Draft 8

Protocol for the Eradication of the Boll Weevil in the Lower Rio Grande Valley in Texas and Tamaulipas, Mexico

Preface:

Boll weevil eradication began with the Boll Weevil Eradication Trial (BWET) in North Carolina and Virginia, in 1978. The BWET proved the technical feasibility of boll weevil eradication. US cotton producers, US state governments and the US federal government have worked together over subsequent years to achieve the cotton farmer's dream of growing cotton without having to fight boll weevils. The cost has been high and the struggle has been long and hard, but cotton growers' determination has been rewarded with the elimination of the boll weevil from all areas of the US, except for southernmost areas of Texas. Since 1996, the cumulative net return for cotton producers in Texas has been estimated at $1.9 billion.

Climatic conditions in the Lower Rio Grande Valley (LRGV) and northern Tamaulipas, Mexico are subtropical; characterized by hot, humid summers and generally mild, cool winters. Freezes rarely occur in the region and cotton plants continue to grow and set fruit. Consequently, boll weevils can feed and reproduce virtually year-round if cotton plants are not destroyed. Unlike other areas which have conducted boll weevil eradication in the US, winter weather is an insignificant cause of mortality in the LRGV/Tamaulipas region. Boll weevil eradication has also been negatively affected by tropical storms and hurricanes. Under these conditions, population reductions achieved in one year can be lost the next. Thus, there is very little room for error operating an eradication program in this region.

In 2011, recognizing the difficulty of eradicating the boll weevil in areas such as the LRGV/Tamaulipas region, the National Cotton Council's (NCC) Boll Weevil Action Committee (BWAC) recommended the establishment of an International Technical Advisory Committee (ITAC) to facilitate communication between the program in Tamaulipas and the program in the LRGV and help improve both programs. The NCC's BWAC suggested that the programs work together to develop a more unified approach to eradication of the boll weevil on both sides of the border. Both parties agreed that if the programs work together to develop and operate a common protocol, boll weevil eradication would progress more quickly and at a lower cost. This document, developed after the first meeting of the ITAC in February 2012, is the result of those discussions.

Mapping Cotton Fields: Mapping cotton fields is one of the first phases of operation in any boll weevil eradication zone. The purpose of mapping is to identify the exact location of each cotton field and to describe important features located nearby (schools, houses, towers, highways, hospitals, etc.). As the

planting season approaches, farmers, ginners, consultants and agricultural supply buisnesses provide program employees with information on which farmers will be growing cotton and where cotton fields will be located.

In South and East Texas, all fields which have been planted to cotton in the last two years are mapped. This allows program personnel to install traps in fields that were previously in cotton, and inspect these fields for volunteer cotton plants. This ensures timely treatment decisions if hostable volunteer cotton host plants are present and boll weevils are trapped.

All cotton fields are mapped using differentially-corrected Global Positioning System (GPS) technology. Program employees use handheld receivers to acquire satellite signals and describe points around the perimeter of each cotton field, thereby describing the location of the field (latitude / longitude). Employees drive around the fields, collecting the way-points which describe the field perimeter, download the information to computers in their offices, and use mapping software to construct maps of the area showing field locations. Locations of important features near each field are also mapped in this manner. Each field is assigned a unique number for identification purposes. The mapping software is able to add layers which describe the locations of streets, highways, railways, rivers, lakes and county/state/international borders. Trap maps are created and used during trap deployment to indicate trap locations and identification numbers of all traps surrounding all cotton fields (and fields that were planted to cotton during the previous two years).

Trapping

Eradication programs use light yellow-green plastic traps, developed specifically for capturing boll weevils. In the initial years of the programs, the traps are installed around all sides of all cotton fields as crops are planted and during seedling emergence. The traps are placed on four-foot stakes (wooden stakes, fiberglass rods or one and a half inch diameter PVC plastic pipe). The traps are placed near vertical structures (e.g. utility poles, trees etc.) so that they are less likely to be destroyed by farm equipment and help reduce the effects of wind, improving pheromone effectiveness. Trap locations downwind of brush-lines, shrubs, tall crops (sugar cane, corn or forage sorghums) and other windbreaks are preferred. The wind break afforded by these locations improves boll weevil trap effectiveness. However, approved distances between traps must be maintained and all sides of all fields must be trapped. Traps are installed along the edges of the cotton fields and are inspected weekly.

In the early years of a program when the weevil populations are typically high standard density is one trap per 1/10 mile (1 trap/80-100 meters in Mexico) around field perimeters. Any land adjacent to a cotton field and not planted to an annual crop is considered habitat. The edges of fields adjacent to boll weevil habitat must have one trap deployed per each 1/20 mile (1 trap per hectare in Mexico) around the field perimeter. As weevil numbers decline, trap densities

are reviewed and adjusted (to lower densities) annually by Technical Advisory Committees.

A field planted to cotton is inspected for the presence of cotton plants the subsequent two years , even if the field is planted to another annual crop. Where there are fewer fields (such as in the Tamaulipas program), program staff must inspect fields which were planted to cotton in previous years several times in the 5-6 week period after spring crops are planted. Where cotton fields are more numerous (such as in the Lower Rio Grande Valley program) fields must be trapped the first year following cotton, requiring trappers to visit and inspect them weekly for cotton plants. Four boll weevil traps (one per side) are deployed around fields in which cotton was grown the previous year. When volunteer cotton plants are found the trap density on the field is immediately increased to the standard density for the zone. When boll weevils are caught in the traps on these fields, the fields are treated. In both Tamaulipas and the LRGV, fields which have not been in cotton for two years must be inspected for cotton plants at planting time. Several additional field inspections must be conducted during the next 5-6 weeks. If cotton plants are found, the fields are trapped at standard density for the zone. If boll weevils are found on these fields, the fields are treated.

Boll weevil lure (grandlure) dispensers and insecticide kill strip are placed in the interior of the capture cylinder of the trap. Each lure piece is a one square inch laminated polyvinyl chloride dispenser impregnated with 10 mg of grandlure. Employees place the date on each lure piece with a permanent marker when it is placed into the trap. After two weeks in a trap, lure pieces have depleted most of their pheromone. When traps are inspected, the oldest lure dispenser is removed, placed in a bag and taken to the office for disposal. Then, a new, dated-lure is placed in the capture cylinder. After trap inspection and lure change, each trap has one lure that is two-weeks old and one new lure in the capture cylinder. Kill strips are 1 x ½ inch PVC strips impregnated with 0.6 g of DDVP insecticide. They are placed in the capture cylinder to kill weevils caught in the traps and to reduce predation of captured weevils by spiders and other insects. The insecticide tape is changed every four weeks.

The date of trap inspection, the number of weevils trapped, and the dates each lure and each kill strip was changed are written on the side of the trap with a permanent marker. This information allows program staff and/or producers to make quality control inspections of the trapping and to track weevil captures over time in fields.

A unique barcode is attached to the inside of the trap body (base) of each trap, allowing individual trap information to be recorded electronically using a handheld barcode scanner. As traps are deployed, the bar codes are scanned, and the work unit number, field number and trap number are entered into the scanner using the keypad. The scanner records the time and date that each trap is

deployed; and the time and date of each trap inspection. When data are downloaded from the scanner to the computer in the boll weevil eradication field office, the information becomes part of the Boll Weevil System database. Deployment of traps in the field and data download in the Boll Weevil Expert System (computer program) allows Field Unit Supervisors to create a trap map, establish a permanent record of trap location, and initiate a record of deployment and subsequent trapping records on the trap. The proper deployment of traps in the Boll Weevil Expert System allows the software to create a format for recording data as the traps are checked each week during the season.

Trap inspections begin at least one week before the cotton in each field produces pinhead size squares and continues weekly until none of the cotton plants in the field are hostable for boll weevil. When fields are muddy, employees are instructed to service all the traps that they can reach without damaging producer's fields or eradication program vehicles.

Employees inspecting traps first scan the bar code. They are then prompted by the scanner to identify the task (ie, remove = 0, inspect = 1, non-functional = 2, missing / replace = 3, missing / wet = 4 or install = 5). Next, employees determine and enter the number of boll weevils caught in the trap. Trapped weevils are removed and placed in a bag on which the field number, date and number of weevils captured is written with a permanent marker. They then inspect the field and enter the crop stage (Table 1). Accurate crop stage information is very important because treatment is based on the presence of weevils and the hostablility of the crop. Finally, eradication employees are prompted to enter information on whether they changed the lure and kill strip during the trap inspection.

Table 1. Cotton Boll Weevil Expert System Crop Stage Codes

0	Pre Plant
01	Recently planted
05	Cotyledon
10	1-2 True Leaves
20	3-4 True Leaves
30	5-6 True Leaves
31	5-6 True Leaves, 1st Pinhead Square
32	5-6 True Leaves, Late Pinhead Square
40	7-8 True Leaves
41	7-8 True Leaves, 1st Pinhead Square
42	7-8 True Leaves, Pinhead Square
51	9-10 True Leaves, 1st Pinhead Square
52	9-10 True Leaves, Late Pinhead Square
60	Bloom
70	Open Boll
80	Defoliated, Hostable
81	Harvested, Hostable
82	Regrowth, Hostable

90	Defoliated, Non-Hostable
91	Harvested, Non-Hostable
92	Regrowth, Non-Hostable
93	Shredded
94	Disked or Plowed

Employees return to the office at the end of the day and download data from scanners to the computer. Additionally, employees are instructed to bring any boll weevils or insects that they suspect may be boll weevils, to their supervisors for verification.

Control

Cultural, mechanical or chemical controls are important components of boll weevil eradication.

One of the key cultural controls is maintaining a uniform window for planting and harvesting cotton in boll weevil eradication zones. Texas Boll Weevil Eradication Foundation's Technical Advisory Committee (TBWEF TAC) has emphasized, for the record, that maintenance of a host-free period during fall and winter is essential in boll weevil eradication programs. Local growers serve on committees established by the regulatory agencies to set mandatory dates for planting and/or stalk destruction. The committees provide input on regulations, including penalties for noncompliance. Stalk destruction programs are mandatory in both the US and Mexico, but enforcement is more effective in Mexico (planting permits are not given to farmers who do not maintain fields free of cotton during the host free period in Mexico). Failure of programs to achieve timely and complete stalk destruction leads to increased boll weevil survival and reproduction in the winter, and reduces program effectiveness. The result is higher cost and potential failure of the program.

Destruction of cotton plants in the host free period must be complete. It must eliminate both plants which regrow from stalks and those growing from seed (volunteer cotton). Cotton fields, fallow fields and fields where other crops are growing can support volunteer cotton plants. Employees must identify fields in violation of stalk destruction regulations due to the presence of cotton plants. Written notice must be given to the producer when fields are out of compliance. Penalties for non-compliant growers must be sufficient to insure compliance.

At the end of each season, eradication program staff provides an overview of weevil captures, a review of trap densities used in previous years, and acres treated during the previous years to their Technical Advisory Committee (TAC). Program managers propose trap densities and treatment triggers for the coming year. The TAC considers the proposal and may change the recommendation. The committee's recommendation on trapping density and trap triggers becomes the operational protocol for the upcoming season. The ITAC may provide assistance in the process of reviewing trap densities and treatment triggers for either the LRGV or the Tamaulipas zone.

Chemical control programs to eradicate the boll weevil begin with reliable trapping information. Each day during the season after employees have downloaded scanner information from the field, supervisors use the data and program software to construct tables and maps to help them visualize the locations of boll weevil captures. They then determine which fields or parts of fields require insecticide applications. These decisions are made based on the TAC approved trap trigger protocol (Tables 2 and 3). Field Unit Supervisors then construct field treatment maps and prepare the necessary documents and ordering treatment by contracted aerial applicators of the specific fields which triggered for treatment.

Table 2. Normal Eradication Program Trap Triggers (Source: Texas Boll Weevil Eradication Training Materials)

Program Year [1]	Early Season[2]	Mid-Season[3]	Late Season[4]
1st	2 BW/40 ac	2-5 BW/40 ac[5]	2 BW/40 ac
2nd	1 BW/40 ac	1-2 BW/40 ac[5]	1 BW/40 ac
3rd	1 BW/field	1 BW/field	1 BW/field
4th	1 BW/field & adj. fields	1 BW/field & adj. fields	1 BW/field & adj. fields
5th	1 BW/field & surrounding fields[6]	1 BW/field & surrounding fields[6]	1 BW/field & surrounding fields[6]

[1] Treatment triggers are not used in the first partial year, the diapause year of the program. Years represented are the full program years.
[2]Early Season is from first pinhead square to bloom.
[3]Mid-Season is from bloom to first open boll.
[4]Late Season is from first open boll to stalk destruction and non-hostable field.
[5]Mid-Season trap triggers are only adjusted when secondary pest infestations threaten crops in a majority of the fields in the work unit.
[6]Field and surrounding fields indicates all fields within ¼ mile of the capture field are treated.

Table 3. Examples of the Actual End-Of-Year Trap Captures and TBWEF TAC Approved Triggers The Following Year for the Lower Rio Grande Valley.

Year	Yr-End BW/Per Trap Inspected	Following Year	Spring Treatment Trigger (Threshold)
2005 diapause	17.77	2006	2 BW/40 ac
2006	3.07	2007	2 BW/40 ac
2007	2.67	2008	2 BW/40 ac
2008	0.83	2009	1 BW/fld
2009	0.144	2010	1 BW/fld and surrounding flds
2010	0.391	2011	1 BW/fld and surrounding flds
2011	0.152	2012	1 BW/fld and surrounding flds

Beginning in 2010, TBWEF management proposed and the TBWEF TAC approved a protocol change allowing areas with high boll weevil captures the previous fall, to receive two automatic treatments (one week apart) beginning at pinhead square in the spring, regardless of weevil catches during those two weeks. This policy has been in place since 2010. In practice, near constant winds above 10 mph have limited spraying on those fields in 2010-2012. Generally, only fields that have caught boll weevils have been sprayed.

It is standard protocol that producers are informed of boll weevil captures on the day that the weevils are trapped on their field. They are also informed that a treatment will be made. Standard protocol requires the field to be treated the next day, but the treatment can be delayed due to weather, mechanical or other limitations. Maps showing the fields to be treated and other documents are taken to the aerial contractor early the next morning. The documents provide pilots with the information and authorization they need to treat the fields. Only the fields which triggered for treatment are sprayed. Contractors are required to have fully functional SAT-LOC or other GPS-based flight tracking systems on their aircraft. After the fields are treated, the aerial contractor must provide programemployees with treatment records, including electronic maps of the flights. Designated program employees serve as airport recorders. Their job is to record flight times, verify the amounts of insecticide used, pick up and deliver treatment documents, and coordinate with aerial contractors.

Every effort is made to treat the perimeter of each field triggered for an application with a truck-mounted mist blower sprayer. These applications have been an effective factor in reducing boll weevil populations. Occasionally, muddy conditions, obstructions and other physical factors prevent perimeter treatments in a few fields, but mist blower treatments on field perimeters are high priority. Fields near sensitive sites such as schools, hospitals, etc., are treated using high clearance ground sprayers in order to reduce drift issues.

Aerial applications are made using 12 ounces of ULV malathion per acre (or the equivalent rate per ha. in Mexico), while treatments with mist blowers and high clearance sprayers are made with 16 fluid ounces of malathion ULV per acre (or the equivalent per ha.).

Treatments with ULV malathion and other insecticides are most effective when applied directly to the host cotton fields. Treatment of non-hostable cotton fields, overwintering habitat and other areas where fruiting cotton is not present is not recommended.

While there are effective alternative insecticides labeled for boll weevil control, none have the residual control of ULV malathion. ULV malathion is the premier product for boll weevil eradication treatments and proper timing of alternative products is necessary for effective control. It is very important that the fields be

treated within 1-2 days of triggering to obtain effective control and prevent or limit boll weevil reproduction. After reviewing the available research, the TBWEF TAC reccomended two applications of alternative boll weevil insecticides per week when producers opted to spray with alternatives. Programs can allow grower treatments with alternative products - labeled for boll weevil control - when fields trigger at the same time treatments are needed for cotton fleahopper or other pests. In this case, two applications should be made per week to bring the residual effectiveness for boll weevil up to the level of a single ULV malathion treatment.

Quality Control

Implementation of quality control ensures that program guidelines for the boll weevil trapping and treatment are being followed. Quality control inspections must be conducted throughout the season. Fifteen percent of the fields are randomly selected for quality control inspections each week. Quality control inspections include visual inspection of trap density, trap position and trap conditions (whether there are large number of insects in the trap - indicating it has not been serviced or cleaned recently), lure and insecticide strip replacement (dates written properly on lure and kill strip), and lure and insecticide strip replacement dates written on the body of the trap, crop phenology and planting weevils or spiking. Spiking is a trap inspection quality control procedure whereby the quality control supervisor places dead weevils - marked with fluorescent dye - in specific traps. The supervisor records the trap number, the number of weevils placed in the trap and placement time. The record of traps spiked by the quality control supervisor is compared to the daily report submitted by the employee who checked the traps to determine employee performance in finding, reporting, and retrieving boll weevils for supervisor verification. Boll weevils retrieved from spiked traps are inspected under a black light to ensure that they glow and are, in fact, spiked weevils.

The electronic scanners used to collect information about the boll weevil eradication program also record the time and date that each trap is inspected. Information from the scanner is used to verify trapper efficiency. The time between trap inspections is used to evaluate the performance of personnel assigned trap inspection duties.

Visual inspection of the traps is another key element in quality control. Traps should be in good condition, placed in protected locations, properly spaced, and properly serviced. Quality control is taken seriously. Failure of an employee to follow protocol or to find and report boll weevils in traps results in termination of his/her employment.

Quality control is also conducted on insecticide applications. Flights are visually inspected by eradication program staff who maintain radio/cell phone contact

with aerial applicators and can advise them if there are people in fields, obstructions present, etc. Ground observers check the aircraft height above the crop canopy and wind speed during application. Dye cards are used to determine the effectiveness of insecticide deposition in 10-20 percent of fields each week. Dye cards are also placed between fields and in sensitive sites to determine if drift toward sensitive sites is occuring. If insecticide drift is detected, the flight is terminated. Additionally, quality control of aerial applications is done at the office. Aerial applicators are required to provide electronic records of their flights (SAT-LOC or other systems). The Field Unit Supervisors overlay the flight track on their field maps to determine if fields were treated effectively. Supervisors review and discuss inadequate applications with the aerial contractors and may require poorly treated fields to be treated again at the expense of the applicator.

Designated eradication employees have responsibility for environmental monitoring and protection. When necessary, they collect plant tissue, soil, water and take swab samples from structures, equipment or vehicles. The dye cards, samples of water, soil, swabs and plant tissue are sent to laboratories for diagnosis to detect the presence of malathion. They control flights near sensitive sites and keep detailed records of these flights. In addition, these employees take samples of ULV malathion and pheromone lures for laboratory analysis to ensure the quality of these two critical program components. Furthermore, testing for the effects of pesticide exposure – a cholinesterase test - is required for program employees who may be exposed to insecticides. A database of environmental monitoring information, lure and malathion quality control and cholinesterase screening, is maintained to ensure that these important records are easily accessible.

Training

Time and effort is invested in training employees. Step by step instructions are provided on how to perform essential responsibilities. Additionally, employees are trained on how to work safely and how to interact professionally with co-workers, farmers and others. Weekly safety meetings with staff are conducted, as well as frequent, brief training sessions.

Oversight, information and guidance

Grower groups and committees, government agencies (state and federal), and others provide oversight of the boll weevil eradication program. Audits of the financial (at least annually) and program operations, procurement systems, and compliance with state and federal regulations are conducted. Local grower committee meetings are held on a regular basis to share financial and program information and to allow program staff to receive feedback from farmers on operational and program funding matters. Local producer committees make policy recommendations to program management and the oversight agencies and committees.

The program progress reports are made during grower information meetings and field days. Newsletters, newspaper articles and individual contacts are used to keep producers and communities informed about program activities and progress.

The TAC committee's functions include working with program managers in establishing zone boundaries, setting trap densities, making trapping trigger recommendations, dealing with issues related to insecticides, working on organic production problems, providing recommendations about sensitive site issues, dealing with issues related to unique cotton production areas, and quarantine and post-eradication issues.

The International Technical Advisory Committee (ITAC) serves as a binational advisory group to provide additional technical support to both programs in the LRGV/Tamaulipas region. The ITAC may work in a technical capacity with program and technical experts in both the Lower Rio Grande Valley and in Mexico.

Communication

Frequent and open communications between boll weevil eradication programs in the LRGV and Tamaulipas, Mexico, are essential because cotton in this binational region is not separated by distance or by geographical characteristics other than the Rio Grande River. It is, therefore, the biological equivalent of a single boll weevil eradication zone. Frequent communication between program managers across programs is essential to ensure program leadership in both the LRGV and in Tamaulipas are aware of the conditions and needs of the neighboring zone. This communication will provide the managers with the best information available to address emerging issues. Zone Managers should report trap capture and treatment information, as well as their thoughts about trends and expectations. This procedure will allow both programs to develop contingency plans as circumstances change.

References

Allen, C.T. 2008. Boll Weevil Eradication – An Area wide Pest Management Effort. *In* Area wide Pest Management: Theory and Implementation. Koul, O., G. Cuperus and N. Elliot eds. CAB International, Wallingford, UK. pp 467-559.

Castro, B.A. and S. Armstrong. 2008. Comparative efficacy of selected boll weevil insecticides using laboratory bioassays. Proc. Beltwide Cotton Conf. National Cotton Council of America. Memphis, TN. 1291-1297 pp.

El-Lissy, O., Frank Myers, Ray Frisbie, Tom Fuchs,Don Rummel, Rick Smathers, Ed King, Fred Planer, Chuck Bare, Frank Carter, Gary Busse, Nolan Niehus, Jack Hayes.1996. Boll Weevil Eradication Status In Texas. Proc. Beltwide Cotton

Production and Research Conf. National Cotton Council of America. Nashville, TN. pp.831-837

El-Lissy, O. and Moschos, J. (1999) Development of a computerized expert system as a management tool for boll weevil eradication. In: Dugger, P. and Richter, D.A. (eds) *Proceedings of the Beltwide Cotton Conference*, National Cotton Council, Memphis, pp. 834–837.

England, M., R. R. Minzenmayer, C. G. Sansone, 1997. Impact of selected insecticides on boll weevil and natural enemies. *In* Proc. Beltwide Cotton Conf. P. Dugger and D.A. Richter (eds). National Cotton Council, Memphis, TN. pp. 989-993.

Goswick, C., Welch, R. and Broyles, L. (2007) *Field Training Manual*. Texas Boll Weevil Eradication Foundation, Abilene.

Harris, F.A. and Smith, J.W. (2001) Boll weevil eradication in Mississippi. In: Dickerson, W.A., Brashear, A.L., Brumley, J.T., Carter, F.L., Grefenstette, W.J. and Harris, F.A. (eds) *Boll Weevil Eradication in the United States Through 1999*. Reference Book Series No. 6, The Cotton Foundation, Memphis, pp. 305–344.

Kiser, D. and Catanach, M. (2006) Boll weevil eradication update – Arkansas, 2005. In: Richter, D.A. and Huffman, M. (eds) *Proceedings of the Beltwide Cotton Conference*, National Cotton Council, Memphis, pp. 1277–1293.

McGarigle, B. (2002) Pest patrol. *Government Technology: Solutions for State and Local Government in the Information Age*, 2 pp. http://www.govtech.net/magazine/story.php?id=8069&story_pg=2

Spurgeon, D.W. and J.R. Raulston. 2006. Captures of boll weevils (Coleoptera: Curculionidae) in traps associated with different habitats. Journal of Economic Entomology. 99:752-756.

U. S. D. A. 1991. National Boll Weevil Cooperative Control Program