National Fish and Wildlife Foundation
Final Programmatic Report

This material is based upon work supported by the Natural Resources Conservation Service, U.S. Department of Agriculture, under an NRCS Conservation Innovation Grant.

Project Name: Conservation and Integrated Pest Management (OK)

Recipient Organization/Agency: Oklahoma State University

1) Summary of Accomplishments

The overarching objective of this project was to increase no-till adoption in the southern Great Plains through demonstration and education. Over the course of this project we provided educational opportunities at four statewide extension conferences, ten in-field demonstration days, and 64 county-level extension meetings reaching over 6,000 stakeholders. Research sites demonstrated that biologically diverse cropping systems were feasible in Oklahoma and that IPM strategies for pest management were extremely effective in controlling Hessian fly activity in wheat. The educational opportunities created and demonstration plot findings assisted in a 25% increase in no-till adoption and a significant shift towards wheat cultivars resistant to Hessian fly.

2) Project Activities & Results

Activity # 1 – Deliver a comprehensive set of demonstration locations that will provide stakeholders with a visual reference of the beneficial aspects of crop rotation and no-till production systems

We established no-till demonstration plots at Goodwell, Altus, Lahoma, Union City, and Stillwater, OK during the 2008 – 2009 crop year. In order to demonstrate alternatives to continuous, monocrop wheat, each of these demonstration sites included crop rotations that were appropriate for the surrounding region of the state. By showcasing these alternative crop rotations to local producers we planned to increase adoption of more diversified cropping systems and increase the success rate of no-till farmers. These demonstration plots and the data generated from their management were used at numerous in-field demonstrations, county-level meetings, and statewide extension conferences (reported under Activity #2). A few highlights from each site are listed below.

Lahoma Location

This was our most prominent and frequently visited demonstration site. It is located adjacent to a major highway on the premier research and extension center in Northwestern Oklahoma, so it was used in numerous formal and informal educational settings. Our primary objective was to demonstrate to producers that alternative crops could grow in Northwestern Oklahoma and produce acceptable yields most years. We were successful in accomplishing this objective. Approximately one year into the project some stakeholders raised concerns over increased water use by more intensified rotations relative to the continuous wheat system. We used a neutron probe to measure the amount of water used in biologically intensified and continuous wheat systems during 2009 and 2010. Biologically intensified (3 crops in 2 years) no-till cropping systems utilized ~85 to 95% of rainfall (2-yr period) during the growing season. Only 5 to 15% was lost to evaporation (E) (Figure 1). In contrast to continuous wheat-fallow systems that only utilized 60% of rainfall in the same period (Fig. 1). The data show that biologically intensified systems might use more water in total, but they more efficiently use available water resources to produce a marketable product, which aids overall profitability. Our plans are to pursue additional funding sources and continue the work at this location well beyond the life of this project.

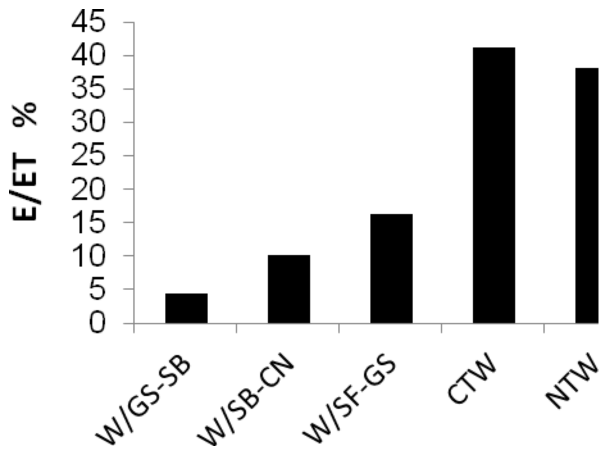

Figure 1. Proportion of total evapotranspiration (ET) that was lost during fallow periods for the following no-till cropping systems: wheat/double crop grain sorghum-soybean (W/GS-SB), wheat/double crop soybean-corn (W/SB-CN), wheat/double crop sunflower-grain sorghum (W/SF-GS), continuous wheat (NTW), and conventional tillage continuous wheat (CTW) at Lahoma, Oklahoma from 2009 to 2010.

El Reno Location

Similar to our Lahoma location, the El Reno site was host to large crowds for in-field demonstrations and discussions, and our objective of providing a visual reference of the beneficial aspects of crop rotation and conservation tillage was met. The production systems on display at this site clearly demonstrated that production of legume and non-legume cover crops are possible in the state of Oklahoma, but nitrogen management is key to making subsequent wheat crops profitable. We also discovered that warm-season cover crop had no effect on subsequent Hessian fly activity. Although not stated in our objectives, we used this educational opportunity to demonstrate the use and benefits of sensor-based nitrogen management strategies for wheat. These techniques were particularly beneficial in determining the nitrogen contribution/tie up of legume and non-legume warm-season cover crops, respectively. Using the information gathered from this location, we were also successful in graduating one MS student whose stipend was funded through another project. Since this demonstration was on a farmer's field, the rotation demonstrations were not continued beyond the life of this project.

Goodwell and Altus Locations

These were our two westernmost sites and as a consequence management and selection of alternative crops was more difficult than the Lahoma or El Reno sites. Our Goodwell site focused primarily on a grain-sorghum wheat rotation and showed the resilience of grain sorghum in a no-till setting. Our Altus location focused on cotton, wheat, and grain sorghum and results showed greater crop yield in more biologically diverse systems, regardless of tillage. The Altus data also showed a slight benefit in crop yield and increased crop revenue for no-till systems over conventional till. Both of these sites were severely affected by the extreme drought of 2010-2011. These sites will be continued beyond the life of this project contingent on securing additional funding.

Activity # 2 – Deliver opportunities for stakeholders to learn from on another through field day events and a statewide-no-till conference

Over the course of this project we provided educational opportunities at four statewide extension conferences, ten in-field demonstration days, and 64 county-level extension meetings reaching over 6,000 stakeholders. These educational efforts have had an effect. Prior to this project, a CTIC survey reported no-till acreage in Oklahoma was estimated to be 8%, which was approximately 20% behind the national average. In addition, alternative crops were grown on only 1.1 M acres of cropland in Oklahoma. We surveyed Oklahoma producers during this project via the Oklahoma NASS and resulted showed that 33% of the 1200 respondents practiced no-till. This is a substantial increase compared to the estimated 8% in 2004. Production of alternative crops has increased to greater than 1.6 M acres since 2004, according to Oklahoma NASS. This is an increase of 38% since 2004, most of this acre conversion occurred the last two years. Soybean acres have increased 56% since 2004. This indicates an intensification of cropping systems, since the majority of the soybean crop is double-cropped after winter wheat harvest. This substantial increase in acres being rotated is no doubt associated with the increased no-till acres, which has increased since 2008. While we certainly cannot take credit for the complete turnaround, our demonstration sites, presentations, and data have certainly assisted in this change.

Activity # 3 – Provide demonstration and evaluation tools regarding Hessian fly management through biological and chemical control mechanisms.

In 2008 when this study was initiated, Hessian fly numbers had build up in Oklahoma over successive years in continuous wheat planted to susceptible cultivars (Alvey 2009). We believe that early fall planting and no-till wheat systems were also promoting Hessian fly infestations because early growth provides new vegetation for egg laying adult flies, and stubble in no-till systems provides protective over-summering habitat between wheat crops. According to Alvey (2009), 5 bu/acre are lost for every cumulative fly per tiller during the growing season and the economic injury level for Hessian fly in Oklahoma is approximately 1 fly/tiller. This means that producers are losing money at infestations above 1 fly/tiller. In a few localized areas where yields averaged 70 bu/acre, Hessian fly intensities exceeded 10/tiller caused up to 50 bu/acre yield loss. Our team along with an increasing number of wheat producers initiated a management and plan and evaluated the benefits of insecticidal seed treatments and use of resistant wheat cultivars to prevent yield losses associated with the Hessian fly.

During the 2008-2009, 2009-2010, and 2010-2011 winter wheat growing seasons in Oklahoma, project investigators (1) monitored first and second generation Hessian fly abundance on susceptible and resistant wheat cultivars, and (2) monitored the effectiveness of Gaucho XT wheat seed treatment for control of first and second generation Hessian fly. Data was collected from several locations over the three-year period to summarize the overall impact of these management strategies in Oklahoma. Our cumulative data on fly numbers revealed the significant benefits of planting resistant wheat (Table 1).

Table 1. Three-Year Data for First + Second Generation Hessian fly on Susceptible and Resistant Wheat Cultivars and Annual Estimated Losses. <u>08/09, 09/10 and 10/11 field seasons.</u>

	Average	Estimated losses @ $7/bu	
	Flies/Tiller	bu/ac	$/ac
Resistant (Duster)	**0.0**	**0**	**$0**
Susceptible (Combined)	**2.68**	**13.4**	**$93.80**

The three-year average infestation (flies / tiller) clearly exceeded economic levels in susceptible cultivars, but flies were not detected in adjacent 'Duster' plots. The estimated losses for susceptible cultivars seem dramatic but were verified in separate experimental plots where fly populations were very high (Alvey 2009). The economic importance of Hessian fly of course depends upon yield potential, however, use of 'Duster' to prevent injury in infested fields would provide a significant economic return in any suitable growing area of Oklahoma. 'Duster' is a superior agronomic cultivar for this region and the added benefit of resistance explains why this cultivar ranked first in yield for all cultivars evaluated in Hessian fly trials over the past three-years.

Insecticidal seed treatments were also evaluated in several locations over the three-year period, however, some of these locations had relatively low infestations. Data did reveal that seed treatments provided detectable protection against Hessian fly (Table 2).

Table 2. Three-Year Data for First + Second Generation Hessian fly on Susceptible wheat treated with Gaucho XT and Annual Estimated Losses. <u>08/09, 09/10 and 10/11 field seasons. $7/bu</u>

	Average	Estimated losses @ $7/bu	
	Flies/Tiller	bu/ac	$/ac
Untreated	**0.98**	**4.9**	**$34.30**
Gaucho XT	**0.62**	**3.1**	**$21.70**

Seed treatment effectiveness breaks down during spring growth, and second generation numbers accounted for a large proportion of flies in Gaucho XT plots. The multigenerational protection of seed treatments appeared to maintain populations below calculated economic injury levels, but in fields with low infestations, the use of seed treatments to suppress Hessian fly may not result in a meaningful return on investment. Seed treatments are also effective at preventing co-occurring aphid pests from damaging wheat during the fall. However, because aphid infestations are sporadic (spatially and temporally) scout-and-spray approaches may be more cost effective than insecticidal seed treatments.

Overall impact of project on Hessian fly damage in Oklahoma.

Prior to this project, Hessian fly numbers were generally below economic injury levels throughout Oklahoma, but in a few areas, infestations were severe (Alvey 2009). During this three-year project, wheat producers in severely infested areas were actively utilizing resistant cultivars to suppress local Hessian fly infestations. Subsequent fly intensities were essentially absent in wheat fields planted to resistant 'Duster'. Conservatively, the economic benefits of the project could be calculated by estimating the yield savings associated with targeted 'Duster' acreage in Oklahoma. This would be of course a conservative estimate as targeted Hessian fly management appears to have reduced fly infestations in larger landscapes. Study locations were originally chosen because they were fly hot-spots, however, management (primarily resistance) in surrounding fields appears to have significantly reduced infestations in untreated susceptible cultivars; fly intensities in these plots dropped each year of the project: 3.40/tiller (2008/2009), 2.02/tiller (2009/2010), and 0.03/tiller (2010/2011). A dollar figure associated with this landscape level benefit is difficult to calculate, however, it is clear that tens-of-thousands of wheat acres previously severely infested with Hessian fly and surrounding wheat landscapes no longer suffer economic losses.

3) Lessons Learned

We feel our project was very successful in terms of the objectives and goals set forth in our proposal. We feel one of the primary reasons we were successful was our integration of project objectives and deliverables into existing extension and educational venues. It is doubtful we could have had the same impact had we been taxed with assembling a critical mass of stakeholders while simultaneously working towards our field-based project objectives. Having this critical mass of receptive followers allowed project directors to leapfrog past this initial hurdle.

While we were very successful in incorporating stakeholders into all phases of the project and had numerous stakeholder participants, we were not able to identify stakeholders willing to assume leadership roles in terms of organization and development. We are still working on this initiative and feel that having more stakeholders in leadership roles will be critical for continued success of our initiatives beyond the life of this project.

4) Dissemination

Our dissemination of project outcomes and deliverables was successful. In the future, however, we plan to be more effective at engaging industry partners in information dissemination. Groups such as agricultural retailers and crop consultants attended our events and participated in discussions, but these groups could be more effectively utilized as leaders and advisors in future projects.

5) Project Documents

a) Include with your report 2-10 representative photos from the project. Photos need to have a minimum resolution of 300 dpi.
b) Include with your report publications, GIS data, brochures, videos, outreach tools, press releases, media coverage, and any project deliverables per the terms of your grant agreement.