environmental Protection Agency, Washington, DC.*

Samuelson, P.A. (1947). *Foundations of economic analysis* [Enlarged edition, 1983]. Cambridge, MA: Harvard University Press.

Schnitkey, G. (2013). *2014 crop budgets* (Farm Economics: Facts & Opinions [FEFO] 13-12). Urbana-Champaign, IL: University of Illinois at Urbana-Champaign, Department of Agricultural and Consumer Economics.

Syngenta Crop Protection, LLC. (2013). *Force® 3G insecticide* (Product guide). Greensboro, NC: Author. Available on the World Wide Web: http://ws.greenbook.net/Docs/Label/L31420.pdf.

US Department of Agriculture, National Agricultural Statistics Service (USDA NASS). (2013). *Acreage, 06-28-2013*. Washington, DC: Author. Available on the World Wide Web: http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1000.