PREVENTION OF PLASTIC CONTAMINATION WHEN HANDLING COTTON MODULES

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Executive Summary

The U.S. cotton industry has a long history of producing contamination-free cotton, and we need to preserve that reputation. In the last three years, USDA Classing Offices have been finding plastic in samples that likely originated from round module wrap. Therefore, to maintain the reputation of U.S. cotton and prevent significant discounts to the value of a bale, it is crucial that both producers and ginners take steps to prevent contamination. The recommendations in this document are based on a review of video footage collected by placing cameras on module handers in the field and gin yard, as well as video cameras at the module feeder at four U.S. locations with diverse production (picker and stripper) and environmental conditions (humid to arid). Results presented here are preliminary, and monitoring will continue during the 2020 season. In transporting from the field, the primary issue observed was the failure to fully raise the module above cotton stalks and damage from placing modules on top of cotton stalks. Hitting the bottom of flatbed trailers during loading and unloading was a source of damage to the bottom of modules as were chains on module trucks. Damage also occurred to the side of modules when placing modules on flat bed trailers and when loading oversized modules into module trucks. There were cases where trouble at the module feeder introduced plastic to the gin; however, many contamination events could be traced back to modules that were damaged in the field or during transport. Therefore, producers and module handlers are strongly encouraged to take specific steps to protect modules in the field and during transportation to the gin.

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Introduction

The U.S. cotton industry has a long history of producing contamination-free cotton. That reputation has been a likely contributor to the premium that U.S. cotton can command on the international market. Over the last three years, USDA Classing Offices have been finding plastic in samples (most probable source is round module wrap). Over the same period, the premium for U.S. cotton has eroded, and there have been months when it was offered at a discount relative to cotton produced elsewhere. If a four cent/lb decrease in the premium for U.S. cotton is attributed to plastic contamination, with a crop of 20 million bales, this would correspond to a loss of $384 million annual loss to U.S. growers. Using the 2019 classing data in Figure 1 as an example, over 84% of the plastic calls were associated with colors used for round module wrap. Therefore, to maintain the reputation of U.S. cotton and prevent significant discounts to the value of a bale, both producers and ginners must take steps to prevent contamination.

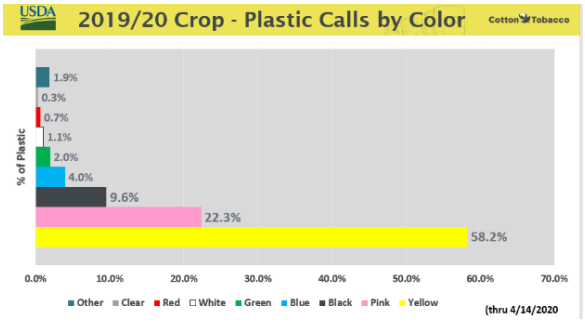


Figure 1. 2019/20 cotton crop plastic calls by color (chart complements of USDA-AMS).

There are many efforts by the U.S. cotton industry to address this issue, including plastic removal systems at the gin and careful handling of modules at the module feeder. This report is focused on what can be done between the field and module feeder to decrease the likelihood of round module damage leading to plastic contamination. Additional resources to support an overall contamination prevention program are provided at the end of this document.

Approach

During the 2018 and 2019 growing seasons, images were collected from a video camera mounted on two different types of module handlers as they staged modules in North Carolina fields. A similar system was developed

Figure 2. One of the in-field module handlers observed in this study.

to capture still images from a module handler on gin yards in 2019 from two Texas gins. Additional images and video of modules were captured at a Texas gin in 2019 when modules were loaded onto the module feeder and then when the modules were unwrapped. Videos of module unwrapping were also collected at a North Carolina gin. Understanding the potential influences of handling practices and how they impact contamination is emerging from the combined efforts. Analysis of existing images is still in progress, and additional image collection is planned for the Fall of 2020. Due to the urgency of minimizing plastic contamination, lessons learned from the images reviewed to date are presented in this report.

Videos of in-field module handling in North Carolina were collected with an off-the-shelf GoPro camera, which had GPS included. Field videos were meant to identify field handling practices which could damage module wrap (Mitchell and Ward, 2020). At the gin, RFID

antennas were attached to a module un-wrapper to identify module serial numbers. A downward-facing camera was attached to the un-wrapper to determine if damage could be identified while the wrap was being removed.

In Texas, the system used at two gins consisted of RFID antennas, an embedded RFID module, GPS receiver, and outdoor security cameras connected to a single-board computer (Raspberry Pi 3B+). The system was designed to be capable of installation on any machinery used to handle modules. The system was installed on wheel loaders used to unload trailers at both gins and at the module truck used to move modules to the feeder at one of the gins. Images are captured when a module is detected and the vehicle comes to a stop, for more details, see Wang et al. (2020).

The system used to collect images and video of modules at the third Texas gin location consisted of an IP camera inspection system mounted in the module feeder dispersing cabinet (Pelletier et al., 2020) and an RFID scanning bridge (Wanjura et al., 2020) collocated with network-video-recorder (NVR) cameras at the intake end of the module feeder. The camera system mounted in the module feeder dispersing cabinet captured images of the dispersing cylinders when the module feeder floor was briefly paused, and a clear image of the rotating cylinders was available. Manual inspection of the still images of the dispersing rollers was conducted to determine if plastic material had accumulated on the cylinders since the last feeder bed pause event. Each time plastic was detected on the cylinders, the gin crew quickly removed it. In some cases, the plastic wrap contained an RFID tag or readable tag showing the module identification number making it a simple task to go back in the RFID scan log from the RFID bridge at the intake of the feeder to determine when the corresponding module was placed on the feeder and unwrapped. The RFID scan timestamp was used review the NVR video log and extract video footage showing the handling and unwrapping of the module that led to plastic entering the ginning system. In cases when no RFID tag or module identifier tag was available, the dispersing cylinder image timestamp and plastic wrap color was used to review the NVR video log to identify any modules (of that color) that were mishandled during the unloading and unwrapping process.

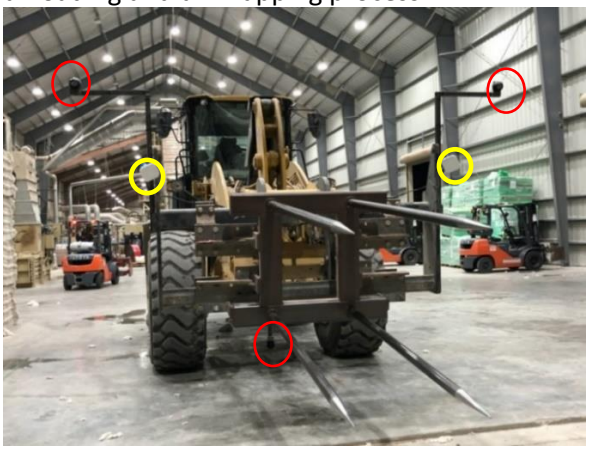


Figure 3. System used at gin yards for two of the Texas gins. Camera locations shown inside red circles and RFID antennas shown inside yellow circles.

Figure 4. Network camera mounted to the back wall of the module feeder dispersing cabinet at 3rd Texas gin.

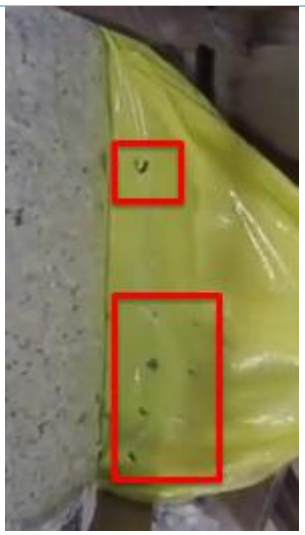
Figure 5. Close-up photo of RFID antenna and NVR cameras on pole mounted to module feeder at 3rd Texas gin.

Results

The results are given in the following table ordered by the following issues: 1) those that likely resulted when staging modules in the field, 2) then problems that likely occurred in transporting from the field to the gin, and 3) finally problems noted at the module feeder. In the left-hand column of the table are probable sources of the damage observed and proposed preventative steps that can be taken to mitigate the damage. The right-hand column contains a sample image illustrating the problem.

Source of Damage / Preventative Steps	Example Images
Source: Stalk Damage. Module not fully raised above stalks during transportation to edge of field. Can cause wrap abrasion or worsen previous stalk puncture damage. The problem can occur with both fork and lifter style module transport systems. **Preventative Steps:** Attempt to raise module as high as safely possible during transport.	 
Source: Stalks between the handler and module. **Prevention Steps:** Stalks in the forks are not ideal. However, significant damage due to stalks between the forks and covering was not observed in the 2019 season. Avoid when possible.	

Source: Clipped by the handler on the harvester, module mover, or tail of the module truck. **Preventative Steps:** Do not turn the harvester sharply or raise the handler before the module is away from the handler. Also, make sure module truck backs into modules with bed tilted completely and avoid sharp turns when moving into the loading position. Take care to make sure module moving equipment is clear of the modules before turning.	
Source: Cotton stalk damage from staging modules on cut stalks. **Preventive Steps:** Unload modules in turnrows or grass borders.	
Source: When loading modules, in this case on a flat bed, modules can be pushed on the decking. Screws or damaged wood can damage the wrap. **Preventative Steps:** Inspect the truck bed regularly. Repair or replace damaged decking or connectors. Avoid sliding module on decking.	 

Source: Punctures in plastic wrap. Could push fragments of the wrap into the seed cotton. **Preventative Steps:** Use proper chains on module trucks with smooth lugs and adjust chain speed to match ground speed. Prevent wrap puncture on sharp objects in the field and gin yard.	
Source: Damage on side at end of module that may have been punctured by spear when staging adjacent modules in the field. **Preventative Steps:** Be aware of adjacent modules when staging.	
Source: Damage to module wrap resulted in complete module failure at the gin yard. **Preventative Steps:** Cuts to module wrap can result in additional tearing – repair immediately.	

Source: Wrap condition - module wrap was damaged in the field. Broken module was loaded with plastic imbedded inside seed cotton, resulting in plastic entering the module feeder and becoming impaled on one of the dispersing cylinders. Once on the dispersing cylinder, it does not take long for significant shedding of plastic into the cotton stream to occur **Preventative Steps:** Repair wrap damage as soon as it is detected. Consider processing all broken modules at one time at the end of the season.	 
Source: Wrap Condition: Broken module with pink wrap underneath cotton. **Preventative Steps:** Repair wrap damage as soon as it is detected. Consider processing all broken modules at one time at the end of the season.	 
Source: Full-size module not unloaded on to flat end. Plastic was visible in the cotton. The portion that could be pulled out was removed. The module could not be repositioned to remove remaining trapped plastic. **Preventative Steps:** Use proper unloading height of module truck above feeder bed to properly flip module onto its flat end. Use secondary equipment (loader or telehandler) to reposition module.	  

Source: Unwrapping technique - module wrap cut too high, not leaving sufficient material to restrain cotton. Module broke wrap and trapped plastic under cotton. Plastic was visible in the cotton, and only the portion that could be pulled out was removed. Plastic trapped between fallen cotton and module feeder bed remained and was subsequently transported into the gin. **Preventative Steps:** Leave the wrap uncut at the top 2 ft of the module to restrain cotton until complete wrap removal.	  
Source: Module Diameter Small module not unloaded onto flat end. Plastic was visible in the cotton but could not reposition the module to remove completely. **Preventative Steps:** Use secondary equipment (loader or telehandler) to reposition module onto flat end once unloaded from the truck.	 

Note from these examples, in many cases, modules damaged before the module feeder contributed to the plastic contamination event. The problem of plastic contamination is now widely recognized by purchasers of U.S. cotton and bales found to contain plastic at the classing office are subject to a sharp discount. Anecdotal information indicates that many bales with a plastic contamination call are challenging to sell even when deeply discounted. There are added concerns that the new blue "Value TamaWrap" being offered by Tama in 2020 will be even more sensitive to improper handling. Therefore, cotton producers and module haulers must be careful when staging and hauling cotton modules.

Summary

Reducing plastic contamination from wrap materials starts during harvest and goes all the way through every time that a module is handled. Module diameter and drop location during harvest can create the initial conditions that lead to contamination later. Improper In-field transport and loading can exacerbate any existing module wrap damage or create more risk. The same is true for gin handling practices. Finally, what happens at the module feeder can directly impact contamination.

Round module wrap condition, unloading method, unwrapping technique, and module diameter influence the risk of plastic contamination. Each of the situations presented resulted in a potential plastic contamination event, as evidenced by plastic wrap being caught by the module feeder dispersing cylinders. If plastic caught on the dispersing cylinders is not immediately removed, the risk of plastic contaminated lint bales increases as the material wears and eventually sloughs off. In some cases, plastic remaining in the seed cotton is visible to gin personnel, and attempts are made to remove the plastic before it is engaged by the dispersing cylinders. However, in other cases (i.e., broken modules or situations where plastic is trapped underneath cotton on the feeder bed), plastic is not visible to the employees and is not removed prior to feeding. Other situations were observed where employees were unable to completely remove trapped pieces of plastic and allowed the material to pass to the dispersing cylinders. To minimize the risk of plastic contamination at the module feeder, management should ensure that employees have the needed training and equipment to unload and unwrap round modules properly. Additionally, employees should be empowered to stop the unloading process so that situations which lead to increased contamination risk can be adequately rectified.

Additional Resources

Proper handling of cotton modules is just one part of an overall contamination prevention strategy. For additional resources see:

- The National Cotton Council maintains an extensive collection of resources related to contamination prevention at: https://www.cotton.org/tech/quality/contamfree.cfm
- Resources to make sure quality is preserved during harvest, including proper module handling and storage is available from: https://www.cottoninc.com/cotton-production/ag-resources/harvest-systems/
- Focus on Cotton webinars that address contamination prevention include:
    - Proper module wrap removal
    - Contamination: Textile Mill Perspective
    - Proper Handling of Round Cotton Modules – From Field to Gin

Acknowledgements

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