Oklahoma Department of Agriculture, Food, and Forestry
(ODAFF)

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Final Performance Report

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EXTENDED SEASON LEAFY GREENS FOR HEALTH AND WEALTH

Project Summary:

Developing season extension techniques for fresh vegetable production is a key aspect of helping producers increase the number of months that they are able to produce and sell fresh produce in the state. Cool season greens can be produced throughout the fall-winter-spring in hoop houses because of their tolerance to cold temperatures. An important aspect of this process is trialing and learning what crops and varieties perform best within hoop houses in Oklahoma. The project included trialing of several leafy greens crops that can be grown for fresh market sales in local farmers markets and within the Farm to School marketing program. Leafy greens include both brassica greens and spinach which can be eaten fresh and cooked. Both types have high levels of nutrients and are considered very healthy foods for adults and school children. Our project sought to determine not only what varieties perform best in hoop houses, but also which crops would have the highest potential for profitability for fresh producers within the state. Replicated trials were carried out at three locations (Tulsa, Lane, Oklahoma City) the first year and four locations (Tulsa, Lane, Oklahoma City, Ardmore) the second year with results being published each year.

Project goals:

1. Determine the best varieties of cool season greens for production within a hoop house.
2. Determine the best mix of different cool season greens crops for production and profitability within a hoop house.
3. Encourage the use of hoop house production within Oklahoma for season extension and increasing profitability for fresh produce producers.
    a. Extension of growing season to 12 months per year.
    b. Cool season crops for filling the market void that occurs during the winter.
4. Increase the nutritional quality of school lunch programs by increasing the availability of fresh greens during the school year.

Project Approach:

Accomplishments for 2010-2011 season:

Prior to trial initiation all investigators met in Oklahoma City and discussed how to organize the trials, what greens crops to trial, planting methods, production constraints, pest management, harvesting, field days, and annual reports. Nine different leafy greens crops were selected for the first year's trials including spinach, Swiss chard, romaine lettuce, collard, turnip, mustard, spinach mustard, kale, and broccoli raab. All crop species were grown at each site in a randomized block design with at least three replications. Trials were initiated at four different sites around the state including: Ardmore, Oklahoma City, Lane, and Tulsa. Field days were held at Tulsa, OKC, and Lane during the first year in addition the Ardmore site had five different tour groups that visited their leafy greens trial site. These outreach efforts provided an excellent opportunity for local growers to see the crops being grown in high tunnels and to ask questions

related to production and marketing. All site specific reports are included in the 2011 MP-164 Vegetable Trial Report available at: http://www.hortla.okstate.edu/industry/vegetables/index.htm Accomplishments for 2011-2012 season: Trial participants met again and discussed changes for the 2011 and 2012 trial season. Based upon discussions it was decided to drop broccoli raab from the trials since it showed little market potential and to add another leaf lettuce. Leaf lettuce the second year consisted of the previous year's romaine and the addition of a red leaf lettuce to the trial. Another change that was made for the second year included using transplants for the lettuce entries to speed up the establishment and improving the yield due to multiple crops being harvested vs. only one harvest for the first season. Field days were held at Tulsa, OKC, and Lane during the second year again the Ardmore site had five different tour groups that visited their leafy greens trial site. These outreach efforts provided an excellent opportunity for local growers to see the crops being grown in high tunnels and to ask questions related to production and marketing. All site specific reports will be included in the 2012 MP-164 Vegetable Trial Report available at: http://www.hortla.okstate.edu/industry/vegetables/index.htm

Goals And Outcomes Achieved:

Goals # 1 & 2: We were able to determine which of the different leafy greens crops would have the best potential for Oklahoma farmers to produce in high tunnels. Of the 10 different crops that were trialed, nine show real potential for commercial production, these include: Spinach, Swiss chard, Romaine and leaf lettuce, Collard, Kale, Mustard, Spinach mustard, and Turnip. Of these nine, spinach brought the highest price per pound. Prices ranged from $1.30 to $4.00 per pound for all the greens that were leaf cut and $3.00 per plant for both romaine and red leaf lettuce. More details are available in the final report written for the trials. This report is titled: E-1031Final Report for Extended Season Leafy Greens Research and is available on-line at: http://www.hortla.okstate.edu/industry/vegetables/pdf/HighTunnelLeafyGreensReport2012.pdf

Goal # 3: Through the trials we were able to determine that leafy greens can be produced throughout the winter season in an unheated high tunnel. This provides farmers with the ability to not only use high tunnels for extending the season of warm season vegetable crops in the spring and fall, but also with cool season leafy greens crops during the coldest months of the year.

Goal # 4: Based on the results of the trials that were completed around the state, the authors conclude that farmers now have information that will allow them to produce leafy greens crops for use in school lunch programs throughout the state of Oklahoma. This is an important step in helping school children have increased nutrition through the consumption of these crops which are very high in both vitamins and minerals.

Field days and other outreach efforts were used to transfer the technology and information generated by the trials directly to growers. Each site had either field-days or tours at trial sites for information sharing (table 1). Further transference of information about this technology was also done at professional and grower meetings around the state and region and also through sharing results in a grower newsletter and at Oklahoma State University's horticulture website. Face to face contacts at meetings are also given in Table 1.

Table 1. Outreach efforts for technology transfer for Extended season leafy greens for health and wealth						
Field days		Field tours		Professional & industry meetings		Overall # of people taught
# field days	# people	# field tours	# people	# meetings	# people	
6	324	11	116	5	637	1,077

Beneficiaries:

Farmers (larger-scale and smaller market gardeners), consumers, and school children have benefited from the information generated from these state-wide trials. As a result of the trials farmers now have information they need to increase their production of fresh vegetable crops to twelve months of the year. The result is that their cash flow should increase during the winter months which in the past was not as profitable compared to the frost free months. At this time it would be difficult to quantify the number of producers who are benefiting from this study as producers are sometimes slow to adopt new growing techniques. As more producers show they can grow leafy greens during these time frames and can make a profit, we will see others adopt these growing principles. School children and consumers have benefited by having a supply of fresh leafy greens for salads and for cooked vegetables during the fall-winter-early spring.

Lessons Learned:

During the two year project, we experienced two very different winter seasons with the first winter recording record low temperatures and the second being unseasonably warm. Well, that's Oklahoma weather . . . unpredictable! We did observe some damage from the cold winter, but in general most of the crops recovered and produced reasonable yields later in the spring. Spinach, collard, kale, and broccoli raab were the most tolerant of cold temperatures. Whereas during the unseasonably warm winter we encountered more insect problems and flowering of several of the brassica greens (collard, kale, turnip, mustard). One issue with leafy greens that have flowered is that they become tough in texture and bitter in taste rendering them unsalable. In general it appears that for most crops at most locations, production ended in March or April during both years. Using a multi-row hand planter and basket harvester was meant to save labor. As experience was gained with these tools some changes were made. Some sites replaced their multi-row planter with a single row precision planter and most sites stopped using the basket harvester and harvested by hand with a knife. Hand harvesting by knife helped to reduce damage on successive harvests of the same planting compared to the basket harvester. The change in the second year of using lettuce transplants instead of direct seeding proved to be an improvement resulting in higher and earlier yields. Profit potential from these crops varied because of market demand. Spinach commanded the highest price per pound with an average of $4.00/lb. Brassica greens crops averaged $1.30 to 1.50/lb. while Swiss chard went for $2.00/lb. and lettuce for $3.00 per whole plant. When information from both years are considered the authors conclude that the crop mix of leaf lettuces, spinach, Swiss chard, and the brassica greens have potential to produce salable crops throughout the coldest months of the year without supplemental heat in a high tunnel.

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Additional Information:

Attached in Appendix A is a copy of the research findings for the Extended Leafy Greens project.

FARM TO SCHOOL…OKLAHOMA HARVEST OF THE MONTH PROGRAM

Project Summary:

The focus of this project was to make a difference in the issue of unhealthy food choices for children in our state thus making a positive impact on childhood obesity. We wanted to make connections to Oklahoma's specialty crops through visual, auditory, and kinesthetic educational applications. The connections included education components using state and national educational standards.

The project provided resources (poster sets, window clings and Oklahoma's Bountiful Harvest) designed to increase child nutrition knowledge and featured specialty crops of Oklahoma connecting them with Ag in the classroom lessons. Our goal was to increase awareness of the crops and encourage healthier eating in school children while providing resources and funding for 4 school gardens for teachers and nutrition educators to use in teaching about Oklahoma agriculture and nutrition.

The posters addressed the visual concepts desired, the gardens provided kinesthetic and more, and the lessons connected to the Oklahoma's Bountiful Harvest provided visual, auditory and kinesthetic activities

The project's timeliness coincided with the school year, professional development calendar, growing seasons, and Ag in the Classroom state conference.

Project Approach:

A set of posters and clings featuring 12 of the state's specialty crops was developed and produced. Each poster provided factual information for students and teachers as well as nutrition educators. The specialty crops featured in each poster were correlated to one or more Ag in the Classroom lessons. The lessons are aligned to state education standards. While teachers are teaching students about fruits, vegetables and healthy food choices, they are also teaching math, science, social studies, language arts and more. The posters are perfect for display in the classroom or cafeteria. Part of the responsibility of promoting a healthy lifestyle has been

accepted by our schools. The poster set is a monthly reminder, bright and visible and a posive force to educate and encourage students and teachers about seasonal produce.

2. Oklahoma's Bountiful Harvest desk-sized flipchart was developed and produced, providing recipes, activities, and crafts that not only connect to state standards but feature Oklahoma's specialty crops and some top commodities.

The activities included in Oklahoma's Bountiful Harvest were the developed, printed and distributed. The flipchart desk-sized resource for teachers includes quick classroom lessons, easy recipes, age appropriate activities and crafts that teach about some of Oklahoma's specialty crops such as the cucurbit family, tomatoes, and strawberries. This resource has been utilized in lesson planning by preK through 8th grade teachers. Because other Oklahoma commodities were included in the resource, only 40% of the overall cost came from SCBG funding and the remaining 60% was paid for by the Oklahoma Department of Agriculture.

3. A final component in the project approach was 4 school gardens. The gardens provided a model for encouraging students to eat fresh fruits and vegetables and as a hands-on experience, the best possible science experiment for students in 4 separate school districts. Each classroom developed a school garden, harvested the produce, and prepared the food. The goal was to help students develop a taste for some of Oklahoma's fresh vegetables.

The 4 districts who piloted the project shared their different experiences and resources with teachers, pre-service teachers, students, nutrition educators, extension personnel, administrators, and cafeteria workers. The presentations were made during State Dept. of Education and Ag in the Classroom workshops and conferences all across the state. The information provided was on display and taught encouraging healthier eating while providing lessons connected to the new and rigorous standards of CORE curriculum.

Goals And Outcomes Achieved:

The completed activities include the development, production, and dissemination of the Harvest of the Month Poster set and clings; the development, production, and dissemination of Oklahoma's Bountiful Harvest flipchart of recipes, games, crafts, and other activities; and 4 productive school gardens. The project was complete.

The set of posters and clings went through two printings. It contained a letter to parents explaining the students were studying the specialty crops, eating them in the lunchroom, and should hopefully discuss and eat at home too. 3000 posters were printed and distributed at state education conferences, college education classes, on-site school professional development workshops, nutrition educator workshops, extension workshops and conferences, and student events such as wellness conferences.

Outcome measures are long term. Progress made is the awareness of students and parents of healthier choices with Oklahoma's specialty crops and the collective impact of educating teachers, food service providers and students on the impact of increasing consumption of fresh fruits and vegetables.

A nutrition survey was developed and completed by the 4 school garden grant recipients. The content of the survey was developed in partnership with the Oklahoma Department of Human Resources. The survey looked at student eating habits of fruits and vegetables, family eating and shopping habits for fruits and vegetables, what they learn in the classroom about fruits and vegetables, identification of common fruits and vegetables, along with asking why they choose not to eat fruits or vegetables. A copy of the survey is attached as Appendix E. Approximately 180 students were surveyed with a 75% increase in knowledge and awareness.

Beneficiaries:

The main group to benefit from the project is students. A healthier life style through eating more fruits and vegetables especially Oklahoma's specialty crops, was encouraged and taught to students. Educators, formal and informal indirectly benefited. The resources developed and provided at no-cost to the educator were aligned to state standards and added an interesting and bright resource to their curriculum. They can be reused multiple years.

3,000 poster sets and clings were distributed. Each poster set or clings were visible to classrooms of 20 to lunchrooms of 500 students each. The number of affected students ranges from 60,000 to 100,000.

The garden recipients impacted more than just the school population. Two of the gardens were visible to the general public and encouraged private support and contributions. Several press releases featured the gardens, their unique stories and had the potential to impact the community.

Lessons Learned:

One thing taken from the school garden grants is that once community partners found out about the project they were willing to provide resources and manpower to establish and maintain the gardens. Also it was determined that for future school garden projects a growing manual would be beneficial to distribute to the teachers. The teachers were eager to participate in the project, but many of them did not have any experience with gardening.

The posters and clings were geared toward elementary classrooms but could be used in so many more learning situations. They were also beneficial to high school and middle school settings.

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Appendix B is a copy of the resource booklet Oklahoma's Bountiful Harvest.

To view a copy of the 12 individual posters click on the following link:
http://oklahoma4h.okstate.edu/aitc/lessons/extras/hom.html

Appendix E is a copy of the Harvest of the Month student nutritional survey.

OK GROWN…OKLAHOMA GROWN SPECIALTY CROP PROMOTION

Project Summary:

The specialty crop industry in Oklahoma mainly consists of small producers who rely on direct marketing their products. With no major wholesaler or processor in the state growers depend on Farmers Markets as outlets for the fruits and vegetables they grow. As a way to have a broader impact for producers statewide, ODAFF has decided to provide grants to Farmers Markets to increase their marketing and promotions. We felt by partnering with the Markets there would be a greater effect for the producers by creating more demand by bring new customers to the markets.

Grants were administered to 100% Oklahoma Grown Farmers' Markets through a rigorous application process. ODAFF awarded 33 selected 100% Oklahoma grown Farmers' Markets. The grants have been very beneficial to the growth of 100% Oklahoma Grown Farmers' Markets in our state with a growth of 39% since 2008. While Consumers have become more health conscious and concerned about better eating habits, market managers are continuously looking for new ways to reach the community. Our goal with this project was to increase the consumer demand for Oklahoma grown produce sold at farmers' markets.

Project Approach:

Through Specialty Crop Block grant funding, Farmers' Markets registered as 100% Oklahoma Grown, were able to apply for grants up to $2,000. This grant was solely used for the purpose of promoting the consumption, purchase, and/or production of specialty crops. The grants could be used by the markets for radio/print advertisements, newsletter publishing, signage, or promotional marketing items. Applications for grants were reviewed by the ODAFF specialty crop coordinator to ensure they met all qualifications, and were evaluated by an outside review committee. The committee scored the applications and awarded the markets with the best-proposed projects that enhanced specialty crops and had the greatest probability of successfully growing demand at their markets. The grants were then awarded to 33 Farmers' Markets. ODAFF staff conducted a minimum of two onsite visits to each Oklahoma Grown Farmers' Market that received a grant along with reviewing annual reports, which included receipts showing how grant funds were utilized to insure the projects were benefitting specialty crops in Oklahoma. By providing these grants to Farmers' Markets, ODAFF felt that we could help Farmers' Markets enhance their ability of specialty crops and also make consumers aware of their local Farmers' Market. 100% of the Markets receiving the grant showed increase in customer demand and vendor participation. After the season, managers expressed that the funding of the grant was extremely helpful.

Goals And Outcomes Achieved:

Our goal with this project was to enhance the competitiveness of specialty crops and to increase consumer demand at Farmers' Markets. Throughout the growing season, Farmers' Markets that received grant funds showed an increase of reported sales by 6%. Customer demand and vendor participation also realized an increase. Data was collected from the usage of piloted EBT machines. Reports show that sales from low income consumers that had the ability to use federal benefits was greater than $18,000. This data will be very beneficial to track revenue for future growing seasons. The grant funds raised customer awareness and demand at Farmers' Markets, with a growth of 39% in 100% Oklahoma Grown Farmers' Markets since 2008. Estimated reports show that the advertising campaign reached over 100,000 prospective consumers throughout Oklahoma. At the end of the year Market Managers reported over 900 producers selling at 100% Oklahoma Grown Farmers' Markets. Advertising, signage, and promotional items continue to be a good way to reach the community.

Beneficiaries:

The beneficiaries of this program were current specialty crop producers participating in 100% Oklahoma Grown Farmers' Markets. With 33 markets receiving grant funding and each market having an average of 8-10 vendors selling specialty crops; it could be said that over 300 producers benefited from the grants by new vendors attending the markets. The impact of the grants are much greater though as it would be too difficult to determine what % of new customers at a market along with an increase in sales are directly related to the advertising initiatives. Also the grants helped increase consumers awareness of markets where they can purchase locally grown fruits and vegetables.

Lessons Learned:

An easy way to make consumers aware of their local markets is through good advertising. Markets have utilized various types of advertising through this grant (banners, newspaper add, radio advertisements), but there is not one specific type that is the best for each market. This grant allows the markets to test and find what form of promotions works best for their area.

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N/A

PLASTICULTURE GARDEN GRANTS PROGRAM

Project Summary:

This grant built on other previously funded Specialty Crop Block grants. With the national push of Know Your Farmer Know Your Food and the Oklahoma Department of Agriculture's OK Grown initiative, we need more locally available fresh fruits and vegetables for a healthier Oklahoma. The Oklahoma Department of Agriculture Food & Forestry's plasticulture garden grant program allows selected individuals to participate in the program for a maximum of three years. As producers complete their three years in the program and roll off; we are able to add new producers. This grant also allowed us to contract with 4 growers to assist ODAFF's plasticulture program coordinator with installing gardens. The addition of the contractors also allowed ODAFF to increase the overall number of participants in the program.

Timeliness is very important to this project. It is imperative to get the gardens in place by early spring in order to get all of the crops planted at the optimum time. In previous years only having one person installing gardens caused some delays for producers. The coordinator would have a location schedule for an install and due to rain or other setbacks would have to reschedule at a later date. The grant participants were very appreciative of being able to get their gardens installed on time. Because of Oklahoma's hot dry summers tomatoes need to be planted early in order to get any production; otherwise the extremely high temperatures inhibit fruit set.

Project Approach:

Grants to participants are awarded by a competitive process. Press releases were sent to statewide news publications to promote the grant and encourage participation. Individuals must qualify based on Langston University's definition of a limited resource farmer being defined as a person with a direct or indirect gross farm income of not more than $100,000 in each of the two previous years and has received little or no assistance from the government. The program is also limited to participants with forty (40) acres or less. The plasticulture program coordinator reviews the applications to ensure that applicants meet all of the program requirements. All eligible applications are forwarded to members of a review committee. The committee members are associated with Cooperative Extension in the state and must have general knowledge of the specialty crop industry. After the committee reviews and scores each application, they convene and scores are combined and the applications are then ranked. There are a set number of new applicants that can be admitted to the program each year and they go down the rankings and review each application again until they reach that set number.

Specialty crop grant funds are utilized by ODAFF to contract with four individuals to assist with the instillation of gardens and to purchase irrigation supplies and plastic mulch. Individuals do not receive grant funds directly; they are used for the instillation and purchasing of supplies for the gardens. Participants may install a minimum of ¼ of an acre; up to 1 acre of ground with plastic. Participants are required to have all ground work completed and the soil ready for the raised bed process. They must also have had their water tested and provided the results to the ODAFF plasticulture coordinator to ensure adequate water quality is available. Once this is achieved contractors will schedule a time with the participants to visit their locations. The

contractors will use their machinery to form raised beds while laying a line of drip irrigation while covering the bed with the sheets of plastic. The contractors will also hook up the irrigation system. Participants also received technical support during the growing season about what and when to plant.

Sixty gardens were installed for farmers across the state during 2010 along with 5 demonstration gardens. Plastic mulch and drip tape were laid by the four contractors and an ODAFF employee. Participants are required to submit production reports at the conclusion of each year. From these reports it was determined that each participant averaged sales of $2,365.49. Weather and pest problems affected some growers resulting in lower amounts of produce to sell.

Goals And Outcomes Achieved:

By funding this program ODAFF has been able to help limited resource farmers within the state to either begin producing or increase their production of specialty crops. By utilizing the grant funds to hire contractors to help install gardens; ODAFF was able to increase the number of participants in the program and get the gardens installed in a timelier manner. As stated earlier timing is everything with plasticulture and by getting the gardens installed in time; growers were put in a position to have better success. The addition of the contractors helped to lighten the workload of traveling all over the state installing gardens from the ODAFF plasticulture coordinator and allowed them to be able to provide more technical assistance to the participants along with being able to administer the program better.

Beneficiaries:

The 60 participants who were selected to participate in the program directly benefited by increased revenue from the production of specialty crops. From the production reports submitted, participants sold $69,498.07 worth of specialty crops. The health and nutrition of the families who participated also benefited by being able to consume a portion of the produce that was grown. Participants showed that they consumed $10,598.76 worth of the fruits and vegetables that were raised. Although these products did not directly generate revenue for the growers, they would have had to pay for them if they purchased them at a local market or grocery store.

Lessons Learned:

Weather is always a factor when growing fruits and vegetables. The plastic mulch will help heat up the soil earlier in the growing season and allow early growth of plants along with suppressing weed competition. One unexpected outcome is the protection provided during heavy periods of rain. The raised beds that are overlaid with plastic help keep plants from drowning in our heavy clay soils when water is standing. Also root crops such as potatoes and onion which are not typically grown in plasticulture are more than protected under the mulch during heavy periods of rain.

Another unexpected lesson was that the plastic mulch can be very hard to get out of the ground at the end of the growing season. Through some experiments our producers have found that instead

of utilizing a machine that would cost them $2,000 to remove the plastic, they can get comparable results utilizing a small cultivator.

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AN OKLAHOMA VITICULTURE WORKBOOK AND ASSOCIATED RESEARCH

Project Summary:

The grape and wine industry has increased substantially in the United States in recent years, particularly in non-traditional areas of wine grape production. Commercial grape production has expanded to every state in the continental U.S. and local wine industries have created significant agri-tourism opportunities that are making important contributions to rural economies.

Oklahoma had only four licensed wineries in 2001 and that number exploded to over 50 by 2009. The wineries want Oklahoma-grown grapes, but the demand greatly outpaces the supply. Poor management of existing vineyards along with poor decisions during the developmental stages of a vineyard was some of the main reasons for lack of supply. New growers are often undereducated in viticulture and enology practices. Issues such as site selection and cultivar choice are crucial for success in many regions, yet new growers lack the knowledge of these critical aspects for optimal vineyard production.

The emphasis of this project was to create a vineyard best management practice workbook for Oklahoman's that growers and wine makers of all levels could utilize. Also the continental climate in Oklahoma is unpredictable and can lead to cold injury during fall, winter, and spring. The project also completed cultivar adaptability research by conducting a cold tolerance screen technique to eliminate undesirable cultivars and focus attention on others that will be more promising.

Due to the loss of Dr. Eric Stafne to Mississippi State University and then his replacement Dr. Damon Smith taking another job and leaving; Oklahoma State University was left without any grape specialist on staff. This along with minimal participation from grape growers who had committed to work on the project has caused the workbook to progress very slowly. The workbook was in a rough draft form at the conclusion of the grant and was not completed. In the original application there was $6,000 allocated to the publication of the workbook. Oklahoma State University did not request nor utilize any money through this grant for activities associated with the workbook. The two growers who participated did so at their own expense. The only funding utilized ($18,900) for this project was for the purchase of laboratory supplies, equipment and travel associated with the portion of this project to determine the influence of black rot severity on vine winter-hardiness.

Project Approach:

In 2011 George and Jane Ingels and Marsha Butler developed a rough draft of the workbook in conjunction with Dr. Eric Stafne and Dr. Damon Smith of Oklahoma State University. The current version of the workbook is composed of three separate sections: Establishing the vineyard (section 1), the young vineyard (section 2), and the producing vineyard (section 3). Currently, section 1 has 7 subsections and 38 questions. Section 2 has 7 subsections and 40 questions. Section 3 has 5 subsections and 29 questions. The workbook project progressed slowly. It was also delayed due to the departures of both Dr. Stafne and Dr. Smith. While a draft has been completed, much time and effort from a limited number of grape specialists at Oklahoma State University are needed to complete the project.

The research portion, addressing bud hardiness was to begin in winter/early spring 2011. This research trial was completely destroyed by the extreme cold temperatures that struck Oklahoma in early February 2011. New research was slated to begin in Fall 2011 under the direction of the lead principal investigator, Dr. Eric Stafne. However, Dr. Stafne left OSU in the Fall 2011 to pursue a new job at Mississippi State University. These issues resulted in a redirection of the research efforts proposed in this project. Because this project was transferred to Dr. Damon Smith while he was still at Oklahoma State University, the research portion of the project focused on the influence of black rot severity on vine winter-hardiness. Extensive black rot incidence and severity data were collected during the 2011-growing season at a research vineyard located at the Cimarron Valley Research Station in Perkins, Oklahoma. During the 2011 season, varying levels of black rot were established on the vines through the use of fungicides or not spraying to control black rot. This resulted in different levels of pathogen-induced stress on the plants. During the winter 2012 buds were collected once per month in January, February, and March from the hybrid grape cultivar 'Noiret'. Noiret is a new cultivar release from Cornell University and possesses traits that make it a good candidate for vineyard production in Oklahoma. The ethylene glycol bath (Thermo ULT-80) purchased from a portion of the funds awarded under this project was used to test the cold hardiness of the buds collected. Relationships between collection-month, temperature of freezing treatment, fungicide treatment, and appropriate interactions were examined.

Goals And Outcomes Achieved:

The following hypotheses were targeted:

1. Higher levels of black rot will result in increased bud mortality.
2. Fungicide treatments will provide increased protection against bud mortality when buds are subjected to freezing events.
3. Colder freeze events will result in higher bud mortality
4. Alternating weather conditions prior to bud collection will result in higher bud mortality when subjected to continuous freezing conditions.

1. Higher levels of black rot will result in increased bud mortality: Linear regression analysis was performed in an effort to identify a relationship between black rot severity data from 2011 on bud cold-hardiness. Modeling was performed using statistical techniques. No statistically

significant (***P***>0.05) model was generated using the data. This is likely due to the fact that 'Noiret' possesses moderate partial resistance to black rot. In our trials in 2011, relatively low levels of black rot severity were observed (21% severity in the non-treated controls). In these experiments, no relationship between black rot and bud mortality was observed.

2. Fungicide treatments will provide increased protection against bud mortality when buds are subjected to freezing events: A marginally significant (***P***=0.05) interaction of fungicide treatment and month of collection was identified in our analysis. For buds collected in January slightly less bud mortality was observed in the non-treated control, while buds that received fungicide did not differ in the level of bud mortality (Fig. 1). For the February collection period the Organic 1 program resulted in significantly less bud mortality than all other programs. For the March sampling date, no differences in bud mortality were observed. The February results indicate that there might be some effect of fungicide application on bud mortality in grape subjected to freezing conditions. However, much more work needs to be done to investigate this effect. The January and March sampling dates indicated no positive effect for reducing bud mortality when vines were treated with fungicide. Therefore, results are inconclusive and more research needs to be performed to investigate this hypothesis.

3. Colder freeze events will result in higher bud mortality: Temperatures of either -15 or -20 C resulted in significantly more bud mortality during the January sampling time compared to temperatures of -5 or -10 C (Fig. 2). For February and March sampling, temperatures of -5 and -10 C resulted in some bud mortality; however, mortality was greater at -15 C and even greater for -20 C.

4. Alternating weather conditions prior to bud collection will result in higher bud mortality compared to continuous weather conditions: Bud Mortality was notably higher in the February samples compared to the January or March sampling (Figs. 1 and 2). This was likely a result of weather conditions immediately prior to the sampling event in February. For January and March, weather was dry and unseasonably warm with an average temperature 14 days prior to sampling of 5 C and no rainfall. Average temperature 14 days before the March sampling was 9 C with only 2.8mm of rain. These mild and dry conditions were much different than the wet and mild conditions 14 days prior to the February sampling date. For this date, average temperature was 7 C with 43.6 mm of total rainfall. Therefore, it is likely that temperatures during the winter of 2012 were not cold enough to induce deep "super cooling" and complete dormancy of the buds, which had more moisture stored within them at the February sampling date. Thus more mortality was observed due to ultra cold temperatures. After the February sampling date there was little rain until March 1, allowing the buds to "dry out" and become more cold-hardy again. Without the rain event it is likely that there would have been no difference in bud survival between the January, February, or March sampling dates. During winter months when temperatures don't get cold enough to induce complete dormancy, significant rainfall can affect bud hardiness, hence the higher mortality of buds during the February sampling time in this study.

Based on these data, bud mortality of 50% or more can be expected in the grape cultivar 'Noiret' when subjected to freezing temperatures of -15 C or more when complete winter dormancy is not induced and significant rainfall accumulates immediately prior to the freezing event. More research needs to be performed to address this scientific theory.

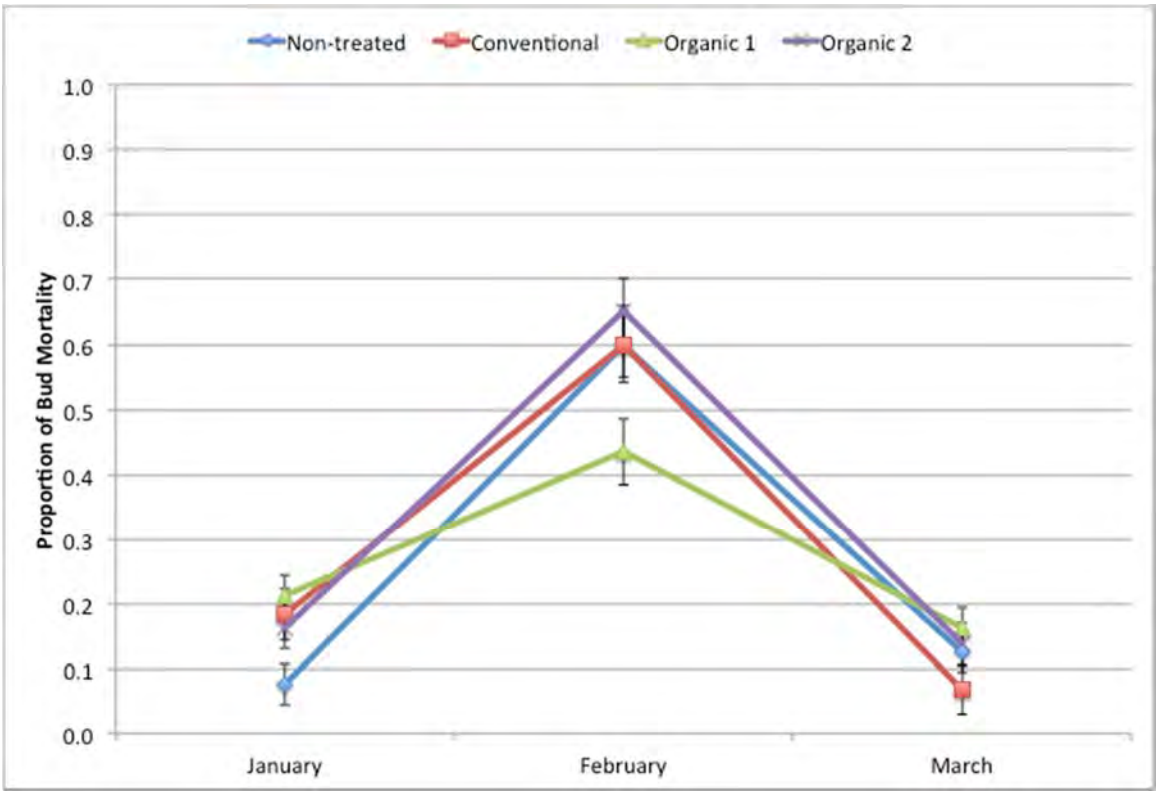

Figure 1. Proportion of bud mortality for grape buds subjected to freezing temperatures. Buds were collected in January, February, and March 2012 after being treated with a conventional fungicide program, one of two organic fungicide programs, or not treated with fungicide during the 2011 field season.

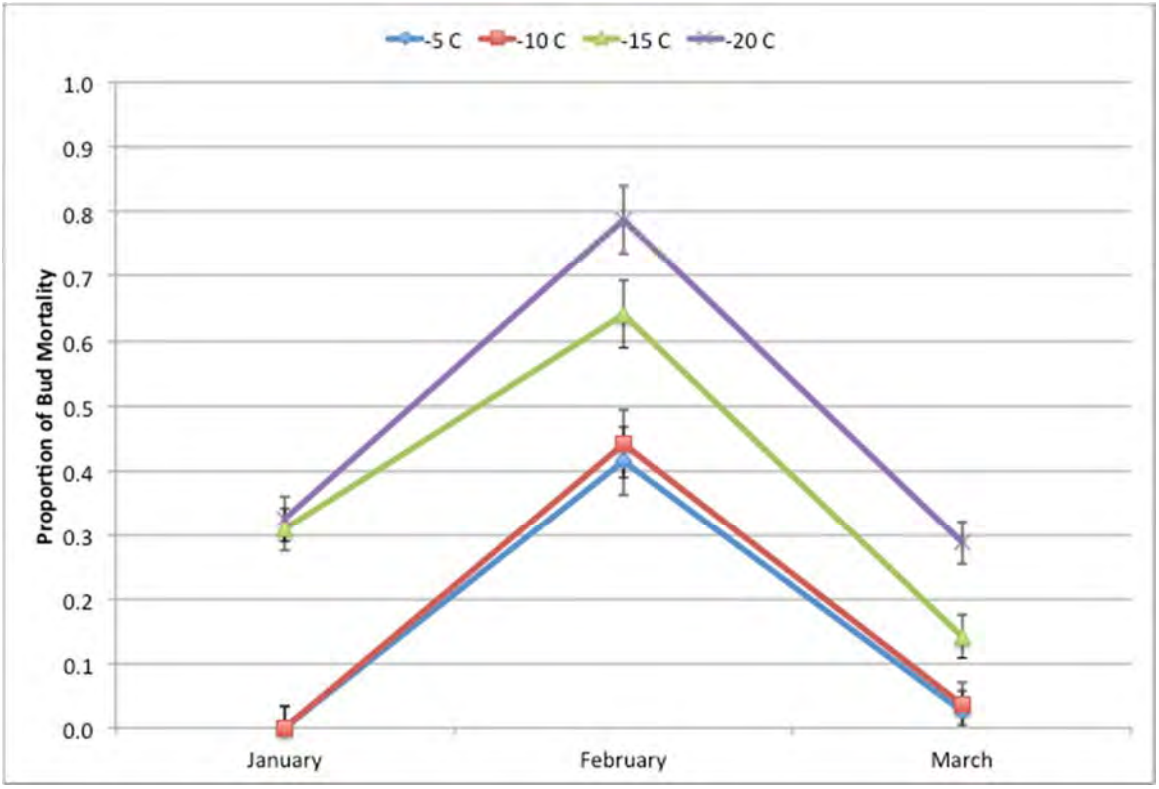

Figure 2. Proportion of bud mortality for grape buds subjected to temperatures of -5, -10, -15, or -20 C. Buds were collected in January, February, and March 2012.

BENEFICIARIES:

In a recent economic impact study of the wine and grape industry in Oklahoma conducted by Frank, Rimerman + Co. LLP it was determined that there are 139 individuals growing grapes. No matter the growing experience producers of all knowledge levels will be able to take something from the workbook once it is completed. The same producers will benefit from the research on black rot severity on vine winter-hardiness.

LESSONS LEARNED:

When a university has a small number of specialists associated with one industry and both of those specialist leave during the course of the grant and are not immediately replaced; the chances of that projects success is greatly decreased. Also this project relied on the participation and input from several growers who had committed to the project. The project was slow moving and as with most projects who have several volunteers commit the majority of work ended up being completed by a very small number of people who were very passionate about the need for such a workbook for existing and new growers. This unfortunately drags the timeline out and the workbook was not completed. The $6,000 that was budgeted was for the publication and printing of the workbook and was not utilized or reappointed to other areas of the project.

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ENHANCING OKLAHOMA'S FRESH MARKET SWEET CORN INDUSTRY

Project Summary:

Oklahoma once was an important regional producer of fresh market sweet corn. Today, smaller producers and local market outlets are more important, but the need for current, research-based knowledge remains high. All producers, from commercial-scale to home gardens, need current information on cultivars best adapted to our challenging growing conditions. Experiment Station funding (Hatch) for such trials is limited, and support from seed companies is tenuous in the current economy. Funding is needed for continued annual cultivar adaptation trials. There also is interest in marketing sweet corn through the Farm-to-School program. The current peak for

Oklahoma sweet corn production is during July. Historically, production of a fall sweet corn crop has been severely constrained by insect pressure. Development of new sweet corn cultivars with inherent resistance to Lepidoptera larvae increases the chances of a successful fall crop that could be marketed as a Farm-to-School commodity.

This project had two primary goals. Goal #1 was to provide current information on sweet corn cultivars best adapted to the challenging growing conditions of Oklahoma. Each year, seed companies develop and offer new cultivars, while older ones are taken off the market. Thus, the available selection changes annually. Literally hundreds of potential cultivars are available to producers, and they need unbiased, science-based information to make appropriate choices. Goal #2 was to research practices that will promote establishment and development of a fall sweet corn crop that will provide a quality product to area schools during as much of the fall term as feasible. This included elucidating planting dates that will provide an extended harvest period during the fall, and determining the level of supplementary pest control necessary to produce ears that will meet school standards.

Project Approach:

Accomplishments for 2010:

Goal #1: Provide current information on sweet corn cultivars best adapted to the challenging growing conditions of Oklahoma.
Planned 2010 Timeline: Spring cultivar adaptation trial planted in April and harvested in June-July (Kahn). Field Day activities at Bixby in late June.
Accomplishments: Goal met for 2010. Details were published in January 2011 as part of the ***2010 Vegetable Trial Report*** (Publication MP-164). Plots were shown to the public during a field day on 23 June 2010. The study also was featured on the Cooperative-Extension-produced television series ***Oklahoma Gardening***, broadcast on OETA (episode #3709, first aired on 28-29 August 2010).

Goal #2: Research practices that will promote establishment and development of a fall sweet corn crop that will provide a quality product to area schools during as much of the fall term as feasible.
Planned 2010 Timeline: Experiment to compare weekly summer plantings of 'GSS 0966' initiated with plantings in June.
Accomplishments: Goal met for 2010. Plantings of the insect-resistant 'GSS 0966' corn were made on 1, 15, and 23 July and on 2 and 12 August at the Oklahoma Vegetable Research Station in Bixby. Once-over hand harvests were made for each planting on 7, 21, and 30 September, 20 October, and 4 November, respectively. Detailed yield data were taken. Approximate percentages of marketable ears produced relative to total ears were 7%, 26%, 56%, 63%, and 55% for the five plantings, respectively. Total ears included many that would have been bypassed in a non-research situation (e.g., immature secondary ears), so commercial marketable percentages would have been higher. Samples of marketable ears were taken to Terry Baker of University Dining Services at Oklahoma State University and confirmed as acceptable quality. Plots were shown to the public during a fall vegetable production twilight tour on 24 September 2010.

Accomplishments for 2011:

Goal #1: Provide current information on sweet corn cultivars best adapted to the challenging growing conditions of Oklahoma.
Planned 2011 Timeline: Spring cultivar adaptation trial planted in April and harvested in June-July.
Accomplishments: Goal met for 2011. Details were published in January 2012 as part of the ***2011 Vegetable Trial Report*** (Publication MP-164). Plots were available for viewing by the public.

Goal #2: Research practices that will promote establishment and development of a fall sweet corn crop that will provide a quality product to area schools during as much of the fall term as feasible.
Planned 2011 Timeline: Second year of summer planting date experiment using 'GSS 0966'. Initiation of summer/fall pest control study comparing 'GSS 0966' with 'Passion'. Initiation of field demonstrations and educational presentations.
Accomplishments: Goal substantially met for 2011. Plantings of the insect-resistant 'GSS 0966' corn were made on 18 and 25 July and on 1 and 8 Aug. at Bixby, Okla. Adequate stands were obtained from all but the 18 July planting. However, plants later succumbed to record heat and inadequate soil moisture. Therefore, no field demonstration was held. A second study with 'GSS-0966' and 'Garrison' was planted on 27 July at Stillwater, Okla. 'Garrison' was chosen instead of 'Passion' based on input from the company producing these hybrids (Syngenta) that indicated 'Garrison' was a sister cultivar to 'GSS 0966' but without the genetic modification for insect resistance. An unsprayed control and four insecticide regimes were tested in factorial combination with the two cultivars. This study received adequate irrigation and plants produced ears. Once-over hand harvests were performed by replication on 10 and 11 Oct. and detailed yield data were taken. Cultivar effects predominated; there was only one significant effect of insecticide regime, and no interactions. For 'Garrison', 28% of the ears were suitable for local markets versus 78% of the ears for 'GSS-0966'. Also, 52% of 'Garrison' ears had insect damage > 4 cm from the tip versus 16% for 'GSS-0966'. Plots were available for public viewing. Information from these studies and those accomplished in 2010 also was shared at the Fall 2011 Oklahoma Market Gardening School, an eight-week course that ran from 22 Sept. through 10 Nov. in Muskogee, Okla.

Accomplishments for 2012:

Goal #1: Provide current information on sweet corn cultivars best adapted to the challenging growing conditions of Oklahoma.
Planned 2012 Timeline: Spring cultivar adaptation trial planted in April and harvested in June-July. Field Day activities at Bixby in late June.
Accomplishments: Goal substantially met for 2012. Details will be published in January 2013 as part of the ***2012 Vegetable Trial Report*** (Publication MP-164). Plots were available for viewing by the public. A Field Day was not held at Bixby in 2012, in part due to extreme heat and drought conditions.

Goal #2: Research practices that will promote establishment and development of a fall sweet corn crop that will provide a quality product to area schools during as much of the fall term as feasible.
Planned 2012 Timeline: Second year of summer/fall pest control study. Summarize research results and determine the need for further work in preparation for publication in popular and refereed outlets.
Accomplishments: Goal met for 2012. A study intended to repeat the work conducted in 2011, but with different insecticide regimes, was planted on 25 July at Stillwater, Okla. 'Garrison' did not make adequate stands for unknown reasons, but 'GSS-0966' succeeded. This study received adequate irrigation and plants produced ears. Once-over hand harvest was performed by replication on 4 Oct. and detailed yield data were taken. Despite record heat and drought, ears filled well. The control averaged 21% cull ears due to insect damage. This percentage was reduced by two of the insecticide regimes: 9% for carbaryl alternated with permethrin, and 8% for esfenvalerate alternated with methomyl. However, overall marketable yields were not statistically different among insecticide regimes. Plots were available for public viewing.

Goals And Outcomes Achieved:

The two overarching goals from the approval project proposal were:
* Goal #1 was to provide current information on sweet corn cultivars best adapted to the challenging growing conditions of Oklahoma.
* Goal #2 was to research practices that will promote establishment and development of a fall sweet corn crop that will provide a quality product to area schools during as much of the fall term as feasible.
Both goals were accomplished. Activities completed have been described in the previous section. Following is a comparison of actual accomplishments with the "expected measureable outcomes" set forth in the approved project proposal. Project results were to be disseminated each year in print and electronically via the Oklahoma State University Vegetable Trial Report (MP-164). This was accomplished. Project results also were expected to be disseminated through refereed scientific journals and presentations at professional meetings. The research was only completed within the past month, and preparation of a manuscript for publication in a refereed journal was listed as a post-grant goal for 2013. An overview of results to date was presented at the 2012 Oklahoma-Arkansas Horticulture Industries Show and published in the Proceedings of that Show. Other measures of outcomes were to include an annual research summary in the Federally-required CRIS report pertaining to Dr. Kahn's research, and the required performance reports that were to be submitted to ODAFF. All of these reports were submitted as required.

Field research plots were available for public viewing. It is hard to determine the number of casual visitors to the research stations, but on average there are around 20 casual visitors per year. As planned, plots at the Oklahoma Vegetable Research Station in Bixby were shown to the public during a field day on 23 June 2010, where 61 individuals attended the event. The study also was featured on the Cooperative-Extension-produced television series ***Oklahoma Gardening***, broadcast on OETA (episode #3709, first aired on 28-29 August 2010). The plots were viewed by 37 individuals during a fall vegetable production twilight tour on 24 September 2010. A 2012 field day was planned for the Vegetable Research Station in Bixby, but it was not held. This event did not depend solely on the experiments associated with this SCBG project.

The reality was that there were not enough studies on the station as a whole in 2012 to justify showcasing via a field day, in part due to extreme heat and drought conditions.

Dr. Brandenberger led additional outreach efforts using accepted methods of Cooperative Extension programming, as planned. These included informal conversations with producers during site visits, and presentations during the Fall 2011 Oklahoma Market Gardening School, an eight-week course that ran from 22 Sept. through 10 Nov. in Muskogee and had 10 participants who were new to growing specialty crops in attendance.

A final specific outcome was to be a revision of the existing Extension Fact Sheet (HLA-6021) on sweet corn production. This was listed as a post-grant goal for 2013, so it has not yet been accomplished. However, information on sweet corn cultivar recommendations for Oklahoma that was generated as part of this project was used in revising the existing Extension Fact Sheet HLA-6035 that lists recommended commercial vegetable varieties for Oklahoma; available at http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-1127/HLA-6035web2012.pdf

Beneficiaries:

All producers, from commercial-scale to home gardens, will benefit from the current information this project provided on cultivars best adapted to our challenging growing conditions. Official statistics are not kept on sweet corn production in Oklahoma. A low estimate can be obtained from the USDA's Census of Agriculture, which showed 228 farms harvesting 400 acres of sweet corn for fresh market in 2007. This would rank sweet corn fifth in number of farms among all surveyed Oklahoma fresh market vegetables. This project opened the option of marketing a fall sweet corn crop to more producers. It specifically enriched the Farm-to-School program by demonstrating the feasibility of sweet corn as another fresh, local vegetable option for participating institutions during the fall.

Lessons Learned:

Specific results and conclusions:
* Current information was provided on sweet corn cultivars best adapted to the challenging growing conditions of Oklahoma. Recommended cultivars included 7143, Bodacious, BSS 0977, Cameo, GSS 0966, Incredible, Obsession, Passion, and Synergy. This information was used to update Extension Fact Sheet HLA-6035.
* A planting interval between about July 20 and August 2 was found to give the best chance of a quality fall sweet corn crop in Oklahoma's main sweet corn production areas. Earlier plantings were subject to excessive heat stress, while an August 12 planting was just short of prime maturity at the time of a damaging freeze in November. Planting dates will vary with individual producers, but this study provided a target interval within which success is most likely.
* When adequate irrigation was provided, it was possible to plant fall sweet corn to a stand. If $\boldsymbol{x}$ represents the desired final stand (averaging one plant per foot of row), that stand could be achieved by seeding at 1.5$\boldsymbol{x}$ (e.g., 30 seeds in 20 feet of row). However, adequate irrigation had to be maintained throughout the growing season in order to produce a successful crop. When that did not occur (2011 at Bixby), the crop failed.

* The study reinforced the value of an insect-resistant cultivar for fall sweet corn production. In 2011, the insect-resistant 'GSS-0966' averaged 78% marketable ears versus only 28% from the near-isogenic but non-insect-resistant 'Garrison.'
* Further studies would be needed to determine possible efficacy and economic value of supplemental insecticide treatments for fall-grown 'GSS-0966' sweet corn in Oklahoma. Data suggest that the use of highly toxic insecticides (signal words of "Warning" or "Danger") is of no added benefit compared to use of less toxic materials (signal word "Caution").
Ideas to improve project efficiency:

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EVALUATION OF FRESH DUG STRAWBERRY PLANTS AS AN ALTERNATIVE METHOD OF ESTABLISHING HOOP HOUSE (HIGH TUNNEL) STRAWBERRY CROPS IN OKLAHOMA

Project Summary:

Strawberries make an excellent addition to the crop mix of Oklahoma market gardeners because of the ability to draw customers early in the season. Strawberry is also a logical choice for inclusion in the Oklahoma Farm-to-School program because the crop is traditionally harvested in the spring while school is in session. Yield trials conducted at the Noble Foundation, as well as yields reported by growers throughout the state, clearly shows the advantages of growing strawberries in hoop houses compared to field plasticulture. Total yield, early yield and quality of hoop house grown berries are superior to field grown berries.

Currently there are three plant types used to establish hoop house strawberries. These include dormant plants, fresh dug plants and plug plants propagated from runner tips or dormant plants. The dormant plant option requires an early September planting date in Oklahoma in order for the plants to achieve sufficient size prior to winter. Due to high air and bed temperatures common for hoop houses in early September and the resulting stress on plants, a large volume of water applied via overhead irrigation is required to establish the crop. The result is a higher establishment cost. Fresh dug plants are not available until October therefore; there is little time to establish the plants so sufficient size is achieved prior to winter. Compared to dormant plants, fresh dug plants are planted later which reduces the amount of stress and does not require the overhead irrigation. Plug plants are currently the recommended method for establishment of strawberry plants in hoop houses. Plug plants establish quickly and require less care compared to dormant plants, but are the most expensive option since the use of a greenhouse is required. Plug plants are started in containers in a greenhouse from dormant plants. This allows growers

to establish the plants in the hoop houses early in the fall, so that the plants are well rooted and have adequate size prior to winter.

The purpose of this study was to determine if a hoop house strawberry crop established from fresh dug plants can be as productive as a crop established from plug plants. If proven to be effective, the fresh dug plant establishment method has the potential of improving the profitability of hoop house strawberry production.

Another objective of the study was to evaluate different cultivars compared to the traditional Sweet Charlie cultivar commonly used by growers in Oklahoma.

Project Approach:

This study was conducted at the Noble Foundation in Ardmore, OK instead of Peach Crest Farm at Stratford, OK because of lack of hoop house and production manager at the time of start of study. Six cultivars of strawberries including, Sweet Charlie, Camarosa, Festival, Camino Real, Ventana and Palomar were used in the study. Cultivars were planted as either started plug plants or as fresh dug plants. The design of the study was a completely randomized block design. Each block was replicated twelve times and each cultivar by planting type was replicated 5 times the first year and 4 times the second year. Planting occurred in permanent raised beds within the structure. Beds were solarized in August. In preparation for planting, soil samples were taken and beds leveled. Plots were measured and marked in September. Plug plants were planted in the greenhouse the last week of September. Both fresh dug and plug plants were planted in the hoop house the last week of October. Plants that did not survive establishment were re-planted until the middle of November, after which no plants were planted. Flowers and runners were removed from plants until January 1. Harvest began the end of March and was completed by the end of June. Each cultivar by plant type within each block was harvested together. Number of fruit was counted and total weight of fruit recorded. Fruit was then graded and number of fruit per grade was recorded.

With the study being conducted at the Noble Foundation, Susan Bergen (Peach Crest Farms) did not participate in the study.

Goals And Outcomes Achieved:

The result of this study indicates that strawberry crops established from plug plants were more productive than fresh dug plants. Plug plants produced 90.9% more fruit per plant than fresh dug plants. Weight per plant was 87.7% higher for plug plants compared to fresh dug plants. However, fruit size was significantly the same for both plug and fresh dug plants.

Sweet Charlie is the traditional standard cultivar used in Oklahoma; therefore, Sweet Charlie was used as a control for this study. When compared to Sweet Charlie (62.97), Ventana and Camarosa plug plants produced more fruit per plant (100.56 and 87.79, respectively), while all fresh dug plants (Camarosa – 52.13, Festival – 33.37, Camino Real – 29.99, Ventana – 40.66 and Palomar – 32.02) and Palomar plug plants (52.67) produced fewer fruit per plant compared to Sweet Charlie. Ventana, Palomar and Camino Real fresh and plug plants all produced larger fruit

than Sweet Charlie. Ventana and Camarosa plug plants (1760.11 and 1283.32 grams) had a higher total production compared to Sweet Charlie (850.32 grams), while Camino Real (754.79 grams), Festival (395.41 grams), and Palomar (592.52 grams) fresh dug plants produced less total production than Sweet Charlie plug plants.

When comparing just the cultivars, Ventana had the highest production per plant over the two years (1258.57 grams), followed by Camarosa (1019.58 grams), Sweet Charlie (854.48 grams), Palomar (758.62 grams), Camino Real (729.62 grams) and Festival (669.33 grams). Ventana and Palomar produced the largest fruit (18.17 and 18.06 grams respectfully) compared to Camarosa, Camino Real, Festival and Sweet Charlie (14.54, 16.29, 12.93, and 13.52 grams respectfully).

These results indicate that strawberry crops established from fresh dug plants were not as productive as a crop established from plug plants. Plug plants required a greenhouse for starting plants in containers. The fresh dug plants were not available as early as desired; therefore, plug plants were larger at planting than desired.

These results also indicate that growers looking for large fruit to sell at the farm markets should be planting Ventana or Palomar. If total production is wanted Ventana or Camarosa should be planted.

Beneficiaries:

This study will benefit growers throughout Oklahoma to help determine the type of strawberry plant to establish in a hoop house system. Results of this study were presented to 35 growers at the annual Horticulture Industry Show in Tulsa, OK, 20 scientists at the Southern Region - American Society for Horticultural Science meeting in Birmingham, AL and 45 scientists at the American Society for Horticultural Science meeting in Miami, FL. There were 15 field days and tours conducted at the Noble Foundation during the two year study where the activities of the study were discussed with approximately 65 participants. The results of this study will also be used in teaching the Oklahoma Market Gardening School which is held twice a year around the state with approximately 15 participants per class.

Lessons Learned:

Problems with availability of cultivars for both plug plants and fresh dug plants occurred. When plants were ordered for plug plants all cultivars were available. Sweet Charlie was not available for fresh dug plants either year. The first year Ventana and Palomar plug plants did not survive transplanting due to poor vigor and root rot. Therefore, additional replications were added for the treatments that were available at planting time in the hoop houses the first year. Ideally plants should be established in the hoop house the middle of October due to the lack of availability of fresh dug plants, the planting date was delayed two weeks.

At this time there are additional sources for strawberry plants, both fresh and plug that would make it possible to receive the plants earlier, allowing establishment in hoop house at the desired

time. However, with the results of this study it is recommended to use plug plants when establishing strawberry plants in a hoop house.

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Additional Information:

Figure 1. Photo of plug plants (photo on left) and fresh dug plants (photo on right) prior to establishment in hoop house.

Figure 2. Plants were randomly planted in blocks across four beds within the hoop house.

Figure 3. Plug plants (front two plants) were significantly larger than fresh dug plants (plant at top of photo) 45 days after planting and did not reach a comparable size throughout

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CANNON SWEET POTATO PROJECT

Project Summary:

The Cannon Sweet Potato Project was conceived for the primary purpose of expanding crop options for market growers in Eastern Oklahoma first, by demonstrating small-scale growing and post-harvest handling technologies and second, through evaluations of alternative (primarily heirloom) varieties. We pursued this project because we observed that few market growers grow

and sell sweet potatoes in our local markets. And when they do, they use the same varieties already found in supermarkets. We feel that small growers are missing market opportunities at a time when a) there is an expanding interest in local foods and the markets that offer them (farmers markets, roadside stands, etc.); b) consumers are hearing the media message that sweet potatoes are a "perfect food" and may be linked to longevity. We believe that one of the reasons for grower reluctance is lack of knowledge about small-scale production and the perception that certain practices—growing slips for transplanting, and harvesting and curing, in particular—are too challenging to undertake. Furthermore, we believe most growers are unaware of the diversity of cultivars available and where to find them.

Project Approach:

Our approach to the sweet potato project mirrored our two main concerns: the lack of grower knowledge about a) small-scale technology and b) varieties. For all three seasons, our demonstrations at the Cannon Horticulture site featured different small-scale growing, harvesting, and post-harvest handling tools and methods. They also featured evaluations of heirloom cultivars. In the final two seasons cultivar trials were fully replicated—increasing precision to better assess differences in yield, quality, and disease susceptibility.

Information dissemination was a major objective. It was and is being accomplished through the following means:

- Publications: To date, two publications have been published and are available on the Kerr Center Web site at: http://www.kerrcenter.com/publications/sweet_potato_2010.pdf and http://www.kerrcenter.com/publications/Sweet%20Potato-Variety-Report-2012.pdf Two more publications are scheduled to be written during the winter of 2012–2013 and published by mid-to-late spring.
- Field days: We held two horticultural field days in 2011, highlighting the sweet potato project and our findings to date. Presentations were given by an Oklahoma State University specialist and by the grower who provides our heirloom planting stock. Both events were moderately well-attended.
- Site Tours: In addition to field days, many farmers and prospective farmers learned about our sweet potato project through individual and group tours that occurred throughout the three growing seasons.
- Student Interns: Grant funding supported work time for student interns to assist Kerr staff on the sweet potato project. In most instances, these interns were on-site only for the summer season. Their experiences, therefore, were limited to the planting and growing phases. They returned to school before harvest. Four student interns were involved over the three years of the grant.
- Seminars/Presentations: We were invited to give several presentations on sweet potatoes at public events. Venues included the 2011 Oklahoma State Master Gardener Conference in Enid, Oklahoma; the 2012 Oklahoma and Arkansas Horticulture Industries Show in Tulsa, Oklahoma; the April 19th 2012 Eastern Oklahoma Agriculture Trade Show in Poteau, Oklahoma; the May 31st 2012 Specialty Crop Conference in Lane, Oklahoma. Sweet potato growing was also detailed over the growing season at four 2012 Oklahoma Beginning Farmer Training program workshops that were held on-site.

Goals And Outcomes Achieved:

In short, the three goals of this project were: 1) to increase growing and marketing options for market growers; 2) to encourage the growing of sweet potatoes in home gardens; 3) to improve the diets of residents of Eastern Oklahoma through increased availability and consumption of locally-grown sweet potatoes.

In the short term we have several indicators of progress towards these goals. The first of these is somewhat subjective. It is the public interest demonstrated through speaking invitations, visitors to the horticulture program site, and requests for general and specific information about sweet potatoes. With regard to the last indicator—requests for information—we do have a means of measuring public interest through downloads of our Web-based publications, and distribution of printed documents.

The 2010 Sweet Potato Variety Report was downloaded 2200 times between its publishing in January 2011 and December 2012. The 2011 Sweet Potato Variety report was downloaded 292 times between its publishing in September 2012 and December 2012. Eighty-four copies of the 2010 report were distributed in 2011. 2012 distribution figures for these publications have not been developed at the time of this writing.

Additional efforts to assess our impact in the short term included an attempt to measure whether field day attendees changed behavior. In 2013 we surveyed those 2012 field day attendees, from whom we'd collected current addresses. The findings are summarized in the table below:

Question	"Yes" Responses	"No" Responses
Are you currently growing sweet potatoes?	12	2
Did Kerr workshops or publications influence your decision to plant them?	6	8
Did you grow sweet potatoes before learning of Kerr's work with them?	8	6
Did Kerr's work influence your choice of variety or growing method?	10	5

Long term impacts are a bit harder to measure, though we have taken steps that will ensure that we continue to educate the public with regard to growing and marketing sweet potatoes, and achieve the final goal of improving diets:

1. We are currently funded for a 3-year project titled ***Developing Enterprises for Beginning Farmers and Ranchers in Oklahoma through Training, Mentors and Resources***. Sweet

potatoes are a key crop within our eight-field teaching demonstration for these beginning farmers. As part of their education they will be exposed to the various methods and equipment we use for small-scale production.

2. Sweet potatoes will also be grown annually in a demonstration of biointensive farming and gardening that is maintained by student interns. The crop fulfills the need for a high calorie summer root crop in the complex design of a biointensive system.
3. A long-term plan, now under discussion for the Kerr Center, includes the possibility of a horticultural marketing project—either a limited season CSA or sales through the Oklahoma Food Coop. Sweet potatoes would be an important crop for such a project.

It is worth pointing out that the Cannon Horticulture Project did generate ***new*** information. The heirloom varieties tested have not, to our knowledge, been evaluated in Southeastern Oklahoma; certainly not in recent times. Also, many of the small-scale methods and equipment we evaluated and demonstrated—while they may have been familiar in some variation to earlier generations—have not been seen by most of the today's market growers.

Beneficiaries:

It would be presumptuous to predict a future economic benefit in dollars from a project such as this, but we can readily postulate where such benefits will occur assuming certain economic, social, and climatic trends continue.

The economic prediction is that recovery from the recession will continue to be slow. Concurrently, higher food prices, especially for meat, are predicted. These circumstances encourage food gardening and the consumption of vegetables, whether home-raised, from direct-marketing venues, or from conventional grocery stores. In this regard, our work is of primary benefit to consumers in the immediate region as it will increase the supply of a very economical and high-quality food. As sweet potatoes are a relatively easy, high-yielding staple crop to grow, there is special value for beginning home gardeners with families needing to tighten their belts.

Social trending towards healthier food and locally grown products are great drivers of interest in both sweet potatoes and organic methods of growing. The beneficiaries, here, are consumers, as well. However, there is also a particular benefit to market farmers as more shoppers frequent farmers markets, roadside stands, and the other venues these growers utilize. They will be able sell a product for which there is a growing demand. They may also be able to demand the higher premiums for heirloom and organic production—features that we emphasized in this project.

Thirdly, climate change is finally being accepted as fact, and we have experienced some of the predicted extremes in the form of high temperatures, drought, and pest pressure. Among the many things learned in this project were that sweet potatoes are a highly survivable food crop that can handle temperature extremes, winds, and considerable insect damage (in our case, striped blister beetles) as long as there is sufficient soil moisture provided. In this regard, we learned that our most efficient option for watering—drip irrigation—works very well for small-scale production. The beneficiaries in this case include all the aforementioned, but especially those actually growing vegetables in the region. Sweet potatoes may be one of a handful of truly

reliable crops that gardeners and market gardeners can grow under the harsh conditions we expect to face.

In addition to economic benefits, we feel it important to report educational benefits from our project. Not counting Kerr Center staff, the beneficiaries who learned the most, are certainly the student interns. They had the most intimate contact with actually growing the crop. We can say this despite the fact that half missed out on the final harvest as their internships terminated at summer's end. As stated earlier, four student interns were directly involved with this project over its three seasons.

Lessons Learned:

One of our challenges was integrating the production of sweet potatoes with our intern education program. Most student interns join the Kerr Center for the summer season. They participate in planting, irrigating, weeding, and pest management, but miss out on harvest, taste testing, and follow-up activities. As we continue with intern programming, we are planning longer-term internships to provide students with a more complete picture of what happens in the production cycle of a full-season crop like sweet potatoes.

We conducted our field trials through three of the most difficult growing seasons in memory. We experienced severe heat, drought, and pest pressure. As a result we learned how resilient sweet potatoes are as a garden crop and how valuable they could be as we face climate change. This is one reason sweet potatoes will remain one of our principal rotation and demonstration crops. In addition, we are discussing means for addressing resilience as a theme in our research, demonstrations, and educational work.

We learned that, sometimes, the simplest technology is the best. On a small market scale of production, we found hand-digging—using high-quality digging forks—was most efficient and left us with the greatest number of marketable roots. We discovered that harvesting with a large tractor and moldboard plow damaged too many roots and still required considerable hand labor to gather them. We also found that the Biagioli root plow, which is designed for use with two-wheel walk-behind tractors, requires more horsepower and traction than our BCS unit could provide.

A positive finding in sweet potato production was the ease of adapting drip irrigation to sweet potatoes. Our initial expectation was that drip tape would create problems at harvest. This was not the case as it was easy to remove. And since drip irrigation is so much more effective and water-conserving than sprinklers, it is a relief to be able to recommend its use.

Another positive finding was the relationship of this crop to our organic management system. Due to our long rotation and the use of cover crops to smother weeds, we had very low weed pressure and close to perfect weed control in all three growing seasons—something not often seen in organic vegetable growing.

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Additional Information:

Appendix C is a copy of the 2011 Sweet Potato Variety Trial.

Additional information will appear in the upcoming publications that are being written during the winter of 2012–2013. There will be two documents—one featuring the results of the 2012 variety trial and one summarizing our experiences with small-scale technology for growing sweet potatoes.

FERTILIZER STRATEGIES IN SPECIALTY CROP ROTATIONS

Project Summary:

Historically, vegetable and other specialty growers have not spared fertilizer on higher value crops. Contract growers must follow instructions from company field men. Some specialty crops are more shallow-rooted and require multiple applications to maintain adequate fertility for economical yield, maximum chemical attribute, and development of quality characteristics such as color.

Nutrient inputs on vegetables commonly outscore crop removal of nutrients by a large margin. As measures of sustainability develop, some crops may be hard to prove sustainable unless the entire farm and rotational practices are also accounted for.

Specialty acres are usually rotated with crops such as wheat or teff that can mine residual N and scavenge P and K. Soils testing with subsoil N and N-Ramps have proven effective tools for Oklahoma wheat producers. These are logical tools that specialty growers should adopt following heavily-fertilized specialty crops.

This project demonstrated the use of these tools on their farms to specialty crop producers. Environmental and economic parameters are attached to the results. The results will be available on the web for access by specialty crop growers around the state. Adoption of these practices will help growers become more sustainable and increase their total farm profitability.

Current demand and profit potential of specialty crops lure producers to attempt to fit the production of specialty crops into their rotation. The need and desire to utilize fertilizer inputs both from economic and environmental reasons enhance the importance and urgency of this demonstration.

Project Approach:

Nitrogen Practices for Teff Following Over-wintered Spinach
Demonstration 1

Demonstration Premise

Fertility management of some vegetable crops, such as spinach, requires large amounts of fertilization, especially nitrogen (N). This exercise was to demonstrate:

1) A soil test should be taken following such a crop, and the results can be used to plan fertility management for the following crop, especially where N requirements are concerned.
2) In addition to a regular surface analysis, results from a subsurface N test may also allow for additional reduction in the following crop's need for added N application.
3) Teff, for grain and forage, or just for forage, maybe a suitable crop to utilize residual N after a crop such as spinach.
4) In lieu of a surface and subsurface N soil test, an N-Ramp plot might be a sufficient replacement to guide additional nitrogen application rates as top dress later in the season. Although there are no Green-Seeker teff algorithms to allow for a computer generated fertilizer recommendation, it was hoped that visual differences in the increasing N-Ramp fertility levels might plainly indicate an N top dress rate to recommend.

Materials and Methods

After spinach harvest, a plot area was marked off to accommodate eight treatments, 12 feet wide by 150 feet long, with four feet between the treatments. A soil sample representative to this area was taken and sent to the OSU Soil, Forage, and Water Analytical Lab for analysis. In the surface layer (0 to 6 inches) soil ph, nitrate nitrogen (lbs per acre), phosphate (OSU P Index), and potassium levels (OSU K Index) was measured. In the subsurface layer (6 to 20 inches), nitrate nitrogen (lbs per acre) was obtained.

The field was sprayed with using 41% glyphosate @ 40 oz/acre and Induce surfactant @ 2qts/100gal of carrier rate equivalents. On June 3, the demonstration area was solidly no-till drilled with 15 lbs of cleaned teff seed per acre. On June 30, the demonstration area was fertilized in eight plots with an N-Ramp applicator, flagged, and areas between the plots later killed with a glyphosate application.

The plots were laid out to maximize visual observation for differences and trends between fertilizer treatments. Treatments were repeated from the exterior area of the field (south) to the interior (north).

The area was irrigated to supplement rainfall, receiving in total about 10 inches of moisture (~5.0 inches of irrigation, ~4.9 inches rainfall) for the approximate 60 day growing period. On July 29, a two person panel individually rated each plot on: percentage of plants recumbent, percentage of plants headed, and gave ratings for visual color (10=very dark green, 1=yellow, obvious nitrogen deficiency). Five random areas of adjacent one foot drill row lengths from each

set of the three main N treatments were clipped and air dried for a month and weighed to estimate biomass yield for the treatments. It was hoped that this sampling could also provide an estimate of grain production.

Observations

Initial Nutrient Levels

The results of the pre-plant soil tests were as follows:

Surface N 25
Subsurface N 30
Phosphorus Index 279
Potassium Index 405
pH 6.8

This field area is quite fertile in terms of P and K, as is to be expected for a well-cared for property of this soil type (Pond Creek Silt Loam). In fact, the P and K levels are well above the minimum OSU sufficiency levels for most crops, and indicate the cooperator should give serious consideration before applying large amounts of these type fertilizers on most crops, especially commodity crops. N Levels of 25 pounds per acre in the surface and 30 pounds in the subsurface indicate that there will be a total of 55 pounds available for the teff crop, if teff is an effective scavenger of nitrogen in the deeper sub-surface zone.

Clipping and Plot Ratings

Since the plot layout was designed for maximum visual effects and not designed for statistical analysis (only two repetitions of each treatment not randomly applied), results are presented as the average of the two plots of each treatment. Not shown, but of note, is that the two treatments of 100 pounds additional nitrogen showed the least variability in biomass yield with only 46 lbs difference. No (0) additional nitrogen plots had the greatest variability with 697 lbs difference. The 50 added N plots were intermediate in variability with a 279 lbs difference. The average of the 50 added N plots was very similar to the yield from the heavier fertilized plots. Biomass yield in lbs / acre were 0- 4112, 50N-4670, 100N-4623 respectively.

In visual ratings, the more heavily fertilized plots appeared more prone to lodging with an average of 59% recumbence. They appeared less mature. Observers thought that there was a consistent increase in color with 0 added N strips trending towards yellow; 100 added N strips tending towards very dark green; and 50 added N strips not appearing N deficient, but not being especially dark green either.

Observations of N-Ramp Strips

Disappointingly, the observers agreed that the results of the N-Ramp applications were not strikingly apparent to visual observation. Without a teff algorithm, the Green Seeker technology could not be applied. It was agreed that, due to the short season nature of teff, it would be difficult to apply the technology for making N fertilizer recommendations.

In general, the observers noted that in the first third of the plots (0 to 42 lbs added N), color and stand density increased. This improvement appeared to maximize in the first half of the next third (56 and 70 lbs added N), after which there was no improvement, and in fact the stand

became more recumbent, with the stand even appearing to thin at N levels over 126 lbs added N. These observations took a great deal of study and could not yield a definitive fertilizer recommendation based on visual observation.

Final Soil Test Results

Surface and subsurface N values were seen to decrease in all plots as shown below.

Ending Soil Test Results

	Pounds Added N		
	0	50	100
Surface N	6	2	6
Sub Surface N	9	4	17
OSU P Index	238	274	267
OSU K Index	478	484	491
Soil pH	7.3	7.5	7.4

Residual N was highest in the 100 added N plots. Surprisingly, residual N was higher in the 0 added N plots than the 50 added N plots. OSU K Indexes were even higher in the final soil tests than the initial test. The OSU P Index was lower in the final tests, especially in the 0 added N plots, but even this level is considerably higher than levels considered adequate for production of most crops.

Quality and Value of Hay

	0	50	100
% Crude Protein	8.2%	12.8%	15.7%
Calculated Value / Ton	$ 51.64	$ 68.18	$ 78.91
Gross Value/Acre	$ 106.17	$ 159.19	$ 182.40
Cost of Added N @ $0.50/unit.	$ -	$ 25.00	$ 50.00
$ Above N Cost	$ 106.17	$ 134.19	$ 132.40

Hay Quality/Value Evaluations

Forage samples were sent to the OSU Soil, Forage, and Water Analytical Lab for analysis of crude protein levels. The values were used to determine the value of the hay produced from the

plots. Based on the ODAFF hay market report for September 30, 2010, the high range for premium (> 13% crude protein [CP]) grass hay in round bales was $80 per ton. Arbitrarily, a bottom range for utility hay (<5% C) was set at $40 per ton (i.e., $20 a bale for 1,000 # bales). A value equation was developed from this relationship

Value of Hay = $40/ton + ((%CP of the Hay-5%CP base) * $3.64))

Where:

$40.00 is the arbitrary base price for utility hay.

Each % increase in Crude Protein increases the value $3.64/ton, so that 16% CP hay is $80/ton.

The hay from 0 added N was 8.2% CP, or fair quality according to ODAFF grass hay guidelines. It would have a value of $51.64 per ton under the value equation above and when multiplied by the yield from Table 2 gives a gross value per acre of $106.17 per acre. The hay from 50 added N averaged 12.8% CP, in the very high end of good quality, valued by the equation at $68.18 a ton, and had a gross value of $159.19 per acre. The 100 added N plots averaged in the very high end of grass hays (15.7% CP), with the hay value closest to $80/ton, and grossing the highest amount per acre, $182.40 per acre. However, when the cost of the additional N was included at a $0.50 per unit charge, the 50 added N and 100 added N was about the same in value.

Estimate of N Utilization

Nitrogen utilization was estimated by taking the crude percent protein and dividing by 6.25. Traditionally, crude protein has been indirectly estimated as the measured % nitrogen in a sample times 6.25, a constant arising from the average nitrogen content of proteins. This percentage nitrogen was multiplied by the dry matter yield in each of the treatments. This value was used in a crude nitrogen balance model shown in Table 5.

Theoretical Nitrogen Balance

Beginning N	55	55	55
Extra N Applied	-	50	100
Total Available	55	105	155
Estimated N Use	49	87	105
Theorectical Residual	6	18	50
Amount Found	15	6	23
N unaccounted for	(9)	12	27

The highest level of extra N applied, 100 lbs resulted in the greatest amount of carryover nitrogen and the greatest amount of nitrogen unaccounted for.

Nitrogen Practices for Cotton Following Spring Collards
Demonstration 2

Demonstration Premise

Fertility management of some vegetable crops, such as collard greens, requires large amounts of fertilization, especially nitrogen (N). This exercise was to demonstrate:

1) A soil test should be taken following such a crop, and the results can be used to plan fertility management for the following crop, especially where N requirements are concerned.
2) In addition to a regular surface analysis, results from a subsurface N test may also allow for additional reduction in the following crop's need for added N application.
3) A deep-rooted crop such as cotton will utilize existing residual nitrogen. Surface and subsurface N soil test should be administered to determine the adequate nitrogen application rate for the growing season.

Materials and Methods

The previous crop that was grown on the test plot area was spring collards. There was no surface or sub surface soil sample taken previous to planting. Fertilization of the collard field consisted of a pre-plant broadcast application dry fertilizer blend of 50-50-20. During the growing season subsequent applications of nitrogen were applied in the form of Ammonium Sulfate, Ammonium Nitrate, and 28% UAN resulting in total nitrogen application in pre-plant and top-dress of 171 pounds of N/ acre. After harvesting 9.5 tons/acre of collards, a plot area was marked off to accommodate eight treatments, 4 rows (36" rows) wide by 120 feet long, with 2 rows between the treatments. A soil sample representative to this area was taken and sent to the OSU Soil, Forage, and Water Analytical Lab for analysis. In the surface layer (0 to 6 inches) soil pH was 7.4, nitrate nitrogen (50 lbs per acre), phosphate Soil Test P Index 207 (OSU P Index), and potassium Soil Test K Index 372 (OSU K Index) was measured. In the subsurface layer (6 to 20 inches), nitrate nitrogen (38 lbs per acre) was present. Residual nitrogen in the top and sub-surface total was 88.

The field was worked with a roto till machine. On July 1, the demonstration area was planted to Dyna-gro 2570 cotton at a seeding rate of 42,000 seeds / acre. On July 20, 2011 the established stand was evaluated by measuring 14.5 feet of the 36" rows representing 1/1000 of an acre. This measurement was conducted in four replications in random sampling across the plot and averaged 36 plants per 1/1000 of an acre giving the established stand count of 36,000 plants per acre. Herbicide applications were made July 15 and August 31 applying 1 quart of Roundup and Induce surfactant for weed control. The plots were also hoed twice to eliminate escaped weeds and volunteer roundup ready soybeans. The cotton was irrigated to enhance emergence by applying .5 inches of water by center pivot. As we all remember, 2011 was an extremely hot, dry, windy growing season. The demonstration plot was surrounded by earlier planted soybeans and was irrigated on the same schedule.

Transpiration and evaporation were very high and water needs were difficult to supply throughout the growing season but were maintained reasonably well.

Fertilization of the plots occurred on August 15, 2011, with treatments of replications 1 and 6 receiving 12.5 gallons per acre of 28-0-0 accounting for added nitrogen of 37 lbs. Replications 2 and 5 received 25 gallons per acre of 28-0-0 adding 74 lbs of nitrogen. Replications 4 and 8 received 37.5 gallons per acre of 28-0-0 increasing the nitrogen in those treatments by 112 lbs per acre. Replications 3 and 7 received no additional nitrogen.

Final top and sub soil samples were pulled on each replication and submitted on November 11, 2011. A boll count was taken the same day by randomly measuring 10 feet of row and counting bolls that were over the size of a quarter in diameter and had sufficient maturity to make a harvestable boll.

Observations

Initial Nutrient Levels

The results of the pre-plant soil tests were as follows:

Surface N 50
Subsurface N 38
Phosphorus Index 207
Potassium Index 372
pH 7.4

This field area is quite fertile in terms of P and K, as is to be expected for a properly managed property of this soil type (Pond Creek Silt Loam). In fact, the P and K levels are well above the minimum OSU sufficiency levels for most crops, and indicate the cooperator should give strong consideration before applying large amounts of these type fertilizers on most crops, especially commodity crops. N Levels of 50 pounds per acre in the surface and 38 pounds in the subsurface indicate that there will be a total of 88 pounds available for the cotton crop where soil structure will allow for adequate root penetration.

Initial observations of plant emergence and seedling growth were excellent on all replications in the demonstration. There was a slight difference in plant growth in one of the buffer zones due to a nozzle problem on the irrigation system, but when correction was made, there was no significant difference later in the growing season and results did not appear to be altered. Visual differences of plant growth after fertilization of the replications receiving nitrogen application were not apparent during the vegetative and reproductive stages of growth.

Plot Ratings

Since the plot layout was designed for maximum visual effects and not designed for statistical analysis (only two repetitions of each treatment not randomly applied), results are presented as the average of the two plots of each treatment. Boll count results were collected by determining the number of viable bolls (eliminating the bolls less than a quarter size in diameter) in random 10 feet of 36" row. The counts for the two like replications were then averaged to give the yield value for each treatment. The treatment where no additional nitrogen was applied had a boll count average of 184. The second treatment of 37 lbs of additional N had an average boll count of 192.5. Addition of 74 lbs of N averaged 195.5 and the addition of 112 lbs of N averaged 200 bolls respectively showing little difference in yield where nitrogen was applied. Boll counts are illustrated in the chart below.

Boll Count for SS Farms ODAFF Fertility Demonstration

Replication #	**Added N rate**	**Boll Count**	**Average for 2 reps**
1	37	184	192.5
6	37	201	
2	74	193	195.5
5	74	198	
3	0	187	184
7	0	181	
4	112	178	200
8	112	222	

Final Soil Test Results

The final soil sample results revealed that surface and subsurface N values decreased in all plots. The samples from the replications where the highest rate of nitrogen was applied did show more residual N in the subsurface samples. This is demonstrated in the following chart.

Treatment #	Additional N Applied	Topsoil N Value	Subsoil N Value
1	37	6	16
2	74	7	24
3	0	4	20
4	112	6	46
5	74	5	28
6	37	4	6
7	0	4	12
8	112	10	32

A full-blown field day was not possible due to budget constraints and because of late planting of alternate plot; the producer partner was eager to reclaim the plot site. In an effort to show the benefits of the trial to our producers, five area crop consultants met at the plot site on November 30, 2011, to evaluate the visual growth and production of the respective replications. They received an overview of the goals, initial soil sample results, treatments, and findings. The consultants will be able to relay the information to their clients and make good use of the data. Both producer partners have recently implemented extensive top and sub soil sampling programs on their farms. The results of the demonstration will also be made available at producer meetings, in Ag Business client programs, and on the Caddo Kiowa Technology Center website.

Goals And Outcomes Achieved

Though specialty crops are high value, successful growers pay attention to the crops grown in rotation. Results of under fertilization are obvious in reduced yields. Over fertilization, especially with N, can increase plant growth, induce lodging, and prolong maturity in teff and wheat, complicating harvest without benefit of increased seed yields. ***One purpose of this project is to encourage growers to utilize available tools to maximize efficiency of fertilizer expenditures across rotations, thereby increasing their overall farm profitability.***

Nutrient inputs on vegetables commonly outscore crop removal of nutrients by a large margin. As measures of sustainability develop, some crops may be hard to prove sustainable under current production practices, unless the entire farm and rotational practices are also accounted for. Sustainability is not a one crop, one season measure, but an ongoing process that involves not only the seed to consumption carbon and pesticide use of a crop, but the overall balance of the entire farm***. Another purpose of this project is to encourage growers to utilize available tools to maximize the efficiency fertilizer inputs across rotations to corroborate their commitment to sustainable production.***

It is the goal of this project to establish two demonstration plots ahead of crops (teff, wheat) in rotation with high nutrient input crops (spinach, peppers, potatoes) in fields with a history of high nutrient input crops, share in analyzing these plots with producers, consultants, and publicize the results locally and make available the information on the internet. These goals were for the most part met with the deviation of substituting a deep rooted crop (cotton) for the wheat rotation. Wheat was included in the trial but was abandoned due to the lack of spring rains and

subsequent lack of usable data. As a result cotton was included in the demonstration with a more successful outcome.

Nitrogen Practices for Teff Following Over-wintered Spinach
Demonstration 1

In spite of a fibrous rather than a tap root system, it appears that teff can be an efficient scavenger of nitrogen in the subsoil after heavily fertilized specialty crops, at least to the 20 inch depth sampled in the demonstration. The production of forage exceeded the theoretical amount that could be produced.

Subsoil N tests should be a part of planning fertility strategies for commodity crops following heavily fertilized specialty crops.

It appears that the 100 lbs of N the cooperator historically applied may represent a desirable N level for total nitrate N for teff under irrigated conditions. Years when lodging or delayed maturity were harvest problems may have been caused by additional nitrogen being available in the soil and not allowed for in nitrogen fertilization management.

Surface and subsurface N levels can be counted as available to teff in fertilizer strategies for teff and should be utilized in calculating the additional N to be applied.

In using teff for forage production, ultimate forage quality for animal consumption is a consideration. Under irrigation, and for one cutting, 105 lbs of available nitrogen produced as much total forage as 155 lbs of available nitrogen, although the higher fertilized plots were of higher quality as measured by forage crude protein. If nitrogen costs are $0.50 or more per unit of N, a producer needs to have a marketing system that captures that added quality better than the system modeled here for the extra fertilization to be profitable.

Teff can be an effective nitrogen catch crop behind heavily fertilized specialty crops such as over wintered spinach.

Nitrogen Practices for Cotton Following Spring Collards
Demonstration 2

Cotton works well as a scavenger crop following highly fertilized specialty crops. In the demonstration there was no significant difference in the yield of the cotton when an ample supply of nitrogen is found in the surface and subsurface zones. Applying additional nitrogen would only increase the potential for leaching and add unnecessary expense.

Not knowing what is available to the plant and blindly applying unneeded nitrogen is not only costly but unfriendly to our environment, specifically our water purity.

There is a wide variation in the price of a pound of Nitrogen during late winter /early spring of 2012 depending on the product considered. This is demonstrated in the table below:

Product	Analysis	Price per ton	Price per unit N
Anhydrous Ammonia	82-0-0	$710	.43
Urea	46-0-0	$680	.74
UAN	28-0-0	$390	1.21

Based on these prices, considering the 88 units of nitrogen that was present in the surface and sub-surface soil test results, a producer could realize a savings of $37.84/acre using anhydrous ammonia, $65.12/acre applying urea, or $106.48/acre utilizing 28% UAN as the nitrogen source.

Beneficiaries:

Beneficiaries of this demonstration include producers, crop advisors, ag retail suppliers, specialty crop contractors, and agricultural extension agents. Producers will experience direct input, yield, and water quality benefits by implementing good stewardship practices. The potential economic impact of the demonstration from a production standpoint would be relative to the amount of residual nitrogen unused by the specialty crop, choice of scavenger crop, current price of nutrient selection, and, of course, weather factors. Consideration of the economic impact in regard to the environmental impact of over fertilization is immeasurable.

Those involved in educating producers can use the demonstration to affirm the value of soil sampling to responsibly and economically apply nutrients and production of crops that are grown with as little negative impact to water quality as possible.

Lessons Learned:

The initial plot for Demonstration 2 was to be on Triple S Farms Cotton following spring harvested spinach. Soil samples were collected, plots were marked, and cotton had been planted on the plots right along with the entire field. When the cotton surrounding the plots was to be fertilized there was miscommunication with the applicator concerning fertilization of the demonstration plots. This rendered the demonstration unusable and an alternate location had to be found for the project resulting in preparation of new site and later than optimal growing conditions. Better communications and understanding of the parameters and goals of the project by all personnel would help eliminate these errors. This includes not only the management but all partner employees and any outside applicators or consultants.

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COST EFFECTIVE SPECIALTY MUSHROOM CULTIVATION

Project Summary:

The purpose of this project was to research and publish instructions on how to build a small scale specialty mushroom farm that could be used in any climate. We designed it to be built cheaply and quickly by someone without a lot of construction experience. There has been increased interest in mushroom cultivation in recent years, and following the principles of small scale permaculture farming, we wanted to create a system that could be used to grow many types of mushrooms at a profit for small organic farmers. The benefits of growing on a small scale include; sustainable income for small scale farmers, increased availability of fresh specialty mushrooms for consumers, production of mushroom compost for gardeners and short farm-to-consumer transportation distance, decreasing use of fossil fuels.

There are many people who want to grow mushrooms but aren't sure how to get started. The local and organic food movement is growing and mushrooms are a good addition to a small permaculture system. We think that this is a perfect time to raise interest and make small scale mushroom farming more conceivable and successful.

Project Approach:

During the course of this grant we built and tested two versions of a mushroom grow room in a shipping container and refrigerated semi-trailer. We purchased materials, hired contractors, and did some of the construction ourselves. The refrigerated semi-trailer version was much cheaper and easier to build and so it was completed first and used to produce mushrooms for several months. The shipping container version was much more complicated and was never completed due to a lack of funds and time, however, in trying to build it many lessons were learned that are included in the report for future farmers.

We altered the refrigerated semi-trailer by adding an HVAC system, building on an end room, splitting it into three sections, installing lights and a humidifier, and building shelves. It worked well to grow several strains of mushrooms, though we didn't have enough time to test to get conclusive data to compare to other types of grow rooms, if data to compare it to even exists in the public sphere. We developed a plan for construction that others could follow and we are confident that the resulting structure is an efficient use of materials and effective at growing mushrooms.

We came up with a plan to use the exhaust air from the building to heat and cool and greenhouse built next to it, but that plan was never tested or implemented. Funds were only used to build the mushroom grow room. Tod Hanley helped develop the HVAC system and troubleshoot some issues we had. Most of the work was done by Jaclyn and Steve Morton.

Goals And Outcomes Achieved:

One of the grow rooms was completed and tested and a 17 page how-to booklet was written and will soon be published on the web and possibly printed. No measurements were intended to be made long-term. We only completed one of the two structures and the testing period was two months rather than two years. We did build a working grow room and complete the how-to booklet, which we see as the most important goals of the project.

There is only one specialty mushroom farm in Oklahoma at this time, and it is operating in our semi-trailer grow room. We are eager to see other farms use our plans, and publishing our how-to booklet will be progress toward this goal.

Beneficiaries:

Individual producers who have limited land availability, yet would like to grow specialized mushrooms will benefit from this project. Through this project a manual was produced to help educate current or potential mushroom farmers about the mushroom module growing system. The manual is available at the following website www.mushroommodules.org , which will serve as a platform for information sharing between farmers on this topic. The two module units have been moved from Om Gardens location to a farm in Edmond, Oklahoma. Oklahoma Mushrooms will host a field day on February 9, 2013 for anybody interested in raising specialty mushrooms to visit the two growing modules and learn how they can replicate the process at their location. The field day has been featured by The Mushroom Company on http://www.mushroomcompany.com/events/index.shtml and an article will appear in their next newsletter along with press release that was distributed state wide to local news outlets in Oklahoma.

Lessons Learned:

- The mushroom module growing system is a viable business model only if one or more of the following is met.
    - The farm consists of many mushroom modules and/or outdoor growing using the same inoculation equipment.
    - There is a local source of inoculated substrate so the grower doesn't need a lab.
    - It is combined with an educational or agro-tourism business.
    - It is combined with a greenhouse and/or vegetable growing business.
    - It is combined with a mycoremediation business.
- An insulated semi-trailer should be used that is in good repair. Holes in the ceiling or floor should be avoided; minimal fix-up is a must.
- Put the trailer close to an existing building for easy utility and physical access.
- Put the trailer somewhere you don't mind people coming to visit. Everyone will want to see it when it's done.
- Plans should be laid carefully for building code requirements and technicalities such as:
    - Getting the trailer onto the property and placing it without getting stuck.
    - Getting enough electricity to the building without spending too much money.
    - Getting clean water to the building.
    - Dealing with waste water and runoff.
    - Hiring knowledgeable and reliable contractors for HVAC, Electrical, Plumbing, and Building.
    - Getting materials in a timely fashion.

- Designing a small system for steam heating and cool mist cooling is a project best taken on by an engineer with knowledge of and access to specialty equipment. We tried to do it, but it was beyond our reach.

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Additional Information:

Appendix D is a growing manual that was established through lessons learned through this grant.

Final Report for Extended Season Leafy Greens Research

E-1031, Oklahoma Cooperative Extension Service
Division of Agricultural Sciences and Natural Resources, Oklahoma State University

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Introduction to Extended Season Leafy Greens Studies

Vegetables are produced in high tunnels (hoop houses) throughout the world. High tunnels are plastic covered frames that receive only passive solar heat for warmth. They have been used to extend the growing season of warm season vegetable crops, but without supplemental heat, warm season crops cannot be grown in these structures during the coldest months of the year (December-February). A key aspect of fresh market farming is producing and selling crops year round allowing for better cash flow and profit.

The extended season leafy greens project was begun in the fall of 2010. The project was funded from a specialty crop grant obtained from the Oklahoma Department of Agriculture, Food, and Forestry (ODAFF). Research partners included Noble Foundation, Oklahoma State University, Oklahoma State University at Oklahoma City, and a private farm "Our Farm". The research was done at four sites: Ardmore, Lane, Tulsa, and Oklahoma City. The project objective was based on the concept of developing crops that could provide nutritious fresh produce during late fall and winter for local markets and for the Farm to School Program.

During the two year project, we experienced two very different winter seasons with the first winter recording record low temperatures and the second being unseasonably warm. Well, that's Oklahoma weather . . . unpredictable! We did observe some damage from the cold winter, but in general most of the crops recovered and produced reasonable yields later in the spring. Spinach, collard, kale, and broccoli raab were the most tolerant of cold temperatures. Whereas during the unseasonably warm winter we encountered more insect problems and flowering of several of the brassica greens (collard, kale, turnip, mustard). One issue with leafy greens that have flowered is that they become tough in texture and bitter in taste rendering them unsalable. In general it appears that for most crops at most locations, production ended in March or April during both years. Using a multi-row hand planter and basket harvester was meant to save labor. As experience was gained with these tools some changes were made. Some sites replaced their multi-row planter with a single row precision planter and most sites stopped using the basket harvester and harvested by hand with a knife. Hand harvesting by knife helped to reduce damage on successive harvests of the same planting compared to the basket harvester. The change in the second year of using lettuce transplants instead of direct seeding proved to be an improvement resulting in higher and earlier yields. Profit potential from these crops varied because of market demand. Spinach commanded the highest price per pound with an average of $4.00/lb. Brassica greens crops averaged $1.30 to 1.50/lb. while Swiss chard went for $2.00/lb. and lettuce for $3.00 per whole plant. When information from both years are considered the authors conclude that the crop mix of leaf lettuces, spinach, Swiss chard, and the brassica greens have potential to produce salable crops throughout the coldest months of the year without supplemental heat in a high tunnel.

The reports that follow are individual reports from each of the four sites that were included in the studies. The entire Extended Season Leafy Greens report can be viewed on-line at: http://www.hortla.okstate.edu/industry/vegetables/index.htm. Printed copies are available on request.

Extended Season Leafy Greens, Ardmore, OK 2010-2011

C. Rohla and S. Upson
Noble Foundation

Introduction: Production of vegetables in high tunnels (hoop houses) are utilized throughout the world. High tunnels are plastic covered bowed, frames that receive only passive solar heat for warmth. High tunnels are used to extend the growing season of warm season vegetable crops such as tomatoes, peppers, and cucurbits. These structures allow farmers to start crops much earlier in the spring and to continue production much later in the fall. Using high tunnels is advantageous, but without supplemental heat, warm season crops cannot be grown in these structures during the coldest months of the year (December-February). A key aspect of fresh market growing is producing and selling crops year round. The objective of this trial was to observe different cool season leafy green crops to determine the feasibility of production in high tunnels during fall, winter, and spring.

Methods and materials: This study was conducted at the Noble Foundation in Ardmore, OK. The hoop house structure used for the study was 20 feet in width and 68 feet in length, covered with a single layer of clear polyethylene film. The study consisted of nine different cool season leafy greens including, spinach, spinach mustard, collard, kale, chard, broccoli raab, romaine lettuce, mustard and turnip. Crops were planted in permanent raised beds within the structure. Beds were solarized in August and in preparation for planting soil samples were taken and beds leveled and plots measured and marked in September. Plots were replicated four times in a randomized design and consisted of approximately 12.5 square feet per plot. Fertility levels of the beds were targeted at 120 lbs. of nitrogen, 150 lbs. of phosphorus and 150 lbs. of potassium per acre. Plots were seeded using a hand push planter (Johnny's 9156 seeder) with rows 4.5 inches apart and approximately 8 to 9 seeds/linear foot on October 6, 2010.
Plots were spot reseeded on October 18, 2010. Harvest began on November 5, 2010 and was completed on June 6, 2011 (24 different harvest dates). Data recorded included fresh harvest weight, pest issues and other issues with the plantings. Crops were given to employees of the Noble Foundation and feedback of preference of crops was requested.

Results: Turnip and spinach mustard had the higher overall yields compared to chard, collard, romaine lettuce, spinach, kale and broccoli raab (Table 1). Yield ranged from a low of 0.9 pounds for broccoli raab to 2.3 pounds for turnip per square foot. The highest early yields (November-December) came from spinach, chard, broccoli raab, collard, kale, mustard, spinach mustard and turnip (Figure 1). Early yields ranged from 1.1 pounds per square foot for spinach mustard to 0.2 pounds for chard. Highest late yields (May-June) came from chard, romaine lettuce, collard and kale (Figure 1). Late season yields ranged from 0.6 pounds per square foot for romaine lettuce to 0.3 pounds for collard and kale.

These results indicate that the production of cool season leaf greens is possible for extending the productive growing season inside hoop houses. There are differences in yield potential and harvest periods. Issues to note included some problems with crops bolting (flowering) during high temperatures, producing unmarketable crops. These crops were topped and marketable harvests occur from re-growth. All leafy greens were given to employees of the Noble Foundation. Feedback from consumers indicated that broccoli raab was not desired even being a free product. Feedback included a strong odor and bitter taste. Therefore,

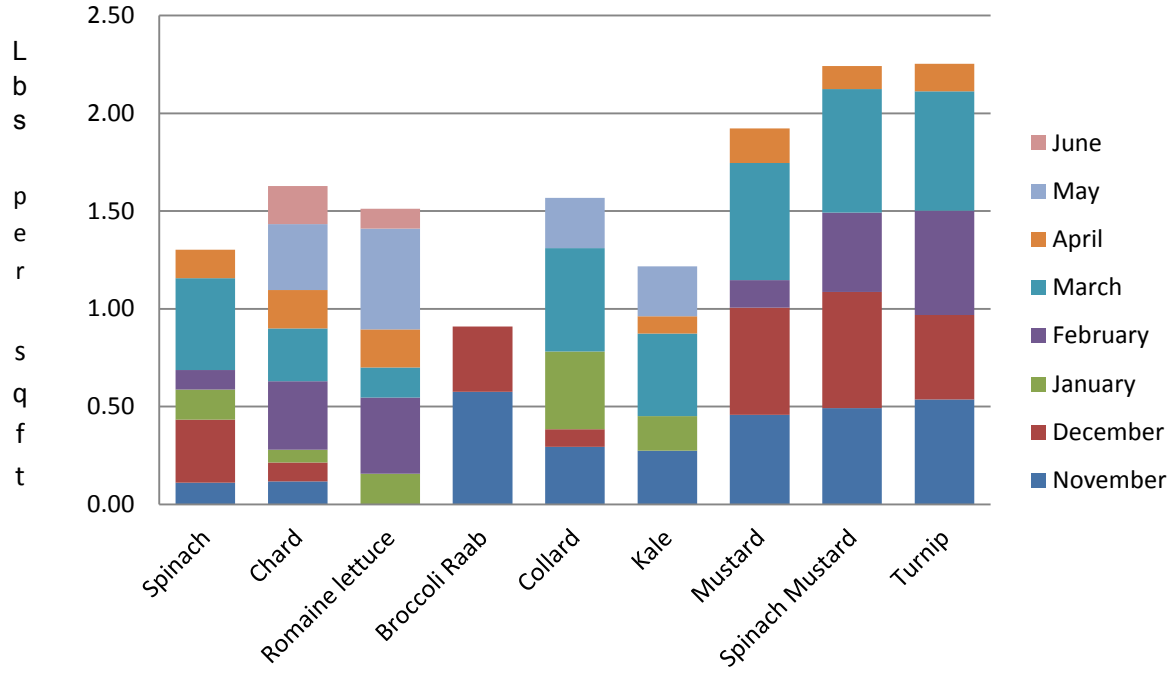
broccoli raab is being dropped from the study for the second year and another leaf lettuce is being added.

Table 1. 2010-11 Extended season leafy greens, Noble Foundation, Ardmore, OK.

Crop	Variety	Source	Yield (lbs.) per sq.ft.	
Spinach	Olympia	Chriseed	1.3	b-d[z]
Swiss chard	Rhubarb Chard	Harris	1.6	b-c
Romaine Lettuce	Green Towers	Seedway	1.5	b-d
Broccoli Raab	Zamboni	Seedway	0.9	d
Collard	Champion	DeWitt	1.6	b-c
Kale	Vates Blue Curled Scotch	DeWitt	1.2	c-d
Mustard	Southern Giant Curled	DeWitt	1.9	a-b
Spinach Mustard	Savanna	Chriseed	2.2	a
Turnip	Southern Green	Chriseed	2.3	a

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Figure 1. 2010-2011 Noble Foundation: Monthly and total yields of leafy greens pounds/sq.ft.



Extended Season Leafy Greens, Lane, Oklahoma 2010-2011

J. Shrefler, W. Roberts, T. Goodson, W. O'Hern, M. Taylor and L. Brandenberger
Wes Watkins Agricultural Research and Extension Center
Oklahoma State University

Introduction: The use of high tunnel vegetable crop production is increasing in Oklahoma. High tunnels (hoop houses) are basically plastic covered frames that are heated passively with solar radiation and are used to extend the growing season for many vegetable and fruit crops. These structures allow farmers to start crops earlier in the spring and to continue production later in the fall than is possible with outdoor, unprotected production systems. A key aspect of fresh market growing is producing and selling crops year round. This trial is part of a study being conducted at four locations in Oklahoma. The objective of this trial was to observe different cool season leafy green crops to determine the feasibility of production in high tunnels during fall, winter, and spring.

Methods and materials: The trial was conducted at the Wes Watkins Agricultural Research and Extension Center at Lane in Atoka County. Three tunnels measuring 12 feet wide and 40 feet long were used. The tunnels are each covered with a single layer of clear polyethylene film. Nine different cool season greens were grown including spinach, Swiss chard, romaine lettuce, broccoli raab, collard, kale, mustard, spinach mustard (mild type mustard), and turnip (Table 1). The tunnels are portable and each fits over two semi-permanent beds that have been in place for several years. Prior to planting, the houses were removed to roto-till the beds and incorporate poultry litter with an amount determined by soil test results and OSU vegetable fertilizer recommendations. Fertility levels were targeted at 120 lbs of nitrogen and 150 lbs of phosphorus and potassium per acre. Plots were direct seeded with a hand push planter (Johnny's 9156 seeder) with rows 4.5 inches apart and approximately 8 to 9 seeds/linear foot on 10/15/10. Plots were replicated three times in a randomized block design and consisted of an area of approximately 16 sq. ft. per plot. Each tunnel was used for one replication of the trial. Crops were generally harvested when leaves reached a height of about 12 inches. Exceptions are lettuce which was harvested once for the outer leaves and a second time for the entire head. Spinach did not get as tall as other crops and was harvested at about eight inches. Harvests began on 12/3/10 and were ended on 5/31/11 (12 different harvest dates – Table 2). Due to poor germination, followed by cold injury, spinach mustard was not harvested. Data recorded included fresh weight at each harvest.

Results: Harvest began in December with broccoli raab, mustard and turnip. No additional harvests occurred until early March and the final harvest was May 31. Overall yields were highest for collard, kale, mustard (Table 1). Yields of harvested crops ranged from a low of 0.54 pounds for broccoli raab to 1.5 lbs per square foot for kale. Broccoli raab was severely injured by several days of low temperatures (10°F inside of the house at 6 inches above the soil) in late Jan. and early Feb., more so than the other crops. Romaine lettuce was harvested initially as outer leaves and the final harvest was complete heads, which were of a marketable size and quality. Insects observed to cause crop injury included harlequin bugs and diamondback moth larvae.

Table 1. 2010-11 Leafy Greens crops and total yields, WWAREC, Lane, OK.

Crop	Variety	Source	Yield (lbs.) per sq. ft.
Spinach	Olympia	Chriseed	0.62 cd[z]
Swiss chard	Rhubarb Chard	Harris	0.91 bcd
Romaine Lettuce	Green Towers	Seedway	0.64 cd
Broccoli Raab	Zamboni	Seedway	0.54 d
Collard	Champion	DeWitt	1.23 ab
Kale	Vates Blue Curled Scotch	DeWitt	1.50 a
Mustard	Southern Giant Curled	DeWitt	1.08 ac
Spinach Mustard	Savanna	Chriseed	0
Turnip	Southern Green	Chriseed	0.67 cd

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Table 2. Harvest timings for leafy greens grown at Lane, Oklahoma in 2010-2011

Crops	Harvest timings					
	Dec	Jan	Feb	Mar	April	May
Spinach			X			
Swiss chard				X	X	X X
Romaine lettuce				X	X	X
Broccoli raab	X					
Collard				X X	X	
Kale				X	X	X X
Mustard	X			X	X	
Turnip	X			X		

Photos of Lane Extended Season Leafy Greens 2010-2011

January 5, 2011

December turnip harvest

Romaine lettuce freeze injury

chard freeze injury

Collards tolerated freeze

Kale tolerated freeze

Extended Season Leafy Greens, Oklahoma City, OK, 2010-2011

Julia Laughlin
Oklahoma State University – Oklahoma City Horticulture Department

Introduction: Season extension is when growers cultivate a crop beyond its normal outdoor season. Ideally, heated greenhouses are the ultimate season extension device, but other passive approaches include row covers, cold frames, mulches, raised beds , hoop houses (high tunnels) and combinations of these, such as row covers over crops inside a hoop house. High tunnel vegetable crop production is used in the U.S. for season extension. High tunnels are often used to extend the growing season of warm season vegetable crops but can also be used successfully to grow cool season crops throughout the winter. With the ever increasing demand for local produce and the development of year round farmers' markets, food coops and community supported agriculture (CSA's) there is an increased market need for winter production. The objective of this trial was to observe different cool season leafy green crops to determine the feasibility of production in high tunnels during fall, winter, and spring.

Methods and materials: The trial was completed on the grounds of the Oklahoma State University – Oklahoma City Horticulture Department. The high tunnel used for the trial is 30 feet in diameter and is 100 in length and is covered by a single layer of clear polyethylene film. There were nine different cool season greens that were grown including spinach, Swiss chard, romaine lettuce, broccoli raab, collard, kale, mustard, spinach mustard (mild type mustard), and turnip. The greens were grown directly in the prepared soil. Soil testing was performed to determine the levels of nitrogen, potassium, and phosphorus and soil pH. Composted chicken manure and Humor were tilled into the beds. Plots were direct seeded with a hand push planter (Johnny's 9156 seeder) on November 13, 2010. Collard germination was less than optimal and was reseeded on November 24. Plots were replicated three times in a randomized design and consisted of an area of approximately 6 sq. ft. per plot. Harvests began December 12 with a majority completed by April 5 Swiss chard was harvested again June 1. Data recorded included fresh weight at each harvest. Crops were protected with a medium weight row cover during the coldest nights of January and February.

Results: Overall yields were highest for Swiss chard (Table 1). Yield ranged from a low of 1.16 pounds for kale to 5.5 pounds of Swiss chard per sq. ft. Pest problems encountered included aphids but were late season and not treated. No distinct tolerance to cold was observed between different crops that were grown, possibly because we used row covers to prevent damage. The only market price monitored during this time was the Swiss chard and it was selling for $3.00 per pound during the OSU-OKC Winter Farmer's Market on our campus. Based on these results, High tunnel production of these greens would allow a producer to have marketable greens all winter, extending the growing season and helping to fill the winter market void.

Table 1. 2010-11 Leafy Greens crops and total yields, Oklahoma State University at OKC.

Crop	Variety	Source	Yield (lbs. /sq. ft.)
Spinach	Olympia	Chriseed	2.5 b[z]
Swiss chard	Rhubarb Chard	Harris	5.5 a
Romaine Lettuce	Green Towers	Seedway	2.2 b
Broccoli Raab	Zamboni	Seedway	3.0 b
Collard	Champion	DeWitt	2.2 b
Kale	Vates Blue Curled Scotch	DeWitt	1.2 c
Mustard	Southern Giant Curled	DeWitt	2.7 b
Spinach Mustard	Savanna	Chriseed	2.3 b
Turnip	Southern Green	Chriseed	2.8 b

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Photos of OSU/Oklahoma City Extended Season Leafy Greens 2010-2011

Before sowing the greens

Early greens growth

Extended Season Leafy Greens, Tulsa, Oklahoma 2010-2011

L. Brandenberger, B. Kahn, Sue Gray, and L. Carrier Oklahoma State University
Cooperating with Rex and Marie Koelsch "Our Farm"

Introduction: High tunnel vegetable crop production is used in the U.S. and worldwide. High tunnels (hoop houses) are basically plastic covered frames that receive only passive solar heat for warmth. High tunnels are used to extend the growing season of warm season vegetable crops such as tomatoes, peppers, and cucurbits. These structures allow farmers to start these crops much earlier in the spring and to continue production much later in the fall. This is a good use for these structures, but without supplemental heat, warm season crops cannot be grown in these structures during the coldest months of the year (December-February). A key aspect of fresh market growing is producing and selling crops year round. The objective of this trial was to observe different cool season leafy green crops to determine the feasibility of production in high tunnels during fall, winter, and spring.

Methods and materials: The trial was completed at "Our Farm" located in west Tulsa County. The site is a commercial fresh market farm growing both field and high tunnel crops for sale on a local basis. The high tunnel used for the trial has metal bows 18 feet in diameter and is 100 in length and is covered by a single layer of clear polyethylene film. There were nine different cool season greens that were grown including spinach, Swiss chard, romaine lettuce, broccoli raab, collard, kale, mustard, spinach mustard (mild type mustard), and turnip. Raised soil beds within the hoop-house were prepared for planting in early September including soil testing to determine the levels of nitrogen, potassium, and phosphorus and soil pH. Fertility levels were targeted at 120 lbs of nitrogen and 150 lbs of phosphorus and potassium per acre. Plots were direct seeded with a hand push planter (Johnny's 9156 seeder) with rows 4.5 inches apart and approximately 8 to 9 seeds/linier foot on 9/24/10. Plant stands of collard, kale, and lettuce were less than optimal and these species were reseeded on 10/8/10. Plots were replicated four times in a randomized design and consisted of an area of approximately 16 sq. ft. per plot. Harvests began on 10/20/10 and were completed on 5/10/11 (36 different harvest dates). Data recorded included fresh weight at each harvest and recording of pest and other issues with the plantings.

Results: Overall yields were highest for Swiss chard compared to spinach, romaine lettuce, collard, kale, mustard, and spinach mustard (Table 1). Yield ranged from a low of 0.6 pounds for romaine lettuce to 2.7 pounds of Swiss chard per sq. ft. The highest early yields (October-November) came from broccoli raab, turnip, spinach mustard, mustard, kale, Swiss chard, and spinach (Figure 1). Early yields ranged from 2.2 lbs. per sq. ft. for broccoli raab to 0.26 lbs. for spinach. Pest problems encountered included aphids and cabbage loopers which were controlled by insecticidal soap or *Bacillus thuringiensis*, respectively. Tolerance to cold varied between different crops that were grown. Observations of the various crops following a very low temperature event (-20°F or lower) in early February, 2011 indicated that spinach, Swiss chard, broccoli raab, collard, and kale were very cold resistant. During this low temperature event no supplemental heat or additional covering of the crops in the high tunnel was done. Prices for the duration of the trial ranged from $1.30-1.50/lb. for most of the crops to $4.00/lb. for spinach, $2.00/lb for Swiss chard and kale, and $3.00 per plant for lettuce.

Based on these results, the authors would conclude that production of cool season leafy greens is possible during the coldest months of the year. We did see differences in yield potential and also cold tolerance of crops included in the trial. Other issues to note included some problems with the planter. When planting in plots that contained plant debris we experienced soil being pushed along by the planter instead of planting through it. Plans for this coming season include dropping broccoli raab due to low market demand, adding another leaf lettuce to the trial, and the use of transplants for leaf lettuces only.

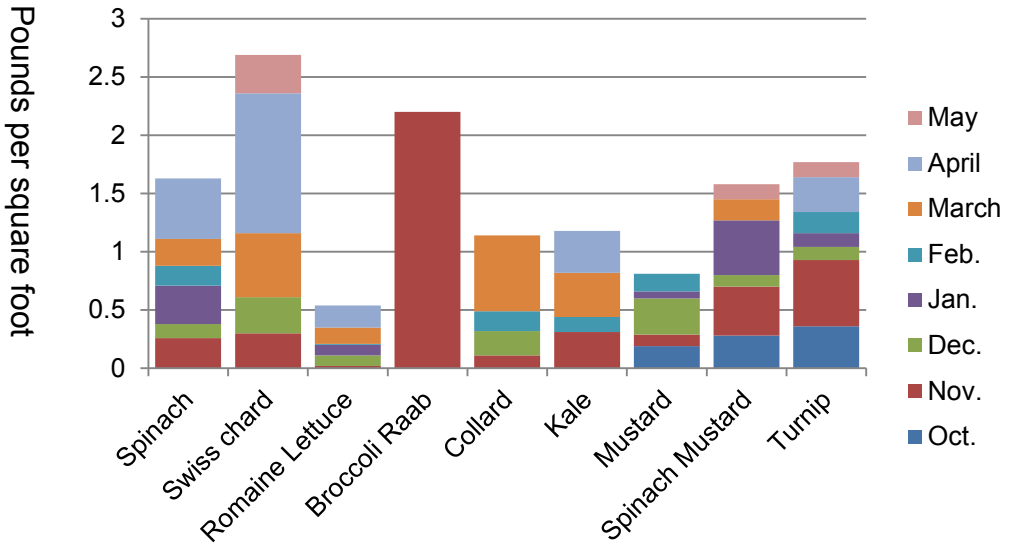
Acknowledgements: The authors wish to thank the Koelsch family for their interest and support of this project and the Oklahoma Department of Agriculture Food and Forestry for their support of the project through the specialty crop grant program.

Table 1. 2010-11 Leafy Greens Variety trial, Koelsch Farm, Tulsa, OK.

Crop	Variety	Source	Yield (lbs.) per sq. ft.	
Spinach	Olympia	Chriseed	1.6	b-c[z]
Swiss chard	Rhubarb Chard	Harris	2.7	a
Romaine Lettuce	Green Towers	Seedway	0.6	d
Broccoli Raab	Zamboni	Seedway	2.2	a-b
Collard	Champion	DeWitt	1.1	b-d
Kale	Vates Blue Curled Scotch	DeWitt	1.2	b-d
Mustard	Southern Giant Curled	DeWitt	0.8	c-d
Spinach Mustard	Savanna	Chriseed	1.6	b-c
Turnip	Southern Green	Chriseed	1.8	a-c

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Figure 1. 2010-2011 monthly and total yields of leafy greens, Koelsch farm, Tulsa, OK.



Photos of Tulsa Extended Season Leafy Greens 2010-2011

Thinning & Weeding

Multi-row push planter

Spring 2011

Kale

Spinach mustard

Swiss chard

Extended Season Leafy Greens, Ardmore, OK 2011-2012

C. Rohla and S. Upson
Noble Foundation

Introduction: Production of vegetables in high tunnels (hoop houses) are utilized throughout the world. High tunnels are plastic covered bowed, frames that receive only passive solar heat for warmth. High tunnels are used to extend the growing season of warm season vegetable crops such as tomatoes, peppers, and cucurbits. These structures allow farmers to start crops much earlier in the spring and to continue production much later in the fall. Using high tunnels is advantageous, but without supplemental heat, warm season crops cannot be grown in these structures during the coldest months of the year (December-February). A key aspect of fresh market growing is producing and selling crops year round. The objective of this trial was to observe different cool season leafy green crops to determine the feasibility of production in high tunnels during fall, winter, and spring.

Methods and materials: This study was conducted at the Noble Foundation in Ardmore, OK. The hoop house structure used for the study was 20 feet in width and 68 feet in length, covered with a single layer of clear polyethylene film. The study consisted of nine different cool season leafy greens including, spinach, spinach mustard, collard, kale, chard, leaf lettuce, romaine lettuce, mustard and turnip. Crops were planted in permanent raised beds within the structure. Beds were solarized in August and in preparation for planting soil samples were taken and beds leveled and plots measured and marked in September. Plots were replicated four times in a randomized design and consisted of approximately 12.5 square feet per plot. Fertility levels of the beds were targeted at 120 lbs. of nitrogen, 150 lbs. of phosphorus and 150 lbs. of potassium per acre. All plots expect romaine lettuce, were seeded using a hand push planter (Johnny's 9156 seeder) with rows 4.5 inches apart and approximately 8 to 9 seeds/linear foot on October 7, 2011. Romaine lettuce was planted as transplants on October 7, 2011. Plots were spot reseeded on October 18, 2010. Harvest began on November 9, 2011 and was completed on May 25, 2012 (24 different harvest dates). Romaine lettuce was replanted as transplants following the harvests on December 7, 2011 and again on April 3, 2012. Data recorded included fresh harvest weight, pest issues and other issues with the plantings. Crops were given to employees of the Noble Foundation and feedback information about preference for each of the different crops was requested.

Results: Romaine lettuce and chard had the higher overall yields compared to collard, spinach, spinach mustard, mustard, kale, turnip and leaf lettuce (Table 1). Yield ranged from a low of 1.6 pounds for kale to 3.2 pounds for romaine lettuce per square foot. All greens produced early yields (November-December) ranging from 1.7 pounds per square foot for romaine lettuce to 0.3 pounds for kale (Figure 1). Late season yields (April-May) ranged from 1.4 pounds per square foot for chard to 0.14 pounds for collard. Spinach-mustard and turnip started bolting in February and did not have any late production.

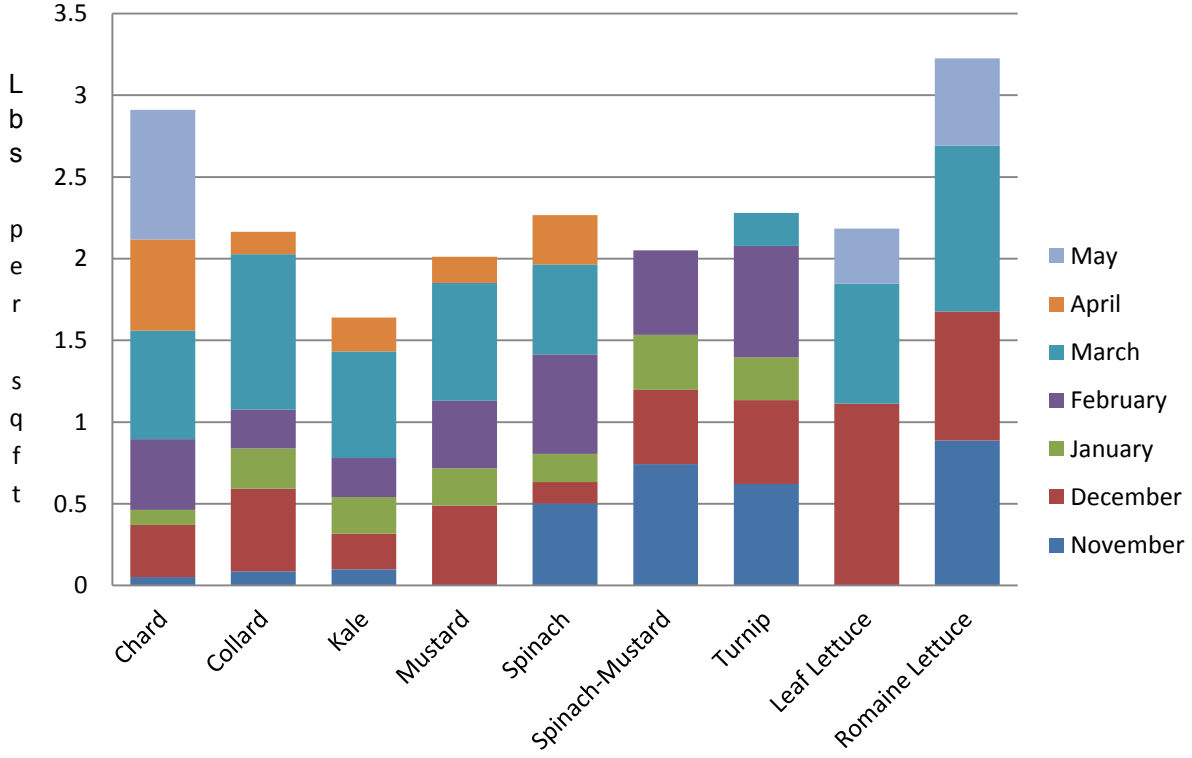
These results indicate that the production of cool season leaf greens is possible for extending the productive growing season inside hoop houses. There are differences in yield potential and harvest periods. Issues to note included some problems with crops bolting (flowering) during higher temperatures, producing unmarketable crops and ending the production earlier than the previous year.

Table 1. 2011-12 Extended season leafy greens, Noble Foundation, Ardmore, OK.

Crop	Variety	Source	Yield (lbs) per sq.ft.
Swiss chard	Rhubarb Chard	Harris	2.9 a[z]
Collard	Champion	DeWitt	2.2 b-c
Kale	Vates Blue Curled Scotch	DeWitt	1.6 c
Mustard	Southern Giant Curled	DeWitt	2.0 b-c
Spinach	Olympia	Chriseed	2.3 b
Spinach Mustard	Savanna	Chriseed	2.1 b-c
Turnip	Southern Green	Chriseed	2.3 b
Leaf Lettuce	Red Grand Rapids	Johnny's	2.2 b-c
Romaine Lettuce	Green Towers	Seedway	3.2 a

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Figure 1. 2011-2012 Noble Foundation: Monthly and total yields of leafy greens pounds/sq.ft.



Extended Season Leafy Greens, Lane, Oklahoma 2011-2012

J. Shrefler, W. Roberts, T. Goodson, W. O'Hern, M. Taylor and L. Brandenberger
Wes Watkins Agricultural Research and Extension Center
Oklahoma State University

Introduction: This is the second year results of trials conducted at Lane, Oklahoma in Atoka County. The objective of this trial was to conduct trial plantings of different cool season leafy green crops to determine the feasibility of production of these crops in high tunnels during fall, winter, and spring in southeast Oklahoma. This trial is part of a study being conducted at four locations in Oklahoma. For this location the trial was conducted on the same plot of land as in the previous year. Materials and methods used in the 2011-2012 trial were similar to those of the 2010-2011 trial with the exception of the use of drip irrigation and an earlier plant date for the 2011-2012 trial.

Methods and materials: The trial was conducted at the Wes Watkins Agricultural Research and Extension Center at Lane in Atoka County, Oklahoma. Three tunnels measuring 12 feet wide and 40 feet long were used. The tunnels are each covered with a single layer of clear, 6 mil ultraviolet protected polyethylene film. Nine different cool season greens were grown including spinach, Swiss chard, Romaine lettuce, red leaf lettuce, collard, kale, mustard, spinach mustard (mild type mustard), and turnip (Table 1). The tunnels are portable and each fits over two semi-permanent beds that have been in place for several years. Prior to planting, the houses were removed to roto-till the beds and incorporate poultry litter with an amount determined by soil test results and OSU vegetable fertilizer recommendations. Fertility levels were targeted at 120 lbs. of nitrogen and 150 lbs. of phosphorus and potassium per acre. During the growing season when plant appearance indicated nutrient stress the plots were side dressed with a soluble 20-20-20 fertilizer applied through the drip irrigation system. Applications began on December 28 using 0.625 lbs. N / 1000 sq. ft. (27 lbs. N / acre). Plots of all crops except the two lettuce cultivars were direct seeded with a hand planter (Glaser Seeder - Johnny's 9461 seeder) with rows 4.5 inches apart and approximately 8 to 9 seeds/linear foot on 9/2/11. Lettuce was started in Speedling brand styrofoam trays using a standard vegetable plug mix. For the first planting lettuce was transplanted on October 28. A second transplanting was made in late winter. Plots were replicated three times in a randomized block design and consisted of an area measuring approximately 16 sq. ft. per plot. Each tunnel included a complete set of plots of each crop species. Crops were generally harvested when leaves reached a height of about 12 inches. Exceptions are lettuce which was harvested as entire heads. Spinach did not get as tall as other crops and was harvested at about eight inches. At any given harvest event, only those crops achieving marketable quality material were harvested. Harvest began on 11/9/11 and ended on 5/31/12. Data that was recorded included fresh weight at each harvest.

Results: Total yields are given in Table 1. Romaine lettuce, which was allowed to produce full size heads before harvest, was the highest yielding of all crops. Spinach was the lowest yielding of all crops. The remaining crops all produced total yields within 1 to 2 lbs. per square foot over the duration of the trial. Crop yield on a monthly basis is presented in Figure 1. Harvest began in November with Swiss chard, collard, kale, mustard, spinach mustard and turnip. During December the harvest of chard, collard and mustard continued leaf lettuce also became harvestable. Except for lettuce, these crops continued to produce during January although at lower harvest weights. Also during January, spinach, kale, spinach

mustard and turnip became available for harvest. Moving into February, all crops produced harvestable yield with the exception of Romaine lettuce. Romaine lettuce grew well through the winter months but head development had not progressed to the point of producing commercially marketable heads. After January there were no additional marketable yields of mustard, spinach mustard or turnip. This was due to the crops bolting. During March the yields of spinach, chard, leaf lettuce, collard and kale progressed steadily. Romaine lettuce was also ready for harvest during this month. Bolting of collard and kale was also progressing and there was no additional harvest of these crops beyond March. Final harvest of spinach and chard occurred during April. Final lettuce harvest was achieved in late May for both lettuce types as some plants began showing signs of bolting.

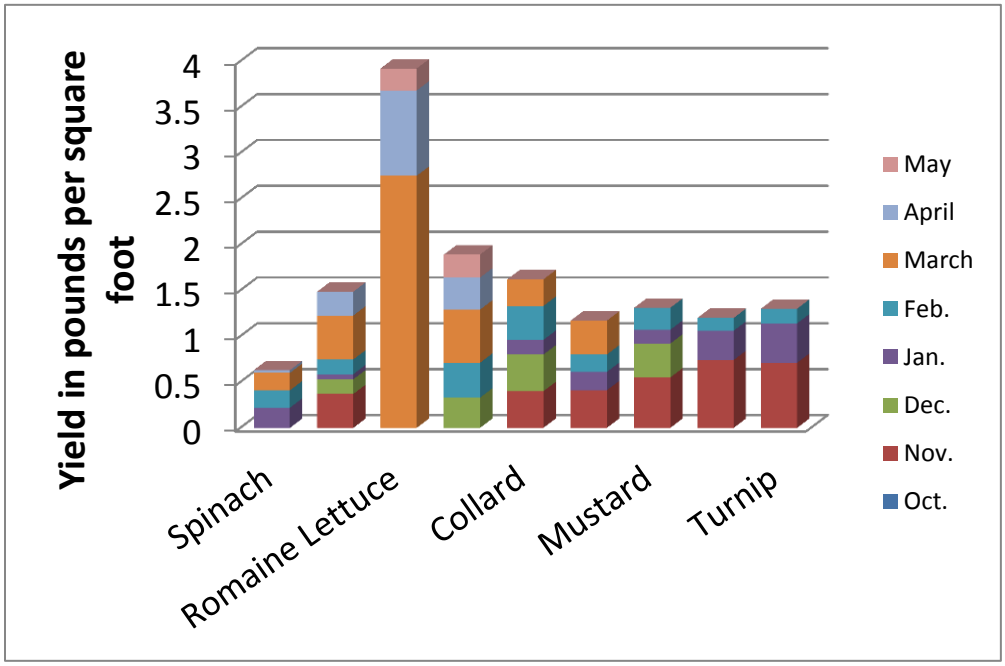
Acknowledgements: The authors thank Mr. Jim Vaughan, Ms. Jacquie Pruit, Mr. John Johnson, Mr. Shannon Reese and Mr. Phil Powell for their assistance with maintaining fields and hoop houses and for assistance with data collection.

Table 1. 2011-12 Leafy Greens crops and total yields, WWAREC, Lane, OK.

Crop	Variety	Source	Yield (lbs) per sq.ft.	
Spinach	Olympia	Chriseed	0.61	d[z]
Swiss chard	Rhubarb Chard	Harris	1.48	bc
Romaine Lettuce	Green Towers	Seedway	3.93	a
Red Leaf lettuce	Vulcan	Johnny's	1.89	b
Collard	Champion	DeWitt	1.62	bc
Kale	Vates Blue Curled Scotch	DeWitt	1.18	cd
Mustard	Southern Giant Curled	DeWitt	1.39	bc
Spinach Mustard	Savanna	Chriseed	1.21	bcd
Turnip	Southern Green	Chriseed	1.31	bc

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Figure 1. Monthly and Total Yields of Leafy Greens at Lane, OK.



Photos of Lane Extended Season Leafy Greens 2011-2012

Movable Hoop Houses

Drip Irrigation Tape

November 7, 2011

Lettuce Ready to Plant

January 5, 2012

March 28 –Some Crops Bolted

Extended Season Leafy Greens, Oklahoma City 2011-2012

Julia Laughlin
Oklahoma State University

Introduction: The second year of season extension research using hoop house (high tunnel) production techniques and different cool season leafy green crops to determine the feasibility of production in high tunnels during fall, winter, and spring.

Methods and materials: This year's trial was again completed on the grounds of the Oklahoma State University – Oklahoma City Horticulture Department. The high tunnel used for the trial is 30 feet wide and is 100 in length and is covered by a single layer of clear polyethylene film. There were nine different cool season greens that were grown including spinach, Swiss chard, romaine lettuce, red leaf lettuce, collard, kale, mustard, spinach mustard (mild type mustard), and turnip. The greens were direct seeded in prepared soil except for the two lettuce entries which were transplanted. Composted chicken manure and Humor were tilled into the beds. Plots were direct seeded with a hand push planter (Johnny's 9156 seeder) on September 26, 2011. Plots were replicated three times in a randomized design and consisted of an area of approximately 6 sq. ft. per plot. Harvests began on November 16, 2011 and were completed by May 15. Data recorded included fresh weight at each harvest. Crops were protected with a medium weight row cover during the coldest nights of January and February, although these were infrequent.

Results: Overall yields were highest for Kale (Table 1). Yield ranged from a low of 4.3 lbs. of spinach to a high of 16.0 lbs. of Kale per sq. ft. Pest pressure was minimal although aphids were present near the conclusion of harvesting. No distinct tolerance to cold was observed between different crops that were grown, possible because we used row covers to prevent damage.

Based on these results and last year's results, high tunnel production of these greens would allow a producer to have marketable greens throughout the winter season, extending the growing season and helping to fill the winter market void.

Table 1. 2011-12 Leafy Greens crops and total yields, OSU/OKC, OK.

Crop	Variety	Source	Yield lbs. per sq. ft.
Spinach	Olympia	Chriseed	4.3
Chard	Rhubarb Chard	Harris	6.4
Romaine Lettuce	Green Towers	Seedway	10.2
Read Leaf Lettuce	Vulcan	Johnny's	5.3
Collard	Champion	DeWitt	11.0
Kale	Vates Blue Curled Scotch	DeWitt	16.0
Mustard	Southern Giant Curled	DeWitt	10.8
Spinach Mustard	Savanna	Chriseed	14.7
Turnip	Southern Green	Chriseed	14.1

Photos of Oklahoma City Extended Season Leafy Greens 2011-2012

Mid-winter growth on right

Early greens growth on left

Photos of Tulsa Extended Season Leafy Greens 2011-2012

Fall 2011 Field Day

Flowering brassica greens spring 2012

End door ventilation

Fall 2012 grasshopper damage

Extended Season Leafy Greens Study, Tulsa, Oklahoma 2011-2012

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Cooperating with Rex and Marie Koelsch "Our Farm"

Introduction: The study this year was a continuation of the first year study. There were some adjustments made to how the work was carried out including dropping broccoli raab and adding another leaf lettuce to take its place and the use of transplants for both lettuce entries. The objective of this study was to observe different cool season leafy green crops to determine the feasibility of production in high tunnels during fall, winter, and spring.

Methods and materials: The study was completed at "Our Farm" located in west Tulsa County. The site is a commercial fresh market farm growing both field and high tunnel crops for sale on a local basis. The high tunnel used for the study has metal bows 18 feet in diameter and is 100 in length and is covered by a single layer of clear polyethylene film. There were nine different cool season greens that were grown including spinach, Swiss chard, romaine lettuce, red leaf lettuce, collard, kale, mustard, spinach mustard (mild type mustard), and turnip. Raised soil beds within the hoop-house were prepared for planting in early September including soil testing to determine the levels of nitrogen, potassium, and phosphorus and soil pH. Fertility levels were targeted at 120 lbs. of nitrogen and 150 lbs. of phosphorus and potassium per acre. Direct seeded plots (spinach, chard, collard, kale, mustard, spinach mustard, and turnip) were seeded with a hand push planter (Johnny's 9156 seeder) with rows 4.5 inches apart and approximately 8 to 9 seeds/linier foot on 9/20/11. Both romaine and red leaf lettuce plots were established with transplants on 9/28/11 with transplants started in the greenhouse on 9/07/11. Plots were replicated four times in a randomized design and consisted of an area of approximately 16 sq. ft. per plot. Harvests began on 10/25/11 and were completed on 4/27/12 (30 different harvest dates). Data recorded included fresh weight at each harvest.

Results: Overall yields were highest for turnip compared to spinach, Swiss chard, collard, kale, and mustard (Table 1). Yield ranged from a low of 0.45 pounds for kale to 2.8 pounds of turnip greens per sq. ft. The highest early yields (October-November) came from turnip, spinach mustard, and mustard (Figure 1). Early yields ranged from 0 lbs. per sq. ft. for collard to 0.92 lbs. for turnip. Pest problems included grasshoppers early in the season and aphids later in the season. There was a record breaking cold winter during the first year (2010-2011) of this study. The second year, this being Oklahoma, the weather was just the opposite i.e. very warm all winter. Of the two seasons, the cool season crops in the study performed best during the extreme cold of 2010-2011, compared to the warmth of 2011-2012. Problems encountered in 2011-2012 included higher levels of insect damage both early (grasshoppers) and season long (aphids) and bolting (flowering) of most of the cruciferous greens (collard, kale, mustard, spinach mustard, and turnip) due to the warm temperatures. One improvement in study results came from the use of transplants for both lettuce cultivars included in the study. Transplants were started in the greenhouse early and then transplanted into the high tunnel. The net result was earlier and multiple harvests from new transplants for each successive crop. Prices for the duration of the study ranged from $1.30-1.50/lb. for most of the crops to $4.00/lb. for spinach, $2.00/lb. for Swiss chard and kale, and $3.00 per plant for lettuce.

Based on these results, the authors would conclude that production of cool season leafy greens is possible during the coldest months of the year. We did see differences in yield potential and also heat tolerance of crops included in the study.

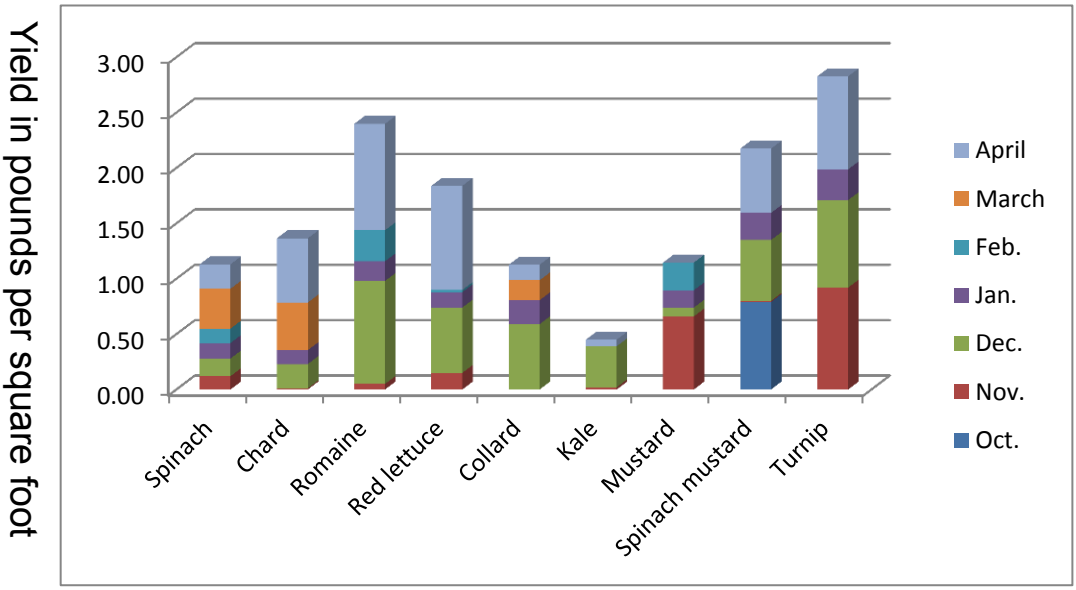
Acknowledgements: The authors wish to thank the Koelsch family for their interest and support of this project and the Oklahoma Department of Agriculture Food and Forestry for their support of the project through the specialty crop grant program.

Table 1. 2011-12 Leafy Greens Variety study, Koelsch Farm, Tulsa, OK.

Crop	Variety	Source	Yield (lbs) per sq.ft.	
Spinach	Olympia	Chriseed	1.1	cd[z]
Swiss chard	Rhubarb Chard	Harris	1.4	bcd
Romaine lettuce	Green Towers	Seedway	2.4	ab
Red leaf lettuce	Vulcan	Johnny's	1.8	abc
Collard	Champion	DeWitt	1.1	cd
Kale	Vates Blue Curled Scotch	DeWitt	0.45	d
Mustard	Southern Giant Curled	DeWitt	1.1	cd
Spinach Mustard	Savanna	Chriseed	2.2	abc
Turnip	Southern Green	Chriseed	2.8	a

[z] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Figure 1. 2011-2012 monthly and total yields of leafy greens per square foot, Koelsch farm, Tulsa, OK.



OKLAHOMA'S
Bountiful Harvest

Ag in the Classroom

Oklahoma Farm To School

USDA Specialty Crop Block Grant

Oklahoma Ag in the Classroom presents Oklahoma's Bountiful Harvest. Inside you will find a collection of simple recipes that correlate with AITC curriculum. Oklahoma's Bountiful Harvest is made possible by a USDA Specialty Crop Block Grant.

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Oklahoma Grain Bread

Related Online Lesson: The Grain Game

3 cleaned and emptied vegetable or fruit cans
ziplock bag
nonstick cooking spray
aluminum foil
½ cup rye flour
½ cup wheat flour
½ cup yellow cornmeal
½ cup pecans (optional)
½ cup raisins or dried cranberries
3 T. sugar
1 t. baking soda
1 cup buttermilk
1/3 cup molasses or maple syrup
¾ t. salt
crock pot or slow cooker

1. Mix all ingredients in a ziplock bag.
2. Spray vegetable cans with nonstick cooking spray.
3. Divide bread mixture equally between the cans.
4. Cover the top of each can with a piece of foil that has been sprayed with nonstick cooking spray.
5. Secure the foil with a rubber band.
6. Place the cans in a crock pot or slow cooker and add enough hot water to reach ½ way up the cans.
7. Put the lid on the crock pot and cook on low for 4 hours.
8. To remove bread from the cans, lay the cans on their side and roll or tap gently.
9. Cool or wire rack or cut and cool on plates.

Cornbread in a Bag

1 c cornmeal
2 T brown sugar
1/2 c whole-wheat flour
1/2 cup all-purpose flour
1/2 t salt
4 t baking powder
1/4 c oil
2 eggs, beaten
1 c milk
gallon size zip lock bag
9x9 inch pan

1. Combine the first six ingredients in the plastic bag.
2. Seal the bag.
3. Mix well by working bag with fingers until the ingredients are completely blended.
4. Add the final three ingredients.
5. Mix well by working the bag with fingers.
6. Open the bag and pour the mixture into a 9- X 9-inch pan.
7. Bake at 400 degrees for 25 minutes.

Related Online Lesson:
Corn in Legend and Myth

Nutter Clusters (Moon Balls)

(Makes about 3 dozen)
1 c nonfat dry milk
1/2 c honey
1/2 c peanut butter
1/2 c oats
1 c dry-roasted unsalted peanuts
1/2 c raisins

1. Mix together nonfat dry milk, honey and peanut butter.
2. Add remaining ingredients, and mix thoroughly.
3. Form into small balls about the size of a walnut.
4. Enjoy.

Related Online Lesson: Math for Peanuts

Tortillas in a Bag

1 1/2 c flour
1/4 t salt
1 t baking powder
3 T shortening
1/2 c hot tap water

1. Place flour, salt and baking powder in bag.
2. Close bag, and shake just a few shakes to mix.
3. Add shortening and reclose the bag.
4. Work bag with hands until the mixture looks crumbly and there are no large pieces of shortening visible.
5. Open the bag, and add the hot tap water.
6. Knead in the bag until the dough is one large piece and the sides of the bag come clean.
7. Take the dough out of the bag, and divide into four pieces.
8. Put the pieces of dough on the table, and lay the bag on top of them. Let the dough rest for 15 minutes.
9. After resting time, roll or pat the dough into eight- to 10-inch circles.
10. Place the circles on a griddle or frying pan heated to medium or medium high.
11. Cook until dark brown spots appear. Turn and cook on the other side until brown.

Related Online Lesson: Tortillas in a Bag

Butter

Related Online Lesson: Say Cheese

Pasteurized heavy whipping cream at room temperature (one pint for 18-20 students)
Condiment cups with lids (Ask at fast food restaurants.) Clear containers work best.
Container for pouring off buttermilk

1. Fill condiment container about 1/2 full of whipping cream and fasten lid securely.
2. Tell students to shake horizontally to prevent leakage.
3. Warn students to keep the lid on the container until the butter is ready and to keep the container moving at all times.
4. Have students pour the liquid off the butter into a container or drink. Explain that the liquid is actually buttermilk.
5. Provide crackers or stick pretzels for students to enjoy with their butter or serve with biscuits or cornbread.

Have students chant the following rhyme as they shake. Go around the group, replacing "Mary" with the name of each student in turn:

Butter, butter, shake, shake, shake
Mary's waiting at the gate
Mary's waiting for her cake
Butter, butter, shake, shake, shake.

Explain: The butter goes through three stages. It starts as a liquid. Ask students if they can hear the sloshing sounds. Then it stops sloshing because it has become a solid. Finally, after the particles of fat and milk solids stick together, the solution separates and becomes solid and liquid. Students should be able to hear a sloshing sound and the butter thumping against the side of the container.

Ice Cream in a Bag

Related Online Lesson: The Story of Milk

(per group of 4)
1/4 c sugar
1/2 t vanilla
1 c 2% milk
1 c (1/2 pt) whipping cream
ice
3/4 c water
3/4 c rock salt
4 plastic spoons
1 gal zip lock freezer bag
1 qt zip lock freezer bag
Measuring spoons
Wooden spoon
Measuring cup
Duct tape
4 8-oz sundae cups
Cloth towels or hot/cold mitts

1. Pour milk, whipping cream, sugar and vanilla into a 1 qt zip lock freezer bag, and seal tightly with duct tape.
2. Place the quart zip-lock bag with the ice cream ingredients inside a 1 gallon zip lock bag.
3. Pack ice around the small bag.
4. Add the rock salt and water.
5. Seal the larger bag with duct tape.
6. Have students shake or toss the bags between them while protecting their hands with cloth towels or hot/cold mitts.
7. Continue until ice cream is frozen.
8. Open the outer bag, and discard the ice and salt.
9. Rinse the bag containing the ice cream.
10. Divide the ice cream into sundae cups with the wooden spoon.

Oklaberrynana Smoothie

(for one student)
2 medium slices banana
1/4 cup fresh or frozen berries
1/2 cup vanilla yogurt
quart-size zip closing plastic bag
small cup

(for blender)
1 banana
1 cup frozen berries
1 cup plain yogurt
small cup

Instructions for one student:
1. Place ingredients in plastic bag.
2. Zip tightly.
3. Use your fingers to "puree" the mixture until berries and bananas are thoroughly mixed with the yogurt.
4. Pour into a cup and enjoy!

Instructions to make in a blender:
1. Place all ingredients in the blender.
2. Puree until all the ingredients are blended.
3. Serve in small cups.

Related Online Lesson: In Strawberry Fields

Snow Ice Cream

Can snow ice cream make you sick? Snow does contain bacteria. In fact, bacteria form the foundation of some snowflakes. But life is full of bacteria, and not all bacteria is harmful. There are no studies showing children becoming ill from snow, but there is no real consensus on the matter. Be aware of the risks, and make sure your snow is clean and fresh.

fresh, clean snow
2 t vanilla
2 T sugar
1/2 c milk
small styrofoam cups

1. Put sugar and vanilla in cups.
2. Pack snow in on top of the sugar and vanilla, leaving enough room for the milk.
3. Pour in milk, and mix it all together.

Related Online Lesson: Snowball Fight

Bug Juice

(10 servings)
2 10-oz. pkgs. frozen strawberries, defrosted
1 6-oz. can lemonade concentrate, thawed
1 quart ginger ale
2 cups raisins
6 gummy worms
blender
punch bowl

1. Mix the strawberries and lemonade concentrate in a blender until smooth and thick.
2. Gradually add ginger ale.
3. Transfer the mixture to a punch bowl.
4. Stir in any remaining ginger ale and the raisins.
5. Place the gummy worms on the rim of the bowl for a swampy effect.

Fruit Rings

4 apples, peaches, apricots
1 T lemon juice
3 T water
sturdy thread or twine

1. Peel, core and slice the apples into rings about 1/8 inch thick.
2. Mix the lemon juice and water in a shallow dish.
3. Dip each ring into the mixture, then pat dry with a paper towel.
4. String the fruit through the center of each ring.
5. Hang in a dry warm place. The rings will take 1-2 weeks to dry.

To expedite the process, dry the apples in a warm oven.

1. Instead of stringing the rings, place them on a wire cooling rack that rests on a baking tray.
2. Put the tray in a 150 degree oven.
3. Allow the rings to dry for about four hours, turning once midway through.
4. When the rings have no moisture left, remove them from the oven.
5. Eat, or cool before placing them in small bags.

Juicy Fruit Salad

1 c shredded apples
1/2 cup diced strawberries
1/3 c diced peaches
1/4 c chopped grapes
3/4 c orange juice
1 T lemon juice
juice of half a grapefruit

Stir the shredded apples, strawberries, peaches and chopped grapes in a medium size bowl.
Pour the orange, lemon and grapefruit juice over the fruit.
Stir well.

Layers of Soil Snack

Students will use the materials provided to build the layers of soil, as indicated.

dried cherries (organic material)
chocolate or butterscotch pudding (topsoil)
chunky peanut butter (subsoil) *
bananas (parent material)
rice cake (bedrock)

Related Online Lesson: Look Out, Below

Sand Clay Loam

1. Divide class into two groups. One group is rain; the other is soil
2. Have students in the soil group stand with their arms outstretched, with each student touching the hand of the student next to him/her.
3. Let students from the rain group work their way through the outstretched arms of the students of the soil group to represent the movement of water through sand.
4. Students in the soil group will stand shoulder to shoulder.
5. Students in the rain group will attempt to work their way through to represent the movement of water through clay.
6. Now have students from the soil group stand with their hands on their waists, with elbows touching.
7. Students in the rain group will work their way through to represent the movement of water through loam.

Pumpkin Pie in a Bag

(for 25 students)
one gallon zip freezer bag
2 2/3 cup cold milk
2 packages instant vanilla pudding mix
one can (15 ounces) solid-pack pure pumpkin
one teaspoon ground cinnamon
1/2 teaspoon ground ginger
graham cracker crumbs
25 small cups
scissors
one can whipped topping
25 spoons

(for two students)
quart-size zip freezer bags
1/8 cup milk
2 T canned pumpkin
dash cinnamon
dash ginger
1 T instant pudding mix*
tart-size premade graham cracker crusts or ginger snaps

Related Online Lesson: Pumpkins By the Pound

For 25 students

1. Combine the milk and instant pudding in the bag.
2. Remove the air from the bag and seal it.
3. Squeeze and knead with hands until the mixture is blended—about one minute.
4. Add the pumpkin, cinnamon and ginger.
5. Remove the air, and seal the bag.
6. Squeeze and knead with hands until blended—about two minutes.
7. Place 1/2 tablespoon of graham cracker crumbs in the bottom of the small cups.
8. Cut the corner of the gallon freezer bag, and squeeze pie filling into the cups.
9. Garnish the cups with whipped topping.
10. Provide spoons. Enjoy.

For individual servings
Follow directions as above and squeeze mixture into tart-size premade graham cracker crusts, or place a ginger snap at the bottom of small cups to serve as crust.
* The mix should have the consistency of pudding. If it is too runny, add pudding mix. If it is too thick, add milk.

Watermelon Salsa

1 seedless watermelon - 15 pounds
1 green bell pepper - chopped
1 red bell pepper - chopped
1 yellow bell pepper - chopped
1 orange bell pepper - chopped
2 jalapeno peppers - finely chopped
1 onion - finely chopped
1/3 cup lime juice
1 bunch cilantro - finely chopped
1 tsp garlic powder
1 pinch of salt

Mix all ingredients together in a large bowl.

Related Online Lesson: Working Watermelon

Watermelon Pops

seedless watermelon
blender
ice cube trays
aluminum foil
toothpicks

1. Puree seedless watermelon in a blender.
2. Pour into ice-cube trays.
3. Cover the trays with aluminum foil.
4. Stick a toothpick through the center of each cube.
5. Freeze for three hours or until solid.
6. Serve as a refreshing treat.

Frosted Watermelon

Seedless watermelon cut into ½ to ¾ inch thick slices
Vanilla flavored yogurt
Granola or similar cereal

Using your favorite cookie cutters, cut shapes out of the slices of watermelon. Frost with the vanilla or other flavored yogurt. Sprinkle with granola.

How to Pick a Melon

Related Online Lesson: Melon Meiosis

Harvesting melons is labor-intensive. Conveyors and other harvesting aids can speed up the harvest process but there are no mechanical harvesters that can decide which melons are ripe. That remains a human skilal dependent upon experience and careful observation. To select your own ripe melons from the grocery or farmer's market, use the following hints:

- For most melons, the blossom end should be fragrant and give slightly to pressure.
- Muskmelons or cantaloupes should be tan or gold under their netting.
- Honeydews should be velvety and creamy yellow.
- Crenshaw melons should be golden yellow and green.
- Casabas are ready when the skin turns golden and the flesh white.
- Honeydews, casabas and watermelons should feel heavy for their size and sound hollow when tapped on the rind.
- Avoid melons with shriveled, punctured or cracked rinds.
- Watermelons should have a waxy look and a yellow patch on the belly.
- Thumping an unripe melon will produce a metallic sound while the sound emanating from a ripe melon will be duller.

Beef Jerky

Related Online Lesson: Food for Keeps

very lean flank steak, partially frozen
teriyaki sauce

Cut steak into thin strips, 1 1/2 to 2 inches wide.
Dip the strips in teriyaki sauce.
Dry the strips, using one of the following methods:

Oven-Dried

1. Arrange the seasoned strips in a single layer on wire racks.
2. Place a piece of aluminum foil on the bottom of the oven to catch drippings.
3. Preheat the oven to 150 degrees F., and then turn the heat back to 120 degrees F.
4. Place the meat in the oven, leaving the oven door open at the first stop.
5. After five or six hours, turn the strips over.
6. Continue drying at the same temperature for four hours more.
7. Jerky is ready when it is shriveled and black. When cooled, the jerky should be brittle.

Microwave-Dried

1. Arrange the seasoned strips flat and close together on a microwave-safe bacon rack. Cover with waxed paper.
2. Microwave at medium low.
3. Turn the strips over, placing the drier strips in the center of the rack.
4. Rotate the rack 1/2 turn, and continue microwaving at medium low for 21 minutes, until the strips are dry but slightly pliable.
5. Remove to the paper towels. Repeat with remaining strips. Cover the strips with paper towels, and let them stand for 24 hours.

Storage: Wrap the sticks of jerky in plastic wrap, and put them in a container with a tight-fitting lid. Store in the refrigerator or freezer.

Hot Beef Sundaes

1 package (17 ounces) refrigerated fully-cooked beef tips with gravy
1 package (24 ounces) refrigerated mashed potatoes

Shredded Cheddar cheese
Sour cream
cherry or grape tomatoes

1. Heat beef tips with gravy according to package directions.
2. Heat mashed potatoes according to package directions.
3. Using ice cream scoop, place 2 scoops (about 1/3 cup each) mashed potatoes in each of 4 individual sundae cups or serving bowls.
4. Divide beef tips evenly over potatoes in each dish.
5. Sprinkle with cheese and top with dollop of sour cream, as desired.
6. Place 1 tomato in center of each serving for "cherry."

Related Online Lesson: Beef is Good for You

Oklahoma Stone Soup

beef chuck roast, cubed
2-3 strips bacon
At least three of the following fresh vegetables commonly grown in Oklahoma gardens. Let your students decide.
tomatoes
carrots
corn
potatoes
green beans
peppers
okra
squash
onion

1. Cook the bacon in a large cooking pot. Put the bacon aside, and brown the onion in the bacon fat.
2. Add the beef, and stir until it is browned on all sides.
3. Transfer all to a crock pot. Add two cups of water, and let it cook while students decide which Oklahoma vegetables they want to add (at least three—Encourage students to try vegetables they have never tasted before.)
4. Prepare the vegetables, and add them to the pot.
5. Let the soup cook in the crock pot on high for 2-3 hours.
6. Serve with crackers, corn bread or fresh bread.

Related Online Lesson: Oklahoma Stone Soup

Ranch Kabobs

small pieces of pre-cooked steak
small pieces of ham
small pieces of pre-cooked chicken
diced squash (yellow or zucchini)
diced bell peppers (red, orange and/green)
cherry tomatoes

1. Heat steak, ham, chicken, squash and peppers on a griddle.
2. Thread one of each item on a skewer.

The word kabob (or kebob) is Persian and originally meant fried not grilled meat. In the 14th century, kabob is defined to be synonymous with tabahajah, a Persian word for a dish of fried meat pieces. Kabob was used frequently in Persian books of that time to refer to meatballs made of ground or pounded chicken or lamb. In North American English, the word kabab usually refers to shish kabab. Shish is Turkish for skewer.

Apricot Oat Nut Snack Mix

Makes 20 servings

3 cups rolled oats
2 cups wheat bran
2 teaspoons cinnamon
1/2 teaspoon nutmeg
1 cups pecan halves, broken
1 cup almonds, coarsely chopped or slivered
1/2 cup raw sunflower seeds
5 tablespoons vegetable oil
3/4 cup honey, melted
1 1/3 cup dried apricots, quartered (one 6-ounce bag)
3/4 cup raisins

Preheat oven 325 degrees F.
1. In a large bowl, combine rolled oats and next six ingredients; toss well.
2. Drizzle oil over mixture and toss until coated.
3. Drizzle melted honey and continue tossing until coated. Mixture should be clumpy.
4. Divide mixture onto two cookie sheets, spreading evenly. In top third of oven, bake 20 minutes.
5. Remove from oven; stir with wooden spoon, mixing thoroughly.
6. Continue to bake 30 minutes more, stirring every 10 minutes.
7. Return snack mix to bowl; add dried fruits. Toss gently and cool.
8. Can be stored for two weeks in airtight containers or frozen up to two months.

Edible Clay

(enough for 18 students)
2 cups peanut butter
1 cup honey
3 cups instant dry milk
oil
wax paper

1. Grease measuring cup with vegetable oil.
2. Mix peanut butter with honey.
3. Add instant dry milk, a little at a time, until mixture is stiff.
4. Cover students' desks with wax paper, and have students wash their hands.
5. Spoon out the edible clay to each student and allow them to experiment and create with the clay.

Edible Caterpillars

bananas
peanut butter or other spread
pretzel sticks
raisins
orange juice

1. Dip the bananas in orange juice to keep them from turning brown.
2. Stick pretzels in the sides to make feet and in the top to make antennae.
3. Spread peanut butter on the back, and stick raisins in to make the interesting patterns found on most caterpillars.

Roasted Pecans or Pumpkin Seeds

pecans or seeds from one pumpkin
salt

spray vegetable oil
knife
steamer
towel
cookie sheet

1. Pre-heat over to 300 degrees F. Skip to #5 for pecans.
2. Cut pumpkin in half.
3. Remove seeds by scraping pulp from the pumpkin with a large spoon.
4. Rinse seeds in a colander, and pick seed from the pulp.
5. Place nuts or seeds in the top of a vegetable steamer with water in the bottom.
6. Cover and cook for 30 minutes.
7. Dry nuts or seeds with a towel.
8. Spread nuts or seeds on a cookie sheet, spray with vegetable oil and sprinkle with salt.
9. Bake for 30 minutes, or until golden brown.

Related Online Lesson: A Tough Nut to Crack

Bugs on a Log

Four 1 inch sections celery (washed and dried)
peanut butter
raisins

1. Fill celery sticks with peanut butter.
2. Press raisins here and there to represent bugs.

Peanut Butter

1 cup unsalted, roasted peanuts
1 tsp vegetable oil, if needed

scraper
blender

1. Pour peanuts into blender.
2. Cover blender, and set it for chop.
3. Stop the blender periodically to scrape the peanut butter from around the blades until all the peanuts have been ground into peanut butter.
4. If necessary, add oil to help the grinding process.

Bagel Smiles

3 whole wheat bagels
1/4 cup whipped cream cheese
fresh vegetables for decorating faces:

- asparagus spears
- shredded carrots
- sliced red bell pepper
- raisins, broccoli florets
- drained canned beans (black garbanzo, pinto, kidney)
- cherry or grape tomatoes
- summer squash rounds
- olives

1. Split bagels in half
2. Spread cream cheese over each bagel half
3. Use your imagination to create faces using fresh vegetables.

Related Online Lesson: The Snack Sack

Blackeyed Pea Spread

1 can (16 ounces) black-eyed peas, drained
3 green onions, chopped with tops
1/2 cup sour cream
1 teaspoon garlic salt
1/2 cup salsa
4 slices bacon, cooked and crumbled

1. Reserving 1/3 cup, place peas in a blender. Process until smooth.
2. Blend in onions, sour cream and garlic salt.
3. Transfer to a bowl, and stir in salsa, reserved peas and bacon.
4. Serve with tortilla chips, bagel chips or corn chips.

About the Blackeyed Pea

Blackeyed peas are Oklahoma's number one vegetable crop. Cowpea is another name for black-eyed-peas. The mature bean contains 23-25 percent protein, 50-67 percent starch, and B vitamins, including folic acid. It is also rich in essential micro-elements, such as iron, calcium and zinc.

Broccoli Trees

(per five students)
1⁄4 c light sour cream
1⁄3 c mayonnaise
1⁄2 tsp sugar
1 Tbsp lemon juice
1 Tbsp finely chopped fresh spinach, basil or other fresh or dried herb
4 carrots
3 c broccoli florets
paper plates

Prepare a dip by combining the sour cream, mayo, lemon juice and spinach or herb in a medium size mixing bowl.

To make the trees, cut each carrot in half widthwise and then lengthwise into four pieces.
Assemble the trees on the plates by laying three carrot pieces side by side for a trunk and placing the broccoli florets to look like leaves. Spread dip under the trunks to serve as the forest floor.

RESEARCH ACTIVITY
Use an online search engine or library references to research trees that grow well in Oklahoma. Students will draw two of the trees they researched and then classify them as deciduous or evergreen.

Cucumber Sandwiches

Loaf of thinly sliced whole wheat bread
2 to 3 cucumber, pared & thinly sliced
2 (8 oz.) pkg. cream cheese, softened

1. Spread each slice of bread with a thick layer of cream cheese.
2. Pile sliced cucumber on one, and cover with the other slice of bread.
3. Press gently, trim crusts and cut into triangles.

A delicious snack and a great combination of flavors.

Related Online Lesson:
Pumpkins, Squash and Other Cucurbits

One-Eyed Monster

one bell pepper
cheese spread
sliced olives

Cut the bell pepper in half, and remove the seeds and membrane.
Cut each half into four wedges.
Spread cheese spread on the wedge, and place an olive slice in the center.

Fresh Garden Salsa

1 tomato, chopped
1 bell pepper, chopped
1 Jalapeno pepper, choped
2 cloves garlic, minced
1/4 onion, finely chopped
1 tsp lime juice
pinch of salt
pinch of sugar
pinch of cilantro, chopped
Mix ingredients together in a bowl.

Related Online Lesson: You Say Tom-may-toe; I Say To-Mah-Toe

Veggie Quesadilla

two 6-inch flour or corn tortillas
2 T grated cheese salsa and/or sour cream
shrededd carrot and zucchini or summer squash
chili powder

1. Saute shredded carrot and zucchini or summer squash and season with chili powder.
2. Place one tortilla on an ungreased skillet over medium heat.
3. Sprinkle lightly with grated cheese and one tablespoon of the veggie mixture.
4. Top with a second tortilla.
5. Cook for about two minutes on each side, or until the cheese melts.
6. Let cool for two minutes.
7. Cut into wedges, pie style.
8. Serve with salsa and sour cream.

Zucchini Boats

5 medium zucchini
1 large tomato, chopped fine
2 green onions, chopped fine
1 T chopped parsley
2 slices salami, finely chopped
1/2 cup shredded cheese

1. Cut each zucchini lengthwise, then crosswise, into three equal pieces.
2. Using a small teaspoon, scoop a small hollow from each of the slices.
3. Cook the zucchini in simmering water for about three minutes. Drain.
4. Run under cold water, and pat them dry with paper towels.
5. Combine remaining ingredients in a small bowl.
6. Spoon the filling evenly into the zucchini boats.
7. Broil the boats 3-4 inches from the heat until the cheese melts.

Ten Minute Root Vegetables

Serves 4 as a side dish

You can use just one of the vegetables or any combination

2 medium carrots, cut into 1/2 by 1/2 by 2 inch sticks (about 2 cups)
1 Tbsp unsalted butter
1 tsp sugar
1/2 tsp table salt
2 small parsnips, cut into 1/2 by 1/2 by 2 inch sticks (about 1 cup)
1 small turnip, cut into 1/2 by 1/2 by 2 inch sticks (about 1 cup)
Freshly ground black pepper

1. Bring the carrots, butter, sugar, salt and 1/2 cup water to a boil over high heat in a large skillet and cook for 2 minutes.
2. Add the parsnips and cook an additional 2 minutes.
3. Add the turnips and continue cooking, stirring about every minute, until all of the liquid is evaporated and the vegetables are tender, browned and shiny, about 6 minutes longer.
4. Adjust the seasoning with salt and pepper to taste, and serve immediately.

Related Online Lesson: These Roots Run Deep

Kitchen Safety Rules

- Turn the handles of pots and pans inward so you can't knock them off and spill something or burn yourself.
- Always use a dry potholder or oven mitt when handling pots and pans. Wet potholders won't keep the heat from burning your fingers.
- Put foods gently into boiling water so it will not splash on you. Lift lids from hot pots with the opening away from you.
- Keep loose clothes, long sleeves and long hair away from hot burners along with dish towels, potholders and recipes. They might catch fire.
- Do NOT put hot grease into water or water into hot grease. It will splatter and might burn you. In case of a fire, call an adult for help.
- When you're finished cooking, always make sure all oven and stove dials are turned off.
- Keep wet hands away from electrical outlets.
- Always pick up a knife by its handle, not its blade. When cutting, always cut away from yourself.

AT THE STORE

- Don't let juice from raw meat, poultry or fish drip on to your hands or any fresh foods in your grocery cart. Raw juices may contain bacteria.
- Shop for cold and frozen products last. Use a cooler for the ride home, especially during the summer if you are running other errands.
- Avoid unpasteurized milk, juice, eggnog or other foods made with raw eggs.

IN THE KITCHEN

- Always wash your hands in hot, soapy water before preparing and after handling raw meat, poultry, seafood or eggs.
- Cook all meat and poultry—or casseroles that contain meat or poultry—at a minimum oven temperature of 325 degrees F.

- Cook meats thoroughly, but don't overcook them.
- Keep your refrigerator at no more than 40 degrees F and your freezer at 0 degrees F.
- Don't store raw fish in your refrigerator for more than 24 hours. Raw poultry or ground beef will keep for one to two days and raw red meat for three to five.
- Thaw frozen food in the fridge or in a microwave, not at room temperature.
- Never put cooked food on the plate used when it was raw.
- To keep bacteria from growing, put your sponge or scouring pad in the dishwasher every time you run it.

OKLAHOMA'S
Bountiful Harvest

Ag in the Classroom

Oklahoma Farm To School

USDA Specialty Crop Block Grant

Oklahoma Ag in the Classroom presents Oklahoma's Bountiful Harvest. Inside you will find a collection of simple recipes that correlate with AITC curriculum. Oklahoma's Bountiful Harvest is made possible by a USDA Specialty Crop Block Grant.

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Balloon Plants

large, clear balloons
markers
ribbons
funnels
measuring cups
towels or wipes
radish seeds
1/2 cup potting soil (per student)
1/4 cup water (per student)

1. Hold a balloon firmly by the neck. Use a funnel, and pour 1/2 cup of soil into the balloon. Don't turn the balloon over.
2. Keep holding the balloon by the neck. Add about 1/4 cup of water through the funnel. Be sure the soil in the balloon is damp but not too wet.
3. Use the funnel to drop the radish seeds into the balloon. Don't turn the balloon over.
4. If the balloon is dirty, clean it with the towel or wipes.
5. Now you're ready to blow up your balloon. Keep holding it gently by the neck. Now carefully blow up the balloon. You need to keep the ballon from tipping.
6. Tie a knot in the neck to keep the air in the balloon. Tie a ribbon around the knot.
7. Hang the balloon from a hook or other place near a window. The neck should be the top. The balloon plant will begin growing soon.
8. Check your balloon daily and chart the plant's growth for 10 days.

Could these plants grow in the balloons forever? Will they run out of anything? Where do plants get food? Where do plants get carbon dioxide? Do plants need water to live?

Bean Babies

1. Provide each student with one large and one small bean, a plastic jewelry bag, yarn and a cotton ball.
2. Students will place the cotton balls and beans inside the bags and moisten the cotton ball with a few drops of water.
3. Help students punch holes in their bags with a hole punch. String the yarn through the hole, and tie the ends to make a necklace.
4. Ask what conditions are necessary for a seed to germinate (moisture, warmth, sometimes darkness). Ask students where they might place the bags to provide the best conditions for germination.
5. Students will hang the bags around their necks and tuck them inside their clothes.
6. Tell students they are responsible for providing their bean babies with the best possible care until they have sprouted.
7. Students will name their "babies" and tell the names to their classmates.
8. Send a note home to parents explaining the needs of the bean baby
9. Students will record the progress of their seeds. Which ones grow faster? Each day students will discuss the changes taking place in their seeds.
10. At the end of three days, make a chart as a class showing how many of the seeds have sprouted.
11. Students will predict what their bean babies will look like two weeks later.
12. After students have cared for their bean babies for a couple of days, discuss how the needs of the bean babies are different or the same as that of an animal or a human child.

Related Online Lesson: A Bean is a Seed

Bandana Apron

1 bandana per student
1/2 yard ribbon
needle and thread
Fold one corner of a bandana 1/3 of the way to the opposite corner.
Sew 1/2 yd. of 1-inch wide ribbon ties on each side.

Carrot Necklaces

carrots
heavy duty needle
dental floss

1. Wash the carrots, and cut them into 1/4-inch round slices.
2. Thread a heavy duty needle with dental floss, and slip the slices onto the floss by pushing the needle through the core.
3. Once you've strung enough carrots, tie the ends together to form a necklace.
4. Lay it on paper in a dark, well-ventilated place, making sure the slices don't touch each other.

As they dry, they turn into wrinkled beads. Drying takes a couple weeks.

Corn Cob Dolls

dried corn cobs
dried corn husks
corn silk, if available
assorted fabric
yarn
markers

Have students use markers to draw faces on the large ends of their corn cobs.

Have students choose fabric remnants to wrap around the cob and tie the cloth in place with yarn.

If corn silk is available, students may use it to make hair for their dolls. The hair may be tied, wrapped in loose strands or braided. If no silk is available, have students draw hair or glue on yarn.

Related Online Lesson: Corn Cob Toys

Garden Journal

1 large paper grocery bag with handles
raffia or garden twine
monthly calendar
notebook paper
markers
3-hole punch

1. Cut the large bag down the side until you reach the bottom.
2. Continue cutting around the bottom of the bag and discard the bottom.
3. Cut 2 pieces 18 x 10 inches, with handles attached.
4. Fold up each piece 7 inches and staple on each side to form a pocket.
5. Punch 3 holes in the side of each piece using the hole punch.
6. Place blank notebook pages and calendar within the two cover pices.
7. Tie the booklet together with raffia or garden twine.
8. Decorate the front with markers.
9. Enjoy your journal.

Related Online Lesson:
The Art of Growing Things

Garden Glove

surgical gloves
yarn
cotton balls
beet, radish, lettuce, and carrot seed

1. Give each student a glove, and have each student write his/her name on the thumb of the glove and the names of each of the seeds on the remaining fingers.
2. In each finger, place a moistened cotton ball and a few of each kind of seeds.
3. Have students tie off their gloves with the yarn.
4. Wait for the fingers to sprout.

Melon Jamboree

dried seeds from any melon, pumpkin or squash
paper plate
streamers

1. Distribute one paper plate per student.
2. On the bottom of the plate, paint a large circle to represent the inside color of their melon, pumpkin or squash.
3. Around the edge paint the outside rind color.
4. Let it dry.
5. Fold in half and place dry seeds inside. (Save 6-8 seeds to decorate the outside.)
6. Staple at the edge to keep seeds inside.
7. Attach streamers.
8. Have a melon jamboree with your students' instruments.

Oklahoma Dirt Shirt

Related Online Lesson: Dirty Pictures

bucket
water
red dirt
purple clothing dye
white cotton
T-shirt
vinegar
long wooden stick

1. Fill a bucket half full with water. Add enough red dirt so the water is gritty and muddy looking. Add a small amount of purple clothing dye.
2. Place a white cotton T-shirt in the bucket. If desired, tie knots in the shirt or tightly secure random sections with rubber bands for a tie-dye effect.
3. Use a long wooden stick to stir the shirt in the muddy water until the shirt has attained the desired color.
4. Hang the shirt in the sun to dry.
5. When the shirt is dry, rinse it in cold water to remove excess mud.
6. Wash the shirt in cold water in the washing machine. Add vinegar to the wash water.
7. Dry hot to set the color.

Prairie Doll

(May be prepared in advance in a baggie by a parent volunteer.)
1 - 14" x 8" piece of muslin
2 - 3" x 9" scraps
1 - 6"x 4"x 4" triangle

1. Measure and rip muslin into a rectangle.
2. Measure and mark 16 1/2-inch increments along the length of the muslin
3. Rip 16 1/2-inch strips
4. Fold 15 of the strips in half, and use one strip to tie off a doll's head. The tie also serves as arms.
5. Cut a 1/2-inch hole in the center of each of the two scraps, and place over the head of the doll.
6. Tie the arms on top of both layers of the dress in the front.
7. Use your imagination to trim your dress or make a heart cutout on the top layer
8. Tie on the triangle as a bonnet.

Related Online Lesson: Piece by Piece

Newspaper Pots

newspapers
masking tape (the cheapest in the paint section – must be thin and not very sticky)
bottle
soil
seeds or plants

1. Fold one sheet of newspaper in half.
2. Put bottle in center of half, and fold the newspaper up around the bottle.
3. Put a piece of tape approximately 12" long around the newspaper to make the pot about 3" tall.
4. Remove the bottle.
5. Tuck the tops of the paper into the pot. The tape should be inside the pot.
6. If planting seeds, fill pot full of soil, then plant seeds and spritz to dampen the soil.
7. If planting plants, put plant in pot first, then put soil around the plant. Spritz to dampen soil.
8. When planting in the ground, dig the hole big enough for the entire pot. None of the pot should be exposed.

The newspaper pot will disintegrate and become part of the soil. The newspaper and the tape are biodegradable. The glue on the cheap tape that doesn't stick well is soluble and will dissolve in the soil. The tape is paper. The ink on the newspaper is usually soy ink.

Related Online Lesson: Germination Observations

Sneaker Salad

clean, old sneakers
lettuce and radish seeds
potting mix

1. Fill sneakers with potting mix.
2. Sprinkle a few lettuce and radish seeds in each sneaker.
3. Water.
4. Wait for the seeds to sprout.

For variety, use larger seeds, like bean, watermelon, squash or pumpkin.

Related Online Lesson: Dirt Babies

Very Hairy Caterpillar

large bowl
4 cups potting medium
4 T ryegrass
empty yogurt container or paper cup
with bottom cut out (for funnel)
one knee high stocking for each student

colorful ponytail holders
bobby pins
googly eyes
pipe cleaners
pom poms
glue sticks

1. Combine the potting soil and ryegrass in the large bowl.
2. Slide a knee-high stocking over the funnel.
3. Pour or spoon 3/4 to 1 cup of the soil mixture into the stocking.
4. Slide a colorful ponytail holder over the end of the stocking to section off the pocket of soil.
5. Repeat Step 3 to make five soil-filled segments.
6. Tie a knot in the top of the stocking, and trim away excess nylon.
7. Submerge the caterpillar in water for 10 minutes
8. Place the caterpillar in a plastic bag, and let it sit overnight.
9. Remove the bag, and loop a semistraightened bobby pin through the front of the stocking.
10. Glue a a googly eye onto each end of the pin.
11. For antennae, cut a pipe cleaner in half, glue a small pom-pom onto one end of each half, and stick them in place.
12. Set the caterpillars on styrofoam plates near a sunny window, and generously water them every other day. The critters should sprout hair in about 4-5 days.

Related Online Lesson:
A Beautiful Captive

Watermelon Mosaic

watermelon slices to taste
watermelon seeds
torn green construction paper
torn white construction paper
torn red construction paper
paper plate

1. Give each student a watermelon slice on a paper plate.
2. Students will think about the sound, taste, smell, look and texture of their watermelon as they enjoy eating it.
3. Students fold clean paper plates in half.
4. Students glue torn green construction paper pieces around the outside curved edge of their plates to represent a watermelon rind.
5. Students add just enough torn white construction paper pieces to make a line of white next to the green.
6. Students glue small red construction paper pieces to fill in the remaining space.
7. Students glue watermelon seeds on the red pieces.
8. Students open their plates and write descriptions about the watermelon they have eaten, using the following guidelines: outside color, inside color, seeds (yes, no), shape, color, outside feel, inside feel, taste, shape.

3-D Berry

pink, blue, red or purple construction paper
2 paper fasteners for each berry
green construction paper for vines
paper punch
scissors

1. Cut three strips, about one inch wide, down the short side of the colored paper.
2. Students write a fact about berries on the inside of each strip.
3. Holding the strips together in a stack, use a paper punch to make three holes in each strip: one in the middle and one a half inch from each end.
4. Still holding the strips together, put a paper fastener in the middle hole.
5. Trace your hand for the leaf (DO NOT SPREAD YOUR FINGERS APART.) and/or cut strips of green and curl them with a pencil for vines.
6. Punch a hole in leaf and vine, and put a paper fastener through the hole.
7. Bring up the ends of the long strips, and fasten them all together.
8. Spread out the paper strips to form a berry.

Beans Around the World

Divide the room into continents (except Antartica). Divide the class into teams, and provide each team with a world map or globe. As you read out the legume fact, have one student from each team move to the part of the room representing the continent where the legume originated.

Cowpea is another name for black-eyed peas or southern peas. They originated in Ethiopia but have been cultivated since ancient times in China. (Africa)

The lima bean is named after the capital city of Peru — the country where it originated. Lima beans are also called "butter beans." (South America)

Snap beans originated in southern Mexico (North America), Guatemala (Central America), Honduras (Central America), and Costa Rica (Central America). They grew on vines and were planted with corn, which served as a prop for the vines.

Lentils, peas, chick peas and fava beans were brought into cultivation by Neolithic people in the Fertile Crescent of the Near and Middle East (present-day Syria, Iran, Iraq, Turkey, Jordan, Israel). (Asia)

Australian aborigines ground the seeds of the wattle plant between stones to form a flour which was then baked. (Australia)

Provide a sample of each of these legumes, and have students glue them to a world map. For those legumes for which a sample is not available, use a representation. (Australian wattles are in the acacia family, the same family as mimosa.)

Related Online Lesson: Field of Beans

Garden is Ready

1. Students sit in chairs scattered around a room.
2. Without telling the others what he or she has chosen, each student chooses the name of a vegetable that grows in the garden.
3. One player serves as the gardener. He or she stands and says: "The garden is ready to harvest."
4. Walking around the room, he or she calls out the names of various garden vegetables.
5. When a player hears the name of his or her vegetable, he or she gets up and walks behind the gardener.
6. When most of the vegetables have been called out of their seats, the gardener shouts: "Salad."
7. At this the students must find new seats.
8. The last student to find a seat becomes the new gardener.

Related Online Lesson: Garden Grid

Pumpkins

For pottage and puddings
and custards and pies,
Our pumpkins and parsnips
are common supplies,
We have pumpkins at morning
and pumpkins at noon,
If it were not for pumpkins
we should be undoon.

Related Online Lesson: Case of the Missing Pumpkin

Farmer, Farmer, What's On Your Mind?

Related Online Lesson: Ag in My Community

Preparation: Three empty corners of a room with little obstruction between each corner. Choose a farmer to sit with his or her back to the group.:

1. Provide background information about three agricultural commodities in Oklahoma. (See Ag Facts.)
2. Assign one of the three commodities to each of the three empty corners, and appoint one student to serve as the farmer.
3. Have each student choose one of the three commodities.
4. As the class spells the word "agriculture" aloud, have each student move to the corner representing the topic he or she has selected.
5. Ask the farmer which commodity he/she is ready to take to market. The group that is chosen is out of the game.
6. Select another farmer, and have the remaining students choose another commodity. Repeat steps 4 and 5 until only 1-3 students remains. Note: Sometimes two or three students figure out a strategy for staying in the game. If so, declare them all winners before the majority of the class gets antsy.

For older students

1. Follow the instructions above, but have four corners. Each corner can be a commodity group (cattle, hogs, chickens, wheat) or a fruit/vegetable.
2. Cut out facts from the AITC website about the represented corners, and place them in a bag.
3. Students move to a corner while spelling AGRICULTURE together.
4. Draw a fact from the bag and read. Students in that corner are eliminated.
5. To keep students attentive, ask the eliminated students to listen to the facts being read to prepare for a review.

Have You Seen My Sheep?

1. Players stand in a circle, with one, the shepherd, standing outside the circle.
2. The shepherd walks around the outside of the ring, stops anywhere, and taps a player on the shoulder.
3. The shepherd asks, "Have you seen my sheep?"
4. The shepherd describes the clothing of another player, and when the player being questioned recognizes the player described, he or she answers: "Your missing sheep is Johnny [or Jane or Mary]."
5. On being identified, the sheep bolts from the circle and races around the outside, pursued by the player who made the identification.
6. If the sheep can get back in place before being tagged, he or she becomes the shepherd for the next round. If he or she is tagged, the pursuer is the new shepherd.

Related Online Lesson:
Sheep as White as Snow?

Sheep Shearing

How delightful to see
In the evenings in spring,
The sheep going home to the fold.
The master does sing
As he views everything
And his dog goes before him when told.

The sixth month of the year,
In the month called June,
When the weather's too hot
to be borne,
The master doth say
As he goes on his way,
"Tomorrow my sheep shall be shorn.

Now as for those sheep,
They're delightful to see,
They're a blessing to man on his farm.
For their flesh, it is good,
It's the best of all food.
And the wool it will clothe us up warm.

Now the sheep they're all shorn,
And the wool carried home.
Here's a health to our master and flock.
And if we should stay
Till the last goes away,
I'm afraid twill be past twelve o'clock.

Melon Man

Preparation: A large open area is required for the movement.
Teach the following song: Melon man, melon man, catch a brownie if you can,
Yes I will, Yes I will, if the brownie will stand still.

1. Divide students into two groups - a melon group and a brownie group.
2. Form a circle, facing inward.
3. Have the melon step forward and put their palms together to make "windows." (Don't weave fingers.)
4. As all sing the song, have brownies go in and out of the windows at least twice.
5. When teachers says "stop," melons should lower the "windows." All brownies inside the circle become melons and join the circle.
6. Play two times so that everyone who started out as a melon gets the opportunity to become a brownie.

Background: Melons are warm season crops that thrive in Oklahoma's long growing season. Melons were grown almost exclusively in home gardens until the first half of the 20th century, when more disease and wilt resistant cultivars were developed by the USDA. A melon that is ripe will have a blossom end that fragrant and gives slightly to pressure. Avoid melons with shriveled, punctured or cracked rinds. Thumping an unripe melon will produce a metallic sound while the sound emanating from a ripe melon will be duller.

Related Online Lesson: Melon Madness

The Name Game

1. Gather students in a circle. The ideal number is 15 or less.
2. Assign each student the name of a fruit or vegetable.
3. A leader introduces the game by saying his/her fruit or vegetable name.
4. The leader calls out the name of a fruit or vegetable and tosses a small soft sports ball to the person with that name.
5. That person calls another fruit or vegetable name and tosses the ball to him/her, and so on until everyone has received the ball at least once.
6. For the duration of the game, each person throws the ball to the same person.

It is fun to get several balls going at once. It is also fun to time how long it takes the group to complete the game.
If you have a large number of students, play the game in groups, with only one group playing at a time, while others watch. Too many students in the circle are not advisable. Have fun!

Scatter Square Dancing

Preparation: Use blue grass, pop, rock or country & western music - anything with a quick, steady beat. Teacher is the caller.

Background: The square dance is an American institution. It began in New England as the first settlers and the immigrant groups that followed brought various national dances. We call them folk dances now, but at the time they were just the popular dances of the day in the countries of their origins. The schottische, the quadrille, the jigs and reels and the minuet are some examples. After a week of toil carving space out of virgin forest and building new homes, the settlers would gather in the community center on Saturday evening and enjoy dancing their old-world favorites. As the communities grew and people of different backgrounds intermingled, so did their dances. As the repertoire increased, it became increasingly difficult for the average person to remember the various movements.

Share background information, and explain the calls:

"Right arm swing" - Lock right arms at elbow, and dance in a circle.
"Left arm swing" - Lock left arms at elbow, and dance in a circle.
"Do-Si-Do" - Cross arms in front, and dance around your partner.
"Right Hand Star" - "High five" right hands, and dance in a circle.
"Left Hand Star" - "High five" left hands, and dance in a circle.
"Honor Your Partner" - Curtsy or bow, and say a kind greeting.
"Hit the Trail" - Keeping the beat to the music, move about the dance area.

Partner up and walk through the calls.

Start the music, and give the calls, There is no "right" order.

Tossed Salad

Related Online Lesson: Be a Food Explorer

The players sit on chairs in a circle, with one player, the grocer, in the center.
The grocer gives each of the others the name of a vegetable.
He or she then calls out the names of any two vegetables.
The two students with these names quickly exhange places, while the grocer tries to get one of their seats.
Of the three, whoever does not find a seat becomes the grocer for the next round.
At any time, the grocer may call out "Tossed Salad," and all the players scramble for new seats.

Wood Fence, Stone Fence, Barbed Wire

Related Online Lesson: Don't Fence Me In

1. Divide students into two groups—fence and cattle.
2. Groups line up facing each other.
3. Cattle group counts off by fives.
4. When the teacher calls "stampede ones," the ones in the cattle group take off running toward the fence.
5. When the cattle get near the fence, the teacher calls out "wood fence", "rock fence", or "barbed wire".
6. The fence responds by doing one of the following:
   - Wood Fence—Students on the fence team stand straight, side by side with arms at their sides.
   - Rock Fence—Students on the fence team stand side by side with their arms crossed in front of them.
   - Barbed Wire—Students on the fence team stand side by side with their elbows hooked.
7. The cattle try to get through the fence. Those who get through return to the cattle side. Those who don't get through join the fence.
8. After all the cattle groups have been called, reverse the teams.

Variation: In addition to running, cattle groups may be asked to walk, skip, hop, gallop, etc.

Get Along Little Dogies

Related Online Lesson: Hit the Trail

In the language of the American West, a dogie is a motherless calf. The origin of the word is unknown, but author Ramon F. Adams suggested it might have originated in the 1880s, when a series of harsh winters left large numbers of orphaned calves. The little calves, weaned too early, were unable to digest coarse range grass, and their swollen bellies "very much resembled a batch of sourdough carried in a sack." Such a calf was referred to as dough-guts. The term, altered to dogie according to Adams, "has been used ever since throughout cattleland to refer to a pot-gutted orphan calf." Another possibility is that dogie is an alteration of Spanish dogal, "lariat." Still another is that it is simply a variant pronunciation of dogie.

As I went a-walkin' one mornin' for pleasure,
I spied a cowpuncher come ridin' along;
His hat was thrown back, and his spurs were a-jinglin'
And as he approached, he was singin' this song.

Chorus:
Whoopee ti yi yo, git along, little dogies,
It's your misfortune and none of my own;
Whoopee ti yi yo, git along, little dogies,
You know that Wyoming will be your new home.

It's early in spring that we round up the dogies,
And mark 'em and brand 'em and bob off their tails;
We round up our horses and load the chuckwagon,
And then throw them dogies out onto the trail.

Repeat Chorus

It's whoopin' and yellinn and a-drivin' them dogies,
Oh, Lord, how I wish that you would go on;
It's a-whoopin' and punchin' and go on-a, little dogies,
Cause you know that Wyoming is to be your new home.

Repeat Chorus

Some cowboys go up the trail just for the pleasure,
But that's where they always go gettin' it wrong,
For nobody knows just what trouble they give us,
As we start a-drivin' them all the way home.

Repeat Chorus

Market Day

Monday morning is market day,
I go to the market for
One fish, for two fish,
And bring them back home to eat.

Monday morning is market day,
I go to the market for
Three eggs, for four eggs,
And bring them back home to eat.

Monday morning is market day,
I go to the market for
Five plums, for six plums,
And bring them back home to eat.

Monday morning is market day,
I go to the market for
Seven cakes, for eight cakes,
And bring them back home to eat.

Monday morning is market day,
I go to the market for
Nine pies, for ten pies,
And bring them back home to eat.

Monday morning was market day,
I went to the market to
Buy food, but ate it,
Now I've got a tummy ache.

Related Online Lesson:
Fresh from the Farm

Peanut Butter and Jelly

Watch the video at www.youtube.com/watch?v=7pRXGywEsdo

Related Online Lesson: Rooftop Sandwich

First you take the peanuts
And you crunch 'em,
You crunch 'em
First you take the peanuts
And you crunch 'em,
You crunch 'em

For your peanut, peanut butter
And jelly
Peanut, peanut butter
And jelly

Then you take the grapes
And you squish 'em,
You squish 'em
Then you take the grapes
And you squish 'em,
You squish 'em

For your peanut, peanut butter
And jelly
Peanut, peanut butter
And jelly

Then you take the bread
And you spread it,
You spread it
Then you take the bread
And you spread it,
You spread it

For your peanut, peanut butter
And jelly
Peanut, peanut butter
And jelly

Then you take your sandwich
And you eat it,
You eat it
Then you take your sandwich
And you eat it,
You eat it

'Cause its good, peanut butter
And jelly
Good, peanut butter
And jelly

First you take the peanuts
And you crunch 'em,
Then you take the grapes
And you squish 'em,
Then you take the bread
And you spread it,
Then you take your sandwich
And you eat it

'Cause its good, peanut butter
And jelly
Good, peanut butter
And jelly!

Picking Peaches

Related Online Lesson: Just Peachy

Tune: Frère Jacques

Picking peaches, picking peaches,
'Til we're done, 'til we're done,
Picking all the peaches,
Picking all the peaches,
'Til we're done, 'til we're done.

Climb a ladder, climb a ladder,
In a tree, in a tree
Hello, everybody!
Hello, everybody!
Look at me, look at me.

Making peach cobbler, making peach cobbler,
Swish, swish, swish, swish, swish, swish
Pouring the peach cobbler,
Pouring the peach cobbler,
In a dish, in a dish.

Eating cobbler, eating cobbler,
Yum, yum, yum; yum, yum, yum.
Eating all the cobbler,
Eating all the cobbler.
Now we're done, now we're done.

Run Berry Run

Berries spread by sending out runners (strawberries) or brambles (blackberries). Play this game to find out which is quicker (in your classroom, anyway).

- Divide the class into teams, one of Brambles and one of Runners.
- For each team, designate a "Mother Plant" to stand in the center, surrounded by three Runners or Brambles.
- Tie a piece of yarn loosely around the waist of the Mother Plant and around the waist of each Runner/Bramble.
- Arrange the other players on each team in three clusters of three (the baby plants) some distance from the Mother Plant.
- Provide all Runners/Brambles and baby plants with equal lengths of yarn to hold in their hands.
- Tie one end of the yarn held by each of the three Brambles/Runners to the yarn tied around the waist of the Mother Plant. Tie the other end to the yarn around the waist of each Bramble/Runner.
- When you call "Run, run, Berries," the three Brambles/Runners go to the clusters of baby plants, taking care not to break the yarn which connects Baby to the Mother Plant.
- As they make it to the Baby Plants, Brambles/Runners stand in the center of the Baby Plants while the Baby Plants each tie one end of his/her yarn to the yarn tied around the new Mother Plant's waist and then carry the other end of the yarn as far as they can to establish a new plant.

See the lesson Oklahoma's Berry Best for a diagram if you are having trouble picturing this.

The Cow

Robert Louis Stevenson

The friendly cow all red and white,
I love with all my heart:
She gives me cream with all her might,
To eat with apple tart.
She wanders lowing here and there,
And yet she cannot stray,
All in the pleasant open air,
The pleasant light of day;

And blown by all the winds that pass
And wet with all the showers,
She walks among the meadow grass
And eats the meadow flowers.

Related Online Lesson: Beautiful Bovine

The Turkey

This old road is hard and bumpy
Our new turkey's wild and jumpy.
Careful, driver, not so jerky
Or you'll make us spill our turkey.

Beans and Peas

Dry beans are produced in pods and belong to the family of plants called "legumes." The shape of the bean distinguishes it from other legumes like peas and lentils. Usually beans are kidney-shaped or oval, while peas are round, and lentils possess a flat, disk-like shape.

Have students sort a mixture of dried beans according to shape to determine if they are peas (round) or beans (kidney-shaped). Then play this game:

- Divide players into two equal lines, one called "Beans" and the other called "Peas."
- Have players stand about five feet apart, facing each other, on opposite sides of a center line.
- Behind each group of players and about 25 feet away, designate a goal line.
- When the game leader calls out "Beans", that group turns and runs toward its own goal line, with the Peas in pursuit.
- Any Bean tagged before crossing the line joins the other side. The action continues with the leader giving each side a fairly even number of chances to chase its opponents.

Related Online Lesson: Fields of Beans

Spud Stuff

Related Online Lesson: Powerful Potato

Green-Haired Potato
Using a big potato, scoop out a hollow in the top, and slice off the bottom so it will stand upright. Line the inside of the hollow with cotton balls. Stand the potato in a dish of water. Sprinkle alfalfa or grass seed in the hollow. Keep it watered, and within a few days the potato will sprout a head of hair. Give the potato eyes, ears and a nose with cloves or anything that will stick into the potato.

Potato Stamps
Cut a potato in half. Draw a letter or design on the cut side with a pencil. Then use a knife to cut away the portion around the design. The design will then be raised. Use the potato as a stamp.

Hot Potato
Everybody stands in a circle. Pass a potato around the circle to music. When the music stops the person holding the potato is out. Pretend the potato is very, very, very HOT.

Carve potatoes and float them like boats.

One Potato, Two Potato
Use this old counting chant: One potato, two potato, three potato, four, / five potato, six potato, seven potato more. / Icha bacha, soda cracker, / Icha bacha boo. / Icha bacha, soda cracker, out goes Y-O-U!

All players put their fisted hands together in a circle and one person starts the chant by tapping each fist in succession. When "Y-O-U" is said, the person whose fist is tapped puts that fist behind his/her back. Then the chant starts again with the chanter starting with the fist of someone else. As soon as one person has both hands out of the circle they are "It".

Tater People

There are those who say they will help but somehow just never get around to actually doing the promised help. They are called "Hezzie Taters."

Some people can put up a front and pretend to be someone they are not. They are called "Emma Taters."

Then there are those who love others and do what they say they will. They are always prepared to stop whatever they are doing and lend a helping hand. They bring real sunshine into the lives of others. They are called "Sweet Taters."

Some people never seem motivated to participate, but are just content to watch while others do the work. They are called "Speck Taters."

Some people never do anything to help but are gifted at finding fault with the way others do the work. They are called "Comment Taters."

Some people are always looking to cause problems by asking others to agree with them. It is too hot or too cold, too sour or too sweet. They are called "Agie Taters."

Why Do Beans Give you Gas?

Beans have complex sugars in them that can't be digested by human digestive enzymes. These sugars sail untouched through the upper intestine, only to be met in the lower intestine by hungry bacteria. The bacteria eat the sugar, and they give off gas.

As with many vegetables, the more beans you eat, the more your body will become adapted to them. Dietitians recommend introducing these foods to your diet a little at a time to give your body a chance to get used to them. You can also reduce gas by soaking and rinsing dry beans before cooking them. Fresh beans produce less gas.

Beans contain a higher percentage of protein than most other plant foods, but they need whole grains to make them complete. Whole grains contribute different amino acids than beans, but in combination they make complete proteins. Ancient people must have known this, since they always grew whole grains like wheat along with their legumes. The US Food and Drug Administration recommends that we include plenty of whole grains and legumes in our diets.

Ag Etymology

Horse of a different color

• Horses are registered at birth, and the registration includes a record of the horse's color. When a horse trades hands due to sale, the registration is also transferred. Sometimes the color recorded on the registration may not match the actual color of the horse, leading one to suspect the horse is not the one in the registration.

Horse sense

• Horses are intelligent animals. They demonstrate the ability to act sensibly and to avoid situations that might cause them harm such as taking a fall, hence, good common sense.

Charley Horse

• A Charley horse is the name for painful spasms or cramps in the leg muscles, typically lasting anywhere from a few seconds to a few hours. The term may date back to the 1880s and a horse named Charley that worked at Comiskey Park, the Chicago White Sox's baseball stadium. In those days, an old, retired horse was often called "Charley."

Long in the tooth

• The age of a horse can be roughly determined by examining its teeth, since a horse's gums recede as they age. The longer the teeth of a horse appear to be, the older the horse.

Ag Etymology

Mad as a wet hen
• Very angry

Don't put all your eggs in one basket
• Don't risk all you have on just one thing

Pecking order
• The way people are ranked in relation to each other

Walking on egg shells
• Behaving in a careful manner so as not to offend someone

Egg on
• Urge someone on

Like a chicken with its head cut off
• In a hurried or disorganized way

Egg on your face
• Embarrassed

Egg head
• An intellectual

Golden egg
• Great profit

Spring chicken
• A young woman

Related Online Lesson:
A Lucky Break

Kerr Center's 2011 Sweet Potato Variety Trial

George Kuepper, Horticulture Program Manager
Luke Freeman, Horticulture Program Assistant

KERR CENTER FOR SUSTAINABLE AGRICULTURE
POTEAU, OKLAHOMA
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Kerr Center for Sustainable Agriculture, Poteau, Oklahoma

2012

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Background

In 2010 the Kerr Center received a Specialty Crop Grant from the USDA Agricultural Marketing Service (AMS), through the State of Oklahoma, for a 3-year project investigating and demonstrating small-scale heirloom sweet potato growing. Our goals include identifying appropriate-sized equipment, small tools, varieties, and organic growing practices suitable for the region's market farmers and gardeners.

In 2010, we identified most of the production practices we would use in subsequent trials and demonstrations. We also planted a small heirloom cultivar planting to familiarize ourselves with the great variation among sweet potato types. Information on this trial has been published as *Heirloom Sweet Potato Varieties: A Preliminary Look* in 2010. It is available on the Kerr Center website at www.kerrcenter.com.

In 2011 we followed with a more thorough, replicated variety trial to test more heirloom varieties. This is our report on that trial.

A Few Facts about Sweet Potatoes:

The sweet potato *(Ipomoea batatas)* is a New World crop, native to the tropics. It is a member of the morning glory family (Convolvulaceae), whose edible portion is a true root. The white or "Irish" potato, by contrast, is a member of the Solanaceae family, which includes tomatoes, peppers, and eggplant; the edible portion of the white potato is actually a tuber or fattened rhizome, which is an underground stem. That is why white potatoes turn green when exposed to light. Though sweet potatoes are sometimes called yams, they are not related to true yams, which belong to the genus *Dioscorea*. True yams are not grown commercially in the United States.

The sweet potato most American gardeners and consumers are familiar with has moist, orange flesh, with red or orange skins. However, there are also dry-fleshed varieties, and flesh and skin colors can vary widely. Yellow, white, purple, and red are among the many colors.

Sweet potatoes are often referred to as a perfect food or "super food." They are "high in fiber, Vitamin A, Vitamin C, Vitamin B6, potassium and manganese. Sweet potatoes can help stabilize blood sugar, making them a good choice for diabetics." They are also low in calories - approximately 95 calories each. [1]

Sweet potatoes are increasingly popular in American diets. This is only partly due to their food value. Interest is also due to their being prepared and served as snack chips and french fries - relatively modern culinary innovations. Upscale manufacturers of pet foods are also including sweet potatoes in some of their dog food formulations.

Another factor that increases interest among gardeners and small farmers is the potential of the sweet potato as a resilient food crop for the uncertain climatic times ahead. Sweet potatoes are heat and drought tolerant, most varieties store easily and, with a little care, "seed" stock can be carried over year-to-year. Yields on good soils can be enormous and satisfying.

The Kerr Center 2011 Sweet Potato Trial:
Location and Methods

We located the sweet potato trial at the Cannon Horticulture Project on the Kerr Center Ranch. The Project was established in the fall of 2007 and achieved certified organic status in June 2011. The Cannon site features a loam soil with moderately-poor drainage. Savvy growers know that this is not good soil for sweet potatoes, which do best in light, well-drained sandy loams. However, the Cannon site has organic matter levels around 3.1% and an ideal pH, which ranges from 6.6 to 7.0. While native phosphorus and potassium levels on these soils are low, compost applications in 2009 improved the phosphorus status considerably, and the potassium moderately.

The previous crop in 2010 was a blend of annual sorghums, with a small amount of buckwheat and southern peas as green fallow. It was followed by a winter cover crop of grain rye and crimson clover. The plot was prepared for ridge-planting using a BCS tiller with hiller-furrower attachment, providing 5-foot row-spacing - a bit wide for commercial production, but well-suited to our evaluation process.

We transplanted ten of the twelve trial varieties (Okinawa Purple, Nancy Hall, Dianne, Hernandez, Oklahoma Heirloom, Bunch Porto Rico, Southern Delight, Georgia Jet, Sumor, Carolina Ruby) on May 31st. Two varieties (Japanese Red and Carolina Nugget) were slow at producing slips and were not transplanted until June 13th. Each plot was 20 feet long with 20 plants on 1-foot spacing. The plots were replicated three times.

We provided supplemental drip irrigation as needed, which was more than usual in the hot and dry season that ensued. No foliar diseases were observed. Striped blister beetles did minor damage in late summer. The pest was suppressed through spot spraying with a combination of pyrethrum, neem, and d-limonene. Weed pressure was light due to the preceding green fallow crop in rotation. Weeds that emerged were managed using wheel hoe cultivation and hand-hoeing.

Luke Freeman with recently-harvested sweet potatoes

Because planting in 2011 was timely, none of the varieties exhibited the heat stress shown in 2010, though this season's growing conditions were decidedly worse.

Harvesting was done on three consecutive days beginning September 27th. We began lifting the roots using a moldboard plow, but found hand-digging with a spading fork more efficient. Marketable roots were harvested, cured, and weighed.

Yield Performance Summary

Despite the harsh summer growing conditions (one of the hottest and driest on record), most varieties performed well in 2011– better, in fact, than 2010, when conditions were somewhat better. This might be explained by our luck in choosing some better cultivars, but also by the fact that planting was more timely. However, one variety - Okinawa Purple - failed completely in 2011. We were reminded that this is a long-season type. Apparently, it requires a much longer season!

Guidance for judging commercially viable yields varies. Oklahoma State University suggests that 300 bushels of #1 grade potatoes qualifies as a good yield. [2] The University of Missouri suggests a yield of 400 bushels is respectable, but does not specify grade. [3] The University of California recorded average yields over three years of 420 bushels, grade not specified. [4] We did not attempt to grade our potatoes, but are satisfied that our top yielding varieties - Hernandez, Dianne, Oklahoma Heirloom, Sumor, and Bunch Porto Rico - provided good commercial yields. Moderate producers, such as Georgia Jet, Japanese Red, and Nancy Hall, may also have hit the mark.

Our varietal yield assessments are shown in the table, above. Listing is in order of final yield from top to bottom.

VARIETY	YIELD ASSESSMENT
Hernandez	Very High
Dianne	Very High
Oklahoma Heirloom	High
Sumor	High
Bunch Porto Rico	High
Georgia Jet	Moderate
Japanese Red	Moderate
Nancy Hall	Moderate
Carolina Nugget	Low
Southern Delight	Low
Carolina Ruby	Very Low
Okinawa Purple	Failure

Taste Testing

In direct markets, flavor and texture become as important as appearance and price in driving sales. Recognizing this, as well as the demands of our own salivary glands, we held an informal test among Kerr Center employees. After "suffering" through the tasting process, our staff provided the following ratings.

RANK	TASTE	TEXTURE
1	Bunch Porto Rico	Oklahoma Heirloom
2	Oklahoma Heirloom	Bunch Porto Rico
3	Georgia Jet	Georgia Jet
4	Sumor	Sumor
5	Hernandez	Hernandez
6	Dianne	Dianne
7	Southern Delight	Carolina Ruby
8	Nancy Hall	Southern Delight
9	Carolina Nugget	Carolina Nugget
10	Carolina Ruby	Nancy Hall
11	Japanese Red	Japanese Red

Organoleptic sweet potato evaluation at Kerr Center

The following photos were all taken by Luke Freeman during the 2011 season. Pictures of the roots were taken following curing and are representative of the variety's general color, size and shape, though there was often considerable variation within a single cultivar.

In addition to our own observations, accompanying descriptions are drawn from sales literature provided by Duck Creek Farm, George's Plant Farm, and Sand Hill Preservation Center, and publications by Oklahoma State University, the University of Arkansas, and other extension services.

Bunch Porto Rico

90-100 Days. Bunch Porto Rico is a compact, bush type sweet potato that produces most of its roots in a central bunch right under the primary stem. Its vines are very easy to detach, making the variety easy to hand harvest. The roots are small to medium in size, with light yellow to gold colored skin at harvest time. The meat is cream to orange in color. Bunch Porto Rico ranked fifth in yield out of the twelve trial varieties. It was voted the best tasting sweet potato by the Kerr Center staff. This is a great garden sweet potato, especially where space is limited.

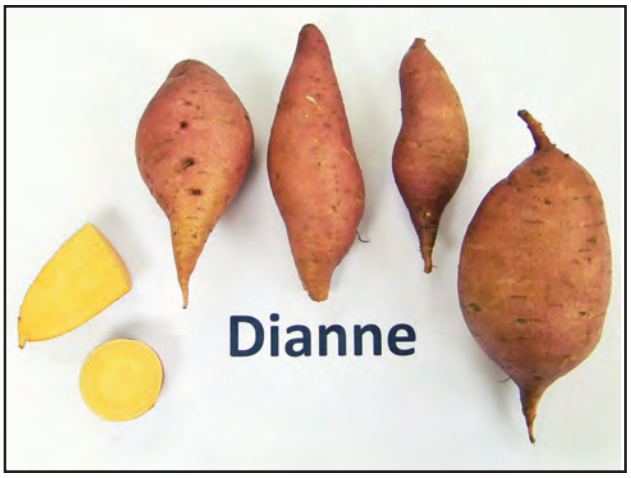
Variety evaluations at the Kerr Center, including our sweet potato trials, focus mainly on heirloom or heritage varieties. As we have learned, however, one person's heirloom might be another's contemporary cultivar. This is certainly true of several selections we planted in 2011, including Bunch Porto Rico. It remains on several lists of recommended varieties, including, for example, that published by Purdue University. [5] It is widely available from several plant sellers.

Carolina Nugget

Developed in North Carolina, Carolina Nugget produces small to medium sized roots that tend to be blocky and veined with rosy skin and orange flesh. Streaks of anthocyanin usually appear in flesh near exterior of roots. Leaves have an interesting deeply cleft shape, and the variety shows resistance to fusarium wilt and southern root knot. This variety purportedly yields well and produces superior root shape in heavy soils, but it did poorly in our trial. It also ranked low in our taste test.

Carolina Ruby

80-90 Days. Carolina Ruby is a mid-season variety developed by North Carolina State University. This variety puts out vigorous vines and grows medium sized, ruby-red skinned roots with flesh color usually described as deep orange. It is considered susceptible to root knot nematodes, but resistant to fusarium wilt and soil rot. However, we noticed several instances of soft rot at harvest. Carolina Ruby performed quite poorly for us.



Dianne

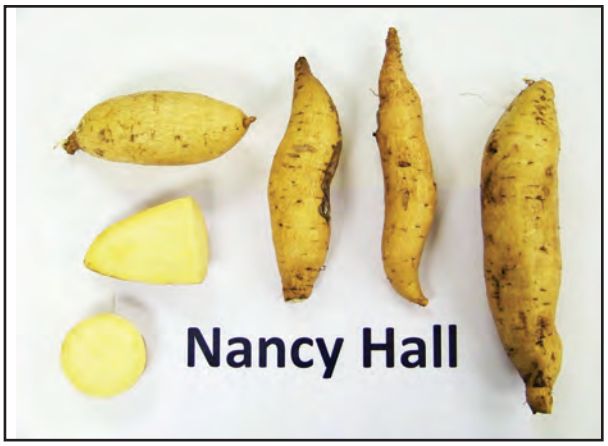
Dianne produces beautiful, red-skinned, medium-to-large roots with flesh often described as deep orange. Roots vary from long and slender to short and blocky. Vigorous vines have fat stems and interesting, deeply cleft or "spiky" leaves. It is a fine baking sweet potato, with acceptable taste and texture. Dianne was also in our 2010 demonstration planting. It performed exceptionally well both years and is certainly to be recommended.

Georgia Jet

80-90 Days. Georgia Jet is an early, vining sweet potato that produces medium to large sized roots with light red skin and light orange flesh. It is not uncommon for this variety to produce several large roots per plant. Susceptibility to stem rot, nematodes, and cracking is mentioned in sales literature. Like Bunch Porto Rico, Georgia Jet remains a popular recommended variety in several states and regions, including Arkansas. [6] Overall, Georgia Jet performed well in the Kerr Center trial. It was also a tasty favorite among our staff, though it can cook up a bit mushy.

Hernandez

115-120 days. Hernandez is a mid-season variety that was developed by the Louisiana State University Agricultural Experiment Station breeding program. It produces vigorous vines and small to large roots with dark orange skin and deep orange flesh. Hernandez resists fusarium wilt and southern root knot nematodes; it has moderate resistance to soil rot and white grubs. It was the top yielder in both the 2010 and 2011 Kerr Center trials, and is highly recommended. The roots are reported to have excellent baking, canning, and storage qualities, tending to be moist when cooked. Kerr staff found its taste and texture good but not exceptional. This variety is recommended by the University of Missouri. [3]



Nancy Hall

110 Days. Nancy Hall is an old-time favorite, mentioned in a 1936 publication by George Washington Carver. [7] It produces roots with cream-colored skin and cream-to-yellow flesh that store well. Nancy Hall is sweet when baked, but has a much drier texture than orange-fleshed sweet potatoes, which elicits mixed reactions at the dinner table. It was a low-to-moderate yielder in the Kerr Center trial, and remains a recommendation of the University of Arkansas. [6]

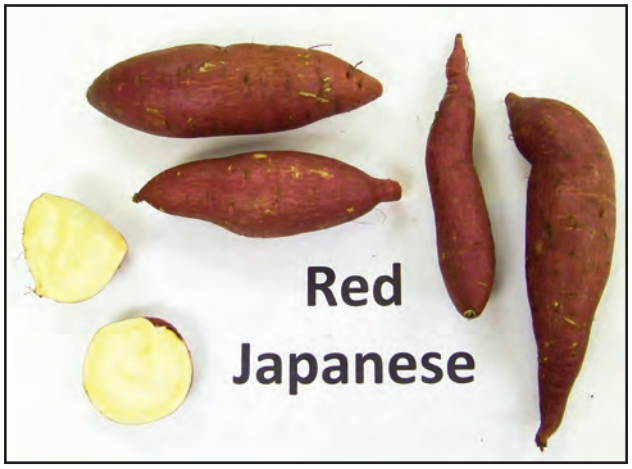
Okinawa Purple

140 Days. Okinawa Purple is a late season Asian type sweet potato, also called "Okinawan." It produces roots with deep purple flesh and light beige skin. Okinawa is very sweet when cooked and has a dry texture. Special health benefits have been attributed to this sweet potato, including their contribution to the longevity of women living on the island of Okinawa. [8] This reputation and its beautiful coloring have led to growing consumer interest.

Okinawa Purple is a very light and inconsistent producer in this region, apparently because of its need for a very long season. It did poorly in 2010 and suffered crop failure in the 2011 Kerr Center trial. Because of market potential, however, we plan to grow it again.

Oklahoma Heirloom

Oklahoma Heirloom is a true heritage variety that came from Ralph Mills of Beggs, Oklahoma, who had been growing the variety for 30 years since receiving it from a neighbor in Colgate. It may have originated from another heirloom variety called Mahan, which is similar in appearance. Oklahoma Heirloom has compact vines and produces roots in a cluster under the primary stem. Its roots are orange-fleshed and moist, with a long storage life. Production is typically early and heavy. This variety performed very well in the Kerr Center trial and was a favorite in our taste test.

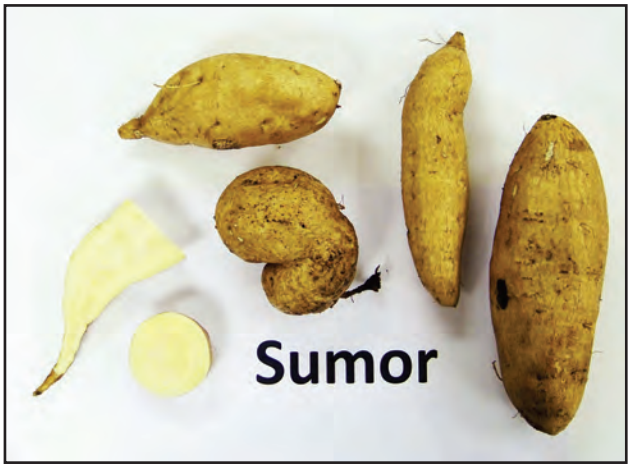


Red Japanese

110 Days. Red Japanese is an Asian type vining sweet potato. It produces long, medium sized roots with deep red or purple skin and ivory flesh. This variety is resistant to fusarium wilt, but susceptible to root knot nematode and russet crack. It is also susceptible to soil rot, which we observed at harvest. Red Japanese is sweet and has high dry matter content. However, it ranked low in the taste test. In the Kerr Center trial, Red Japanese was a moderate producer.

Southern Delight

Developed by South Carolina in 1986, Southern Delight produces small to medium sized roots that have deep orange flesh and rose-to-copper colored skin. It is resistant to a wide array of disease and insect pests, and has the potential to be a heavy producer. However, it performed very poorly in the Kerr Center trial. It is said to have excellent baking flavor, but ranked mid-level in our taste test.



Sumor

Sumor is an early, vining variety developed by Clemson University in South Carolina in 1984. It produces small to medium sized roots with cream white skin and white flesh. Sumor performed very well in the Kerr Center trial. It has a high dry matter content and can be a good substitute for the Irish potato in very hot regions. It was well-favored in our staff taste test.

Summary Conclusions

We feel confident from our trials that at least five varieties - Hernandez, Dianne, Oklahoma Heirloom, Sumor, and Bunch Porto Rico - are to be recommended for our area, though site-specific conditions of soil type, fertility, drainage, and other conditions can lead to individually different results.

Kerr Center's investment in studying sweet potatoes is more than justified. Not only is the sweet potato widely recognized as a close-to-perfect food, the reliable performance of so many varieties under the harsh growing conditions of 2010 and 2011 supports our view that sweet potatoes are one of the most resilient and survivable vegetable crops that one can grow in our region.

Locating Heritage Planting Stock

DUCK CREEK FARMS
(Gary Schaum)
P.O. Box 303
Mounds, OK 74047
918.827.6455
www.duckcreekfarms.com

Duck Creek Farms has served as our main source for planting stock for both the 2010 and 2011 seasons. Exceptional selection of heritage varieties.

GEORGE'S PLANT FARM
1410 Public Wells Road
Martin, TN 38237-5618
731.587.9477
www.tatorman.com

We have used George's Plant Farm mostly for popular contemporary varieties. However, they also stock several heirlooms. Slips are high quality and service is reliable.

SAND HILL PRESERVATION CENTER
1878 230th St.
Calamus, IA 52729-9659
563.246.2299
www.sandhillpreservation.com

An excellent and extensive selection of heirloom varieties; as of the 2012 season, Sand Hill has certified organic stock available.

STEELE PLANT COMPANY
202 Collins St.
Gleason, TN 38229
731.648.5476
www.sweetpotatoplant.com

A reputable source for new and other contemporary varieties; also sells a few heirlooms

NEW HOPE SEED CO.
P.O. Box 443
Bon Aqua, TN 37025
www.newhopeseed.com

Contemporary and heirloom varieties

LEGGETT FARMING PARTNERSHIP
P.O. Box 376
Nashville, North Carolina 27856
252.467.2776
www.leggettfarming.com

Covington and Beauregard varieties; some stock is certified organic.

See back of title page for End Notes/References.

Cost Effective Specialty Mushroom Cultivation

USDA Specialty Crop Research Grant Report 2009-2012

Prepared By: Jaclyn Morton
with Om Gardens Mushroom Farm

Special Thanks to Steve Morton,
Richard and Sharon Hewitt,
Tod and Jamie Hanley
Dedicated to Richard Hewitt 1948-2011

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Why Grow Mushrooms?

Shiitake Mushrooms

Mushroom farming fits well into a permaculture farming system. Mushrooms complete a cycle of decomposition and regrowth, breaking down agricultural waste products, and producing both food and high quality compost. The high profitability of mushroom farming also makes it attractive to farmers. Fresh specialty mushrooms are a gourmet food in the United States, fetching between $8 and $60 per pound! Because of the fragility of fresh mushrooms, their short shelf life, and cold storage temperature, it makes the most sense to grow mushrooms as close as possible to the markets where they are sold. It would be nice to see many small scale mushroom farms growing just enough to supply customers within a 30-50 mile radius. The quality of fresh mushrooms with a short farm-to-consumer chain is astronomically better than those shipped long distances and handled by multiple people and can therefore fetch a higher price.

Cultivation of specialty mushrooms is a relatively new field in the United States. In other countries, especially the Far East, outdoor cultivation is popular and makeshift temporary structures are used to extend the growing season. In the US mushroom farming is most often done year-round in large scale concrete or insulated metal buildings, or underground in existing cave systems. The expense and complexity of designing and building these structures make start-up and small-scale mushroom production difficult.

We have developed an affordable system for the small scale farmer to grow an easily manageable quantity of mushrooms for a one to two person operation. It would fit nicely into a market garden business with 3 or more workers. We also include instructions for adding a temperature regulated green house that operates off of the exhaust from the mushroom building. The compost and waste water from the mushroom operation could both be used to grow vegetables in a green house or outdoors.

We highly recommend that anyone thinking about growing mushrooms on this small of a scale combine it with vegetable production, agritourism, or some other business that takes advantage of the inputs and outputs of the mushroom growing process, as it provides many opportunities for additional profit and stability. We also recommend that mushroom farmers work together on a regional scale. Producing mushroom inoculant requires the use of a fully functional laboratory. Not every farmer will have the time, money, and space to operate their own lab, so having one lab in each state or region producing inoculant for several other farms would be very advantageous.

Mushroom farming is extremely finicky, as is running a small business. Read plenty of books about mushroom farming and business management before attempting anything in this booklet. This is not an instruction manual for growing mushrooms; please read most, if not all of the publications referenced in this booklet.

What You Need to Grow Mushrooms

Space

Growing Medium Storage – Raw materials should be kept in an area relatively free of contamination. Some materials can be stored outside, but need to be as far away from the exhaust from the growing rooms and compost as possible.

Inoculation Area

Sterilization or Pasteurization Area – A well-ventilated area with plenty of room for sterilization or pasteurization equipment and room to maneuver carts.

Inoculation Room – A clean-room with HEPA filtered air intake and enough room for equipment and workers to maneuver, but small enough to easily sterilize.

Incubation Chamber – A room adjacent to the fruiting chamber with controlled temperature, humidity, and fresh air intake. Some or all of it may be lit or may need complete darkness depending on the type of mushrooms.

Fruiting Chamber – A room with controlled temperature, humidity, and fresh air intake. It may need ample lighting, depending on the type of mushroom.

Preparation Space – A table with room to weigh, sort, and package mushrooms. Nearby storage for coolers and packaging.

Product Storage – Commercial refrigerators or a walk-in set at 38 degrees Fahrenheit.

Compost Area – An area away from the growing medium storage and growing rooms where the spent materials can break down. Mushroom compost can be combined with vegetable compost or animal excrement to produce great finished compost.

Growing Chambers

Materials

Mixing Sawdust with Grain

Growing Medium - Mushrooms grow on a variety of materials including but not limited to sawdust, logs, straw, compost, manure, and grain. These materials should be collected and prepared as close to the time of use as possible. Be very careful to get the correct type and quality of materials. For instance many mushrooms that grow on sawdust must have 100% hardwood; red cedar sawdust will kill most mushrooms.

Nutritional Supplements – Grain, bran, nutritional yeast, and minerals are a few things commonly added to the growing medium. Keep them in sealed containers.

Spawn – Spores are commonly started in grain, and then the grain is mixed with the growing medium to inoculate it. There are currently very few companies that supply grain spawn to small growers. You can create your own spawn from spores, but you will need a clean room and lab equipment.

Growing Containers – Unless you're growing on logs or whole bales of straw, you will need plastic bags, trays, jars, or some other type of container that can be sealed for incubation.

Clean Water – You'll need water to sterilize/pasteurize, humidify, water growing mushrooms, and clean the rooms. If you have high calcium or chlorine levels you may want to filter the water to protect equipment and the mushrooms.

Sanitizers - Vinegar, alcohol, peroxide, or iodine. No chlorine for organic production.

Pest Controls - Fly strips are the best defense against the non-microscopic pests. Frogs don't seem to negatively affect mushrooms. It would be interesting to try taking out the fly strips and adding praying mantises and frogs to see if a natural balance can be found.

Selling - Restaurant boxes, clamshells, paper bags, plastic bags, product labels

Clamshell Packaging

Equipment

Custom filling table, Hose, Scale, and Sterilizers

Transporting - Truck and trailer(open top, preferably dump trailer for growing medium and compost, a different liner can be used for each to keep the bed clean) For larger operations a refrigerated trailer for mushrooms might be prudent, but coolers with ice packs work well for short distances.

Growing Medium Prep - Shovels, Wheel Barrows(separate ones for growing medium and compost), Plastic Tubs and/or buckets, Hose with sprayer, a scale

Sterilizing or Pasteurizing – 48 Quart sterilizers for grain spawn and growing on sawdust or grain, electric or gas burners, pots or barrels for pasteurizing straw or compost.

Cold Storage – Separate refrigerators for inoculant and harvest.

Inoculating – Laminar flow hood, scale, lab coat, lab gloves, spray bottle, paper towels, bag sealer if using bags.

Growing – Shelves, scissors, mushroom storage tubs, scale, clipboards and paper.

Cleaning – Rags, hose with sprayer, brooms, mop and bucket.

Selling – Coolers, display tubs, ice packs, scale, money box.

Homemade Laminar Flow Hood

Time Commitment

Material Acquisition – Driving to a mill to get sawdust or picking up a load of logs or straw can take an entire day, usually once every two weeks to a month. Other materials can be procured either at a local store or shipped to your door. Be careful to limit trips to the store. Running back and forth every time you need a light bulb can become your biggest time and money waste. (approx. 4 hrs/wk)

Note: These are very rough approximations of the amount of time it might take to maintain a single grow room built out of a refrigerated semi –trailer, just to give you an idea.

Growing Medium Prep – Preparing the medium and pasteurizing or sterilizing can take 2 hours of labor per batch, then waiting several hours while it cooks. If you do two batches per day, expect to spend 3 to 4 days per week preparing enough to fill one grow room. (approx. 12 hrs/wk)

Inoculating –Inoculating one batch takes about half an hour. (approx. 4 hrs/wk)

Tending – Moving containers around, watering, and dealing with pests takes about an hour per day, 7 days per week. (approx. 7 hrs/wk)

Cleaning – Every room needs to be thoroughly cleaned at least weekly. The inoculation room needs to be sterilized every day. The refrigerators need to be cleaned out and wiped down with sterilizer weekly. Shelves need to be wiped down every time they are emptied. (approx. 5 hrs/wk)

Harvesting – Harvesting must be done at least once per day, every day, better once in the morning and once in the evening. Each harvest varies in size but expect an hour each day. (approx. 7 hrs/wk)

Steve Morton Tending Shiitake

Packaging – Preparing the mushrooms to sell is extremely time sensitive. Mushrooms should not sit in the fridge for more than 2 days before they are delivered to a store, where they should not be kept for more than 5 to 7 days. Some mushrooms degrade even faster, others last as long as two weeks. Some mushroom farmers partially dehydrate the mushrooms before sale to increase shelf life. Dried mushrooms last for months, but drying should be done in a commercial kitchen. (approx. 4 hrs/wk)

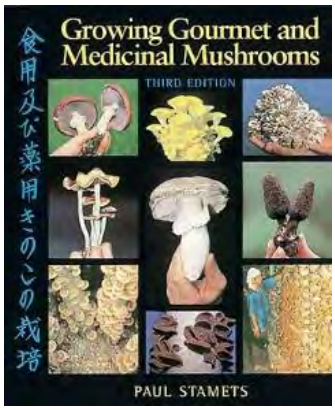
Selling – If you sell at a farmers market you can make much more money, but it takes most of a day and you still have to tend and harvest! At the least you must contact buyers and deliver regularly. (approx. 5-10 hrs/wk)

Accounting – Don't forget about this part! Records need to be kept for materials and inventory as well as money. (approx. 3 hrs/wk)

Total Time Commitment: Approximately 50-60 hours per week

Knowledge and Experience

Books - **GROWING GOURMET AND MEDICINAL MUSHROOMS** by Paul Stamets is a must have book, **THE MUSHROOM CULTIVATOR: A PRACTICAL GUIDE TO GROWING MUSHROOMS AT HOME** also by Paul Stamets is also very helpful. If you're growing Shiitake, **SHIITAKE GROWERS HANDBOOK: THE ART AND SCIENCE OF MUSHROOM CULTIVATION** by Paul Przybylowicz or **GROWING SHIITAKE COMMERCIALLY: A PRACTICAL MANUAL FOR PRODUCTION OF JAPANESE FOREST MUSHROOMS** by Bob Harris are both good. Ongoing research is required to stay on top of new methods and strains. Search online for articles and keep up with the websites and blogs of top growers.



Read This

Take a workshop or intern with a mushroom farmer – Paul Stamets with Fungi Perfecti has regular workshops.

Test the waters – Try ordering a kit and growing a few mushrooms by yourself. Try growing several different ways, inoculating your own logs, buying bags online, or even inoculating a jar full of grain with a syringe of spores. Kits are easily available online. If you're in Oklahoma, Lost Creek Mushroom Farm sells shiitake logs.

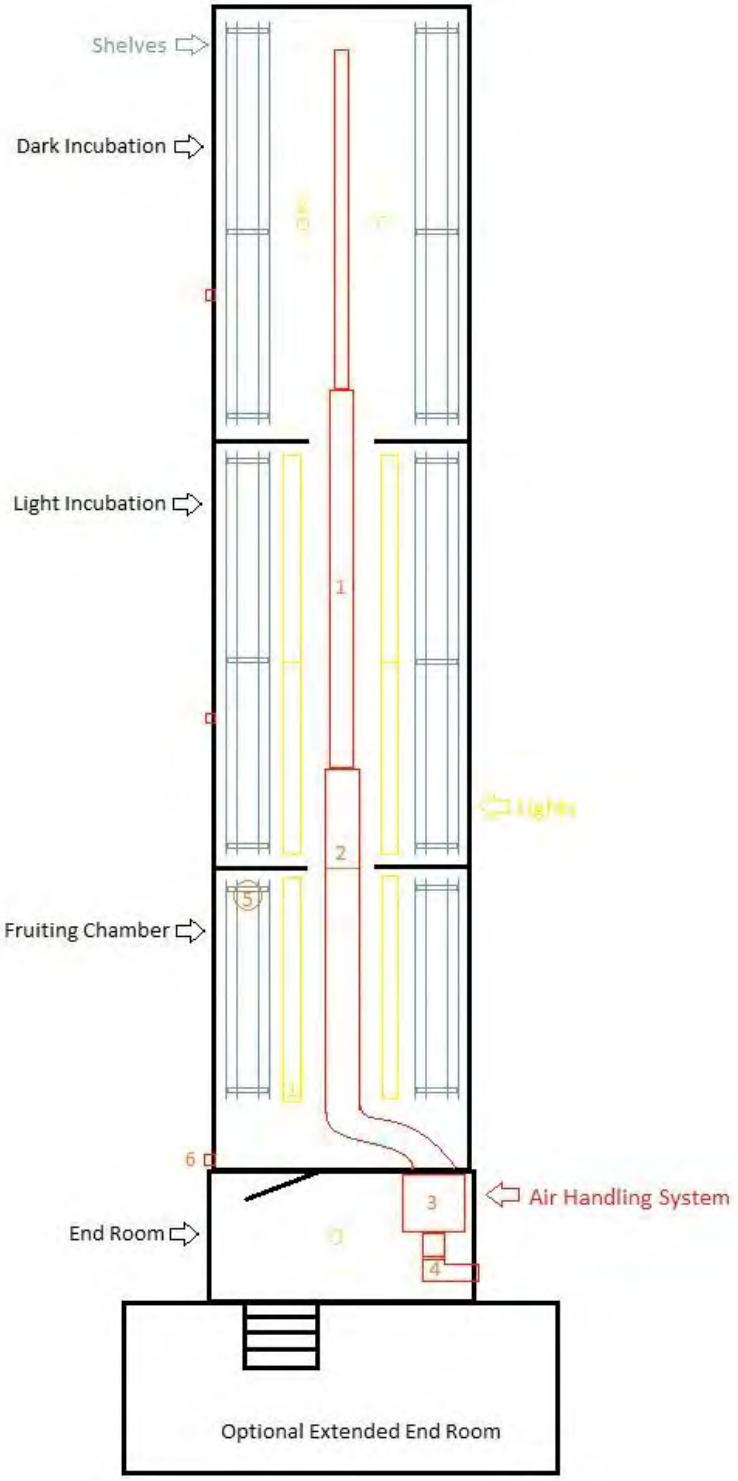
Research the market – Make sure there is an ample market in your area for the amount of mushrooms you will be producing. With one grow room this size you will produce about 50 to 75 pounds of mushrooms each week. You may be able to sell 10 to 20 pounds at a busy farmers market. Restaurants and Grocery stores typically order 5 to 10 pounds per week. Do you have two to three busy farmers markets and several restaurants and grocery stores who will want the type of mushrooms you are growing? Visit your local farmers markets and talk to chefs at fine restaurants and the produce managers at local grocery stores to line up buyers BEFORE you get started growing.

Research small business management – Talk to your local Small Business Development Center and read a basic business management book before you get started.

Farmers Market Setup

How to Build a Mushroom Farm in a Reefer Trailer

Diagram



Separating Wall

End Wall, Duct, Lights

End Room

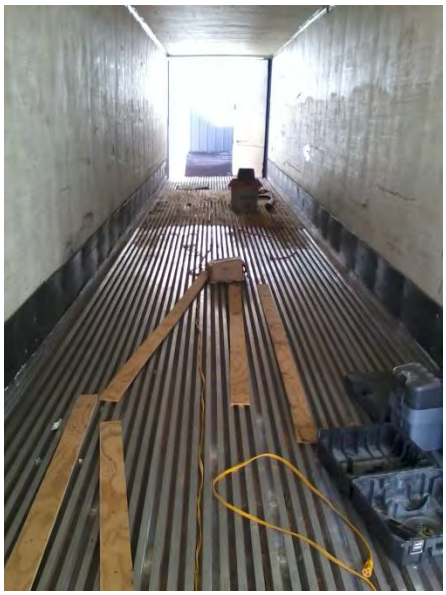
Costs

Description	Source	Low-end Cost	High-end Cost
Used Insulated Semi Trailer	Semi Trailer Resaler	$3,000	$4,000
Building Materials	Building Supply Stores	$1,000	$3,000
Construction Labor	Building Contractor	$500	$2,000
Electrical Materials	Building Supply Stores	$500	$1,000
Electrician	Certified Electrician	$2,000	$3,500
HVAC Supplies and Labor	HVAC Contractor	$3,000	$3,500
Lights	Building Supply Stores	$400	$600
Plumbing Supplies	Building Supply Stores	$100	$200
Plumbing Labor	Plumber	$400	$600
Shelving Materials	Building Supply Stores	$1,350	$1,500
	Total Costs:	$12,250	$19,900

Instructions

1. **Design your structure and get a building permit** - If you are within city limits you will need a building permit from your city and you must follow building codes no matter where you are. Bring your design sketches to your city or county code office and they can help you make any needed alterations. You will have to install electricity, plumbing and HVAC, so that very much puts you in the realm of codes and permits. You may be able to get more lenient codes if you describe it as a green house. Keep in mind that if you ever want to be able to give people a tour of your farm you will need liability insurance so you have to be up to code and safe. It is better to follow codes in the first place than have to re-do everything.

48' Insulated Trailer



Inside of Trailer, FRP and Aluminum Floor

2. **Purchase a used 48' or 53' insulated semi-trailer** Get one that is in reasonably good condition, but without the refrigeration unit. The refrigeration unit is the most expensive part of these reefer trailers, so if you can find a used one without the unit, it should be very cheap. It is possible to use a shipping container and bury or insulate it, but the

cost of shipping containers is going up all the time and reefer trailers are already insulated, making things much easier. You want to be sure the roof doesn't leak and the floor doesn't have holes in it. Other minor holes and dents can be fixed. You'll be taking off the big swinging doors, so don't worry if they're broken. We decided to use a reefer trailer as the body of the grow rooms because they are just the right shape and size and very inexpensive for the square footage. The FRP (Fiberglass Reinforced Plastic) that lines the inside of the walls is the perfect cleanable material and the aluminum floors are made to be sprayed off and have holes in the corners for drainage. The trailer itself should cost between $2,500 and $3,500, but getting it delivered can cost as much as $1,000, depending on how far you are from the dealer.

3. **Place the trailer** - Figure out where the wheels and supports will be and pour a concrete slab at ground level for the supports to rest on so they don't sink. It is possible to hire a towing service to pick the trailer up and then use a blow torch to cut off the wheels and supports and set it back down, but that is quite a pain and increases the cost, not only of placing it initially, but of moving it if ever you decide to. It is a trade-off because the wheels raise the height of the floor substantially, meaning you have to build your end room up on stilts and build stairs or a long ramp to get in and out. It's up to you, consider that you could put a skirt around the bottom and use that area for storage. It also makes it easier to get underneath it for plumbing. Be sure that the semi-truck is able to get in and out and maneuver in the area. With the cab, you're looking at a 60-70' truck that weighs many tons. Muddy or sandy soil can cause it to get stuck. Low hanging tree limbs can get in the way. The driver may have to maneuver around to get it in the right place, try to make it easy on him.

Wheels and Supports

Semi-Truck backing into position

4. **Alter and fix up the trailer** - Take off the large swinging doors, you will frame a new doorway, but wait until you know exactly where the HVAC parts are going first. Close up and insulate the hole where the refrigeration unit was. Patch any holes on the inside or outside, silicone caulk or putty works fine for the walls. Roof leaks can be difficult to patch. I think gluing down a large piece of pond liner with contact cement works better than painting on tar. You could go all out and line the entire top with pond liner, build little 6 inch walls around the edges and fill it in with dirt for a rooftop garden, after everything else is done, of course. You will need to split the trailer into two or three separate rooms. Research the types of mushrooms you will be growing and see if they need light while they are incubating or not. You will need to know exactly how much of each type of mushroom you will be growing, how much space your containers will take up for how long, and the total amount of space you have in order to figure out where your walls need to be. There is a big difference between the space needed to grow Shiitake and the space needed to grow Reishi, so you have to know ahead of time what you will be growing. You have to know this for the spacing of the lights, length of the shelves, and where to put the damper between the fruiting and incubation rooms for the temperature difference, so be sure you have your math right. The wall between the fruiting and incubation rooms can be somewhat insulated, like the picture in the Diagram section, but it's only about a 10° difference and you want to be able to move between rooms easily, so the door can be a slit curtain. If you want, the walls can be made out of used vinyl banners and a simple crease in the middle, maybe with magnets to hold it together will suffice. It just depends on how nice you want it to be and how much money you can spend.

Strip curtain in doorway between fruiting chamber and incubation

5. **Build your end room** - Depending on how much space you need, the end room can vary a lot. You will need substantial space other than the grow room for sterilization or pasteurization, inoculation, spawn, product and material storage. You can use an existing shed or garage, or you can simply build a larger end room to accommodate all of these functions. You may even want to buy a second reefer trailer and connect the two with a small entryway. We assume you are doing this near an existing building that can accommodate at least some storage, but if it not, expect to spend a bit more on your end room. You at least

Stick Frame End Room

need enough space in the end room to put the heating and air system and to create somewhat of an air lock so contaminants aren't sucked into the grow room every time you open the door. If you're putting product storage or your inoculation area in the end room, insulate it and include a window air conditioner and heater. The simplest way to build the end room is stick frame construction with corrugated metal panels on the roof and walls. Metal doors are one of the most expensive components, so don't include extras unless you have to. The floors can be plywood that you cover with tile or vinyl flooring or just paint with polyurethane. We covered the inside of our walls with used vinyl billboard banners, the backs are white and it makes a fine, cheap covering.

6. **Install HVAC system** – You'll need to hire a professional HVAC contractor to meet code requirements and have access to equipment that is not typically sold to the general public. Many HVAC contractors don't want to install equipment that they don't supply. Be sure to hire a contractor who is reliable and willing to work with you to design something outside of the norm. Referring to the diagram on page 11, you'll need ducting down the length of the building from the air handling unit, decreasing in size and capped off at the far end[1]. Rather than spending a lot on directional vents, you can simply punch 1"-2" diameter holes in the ducting along the sides or on the bottom. The goal here is to minimize air turbulence, so use plenty of holes and point them so they don't blow on the mushrooms. You will need an electric damper between the fruiting chamber and incubation rooms that is connected to a thermostat[2]. This is so you can use the same air conditioning unit but keep the incubation rooms about 10° F warmer. You'll also need a heating element in the duct just behind the damper to heat incubation more in the winter. The heating element can also be controlled by the incubation thermostat. You will need an air handling unit[3] big enough to fit a micron filter, which can be 4 to 6 inches deep and 2'x2', though they come in other sizes. You'll need a pre-filter as well which can slide in behind the return vent. You need these filters because mushroom spores will clog the coil and ducts, creating a slimy layer that can grow mold. Between the air handling unit and the ducting a weighted damper with a diversion vent can be used to control the amount of air pressure going through the duct, this is very useful to control air turbulence, especially when the damper to the incubation room is opening and closing, causing

Air Conditioner

Air Intake, diversion vent, thermostat, light switch, and water spigot

differences in air pressure. You'll need a fresh air intake to the air handling unit with a damper to control the amount of fresh air[4]. You'll want to set the thermostat on the air handling unit to run the fan constantly so you are bringing in a consistent amount of fresh air whether or not the heater or air conditioner is running. You'll need an ultrasonic humidifier[5] such as can be found at www.hydrofogger.com. You may also want an evaporative or steam humidifier in the incubation room. These can be plugged into humidistats or timers, though most humidistats don't work in the high range that most mushrooms need to fruit in. You may include a humidifier or evaporative cooling device in the ducting, which would replace the need for a humidifier in the incubation rooms and pre-humidify the air to the fruiting chamber. Because the fruiting chamber needs 80-90% humidity, it is advisable to have a separate humidifier in that room. You may want small outtake vents in each room so you can control where the exhaust air is going, though some air pressure in the rooms is good to keep out contaminants. Be sure to put a screen or small filter over the hole to keep out pests. Placing a half-hoop-house or greenhouse on the side of the mushroom building would be ideal for taking advantage of this high-humidity, carbon dioxide rich constant temperature air.

Fresh Air Intake Vent

7. **Install Electrical and Lights** – When you know the electrical requirements of your HVAC system you can hire an electrician. It is best to have the HVAC and electrical installed at the same time because the electrician needs to know what the HVAC requires and the HVAC contractor will need electricity near the end to set up the thermostat, charge the air conditioner with refrigerant and test the system. Expect to spend a lot on electrical, especially if you have to run a new power line. If you don't already have electricity close by, such as an adjacent barn or house, getting a new line can be very expensive and requires permission from the city/county and electric company. You'll need a fuse box, outlets in the end room, outlets in the grow rooms, as well as connections to the HVAC system and lights. A conduit with moisture tight fittings along the top of one wall in the trailer with one outlet in each room should provide ample power for humidifiers and other equipment. In the grow rooms that require lighting two rows of 8' fluorescent fixtures[1] attached end to end should be enough light, but testing is required with a light meter to check levels on each shelf, according to the types of mushrooms you are growing. You may need lights attached vertically or horizontally along the walls to provide enough light on lower shelves. To increase the life of the fixtures that go in the fruiting chamber you may want to use a liquid sealant on the exposed wiring inside the light fixtures to guard against

Lights, Pex, Conduit, and Outlet

corrosion due to high humidity. Mushrooms need a different light spectrum than plants, so rather than grow bulbs, plain cool white bulbs or aquarium bulbs work best. The grow lights need to be controlled by a timer that will leave them on for 12 hours and off for 12 hours. This can be a timer wired directly into the line, or you can have all the timed lights attached to a plug that goes into a simple Christmas light timer. If you have a dark incubation room, two single bulb fixtures[2] with red bulbs should be enough light. It would be a good idea to use a motion sensor to turn these lights on and off so you don't accidentally leave the lights on when you leave. You'll need lights in the end room too, though putting in a skylight reduces the need for electricity and makes it more pleasant if you have to spend much time in there. I would love to figure out how to use natural lighting in the grow rooms, but because of the need for constant temperature and the great fluctuations in the Oklahoma climate, it would probably cost more electricity to fight against the heat loss/gain than run fluorescent lights. I encourage someone to try building a structure that can accomplish this, though I'm sure it would cost considerably more.

8. **Install Plumbing** – You'll need water running to the building, be sure outdoor lines are buried 2' deep and insulate where it connects to the building. Install a cut-off valve for maintenance. If you have chlorinated water or high mineral levels install a whole system filter. Run PEX inside the building to a garden hose in the fruiting chamber and any humidifiers that can take a direct line. If you want to put a sink in the end room, use a large wash basin or mop sink so you can wash the large plastic mushroom bins and be sure to include a sprayer. You need drain lines from the sink and floor of the trailer. These trailers have small holes in the corners, but you'll have to screw a drain fitting to the underside of the opening to catch the water and direct it away from the building. It would be nice to recycle this water for plants or at least install a grey water system, but your city codes might require attaching to a sewer or septic tank.

9. **Build Shelves** – There are many ways to grow mushrooms, some require shelves and others don't. If you need shelves be sure they can be cleaned easily and completely. Utility shelves from the hardware store often have many corners and crevices that are difficult to scrub and they can get dirty very fast. For the bag method we built shelves out of electrical conduit and 2x4s coated with weather proof paint. We built braces out of the 2x4s and attached the conduit with metal straps. Lengths of conduit were attached together with conduit connectors. The shelves can be attached to the wall or floors for added stability. We built the shelves 4 levels high; 1.5' shelf height with two rows about 1' apart in the center.

Conduit shelves

Additional Infrastructure

Preparation and Inoculation

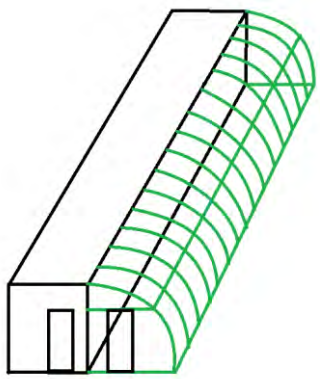
There are many different ways to grow mushrooms and we are not providing full instruction on how to get set up to grow in one particular way. Expect to spend several thousand more dollars on equipment to prepare and inoculate your substrate. It would be nice to see a centralized facility making bags, columns, and logs for many farms in an area so not everyone needs sterilization equipment.

Harvesting, Storage, and Sales

We use stack-n-nest bins from www.lewisbins.com to store the harvested mushrooms. They are ideal because the lids do not seal completely, allowing the mushrooms to breathe. Mushrooms and air tight containers do NOT mix. Also, be sure to keep the storage temperature at a constant 38° F. The best refrigerator we found for storing the bins was a commercial beverage cooler with sliding doors. Two of them would be about the right size for the amounts produced from one grow room. Residential refrigerators have a tendency to freeze things in the back of the shelves and don't hold as much. It is best to package the mushrooms in breathable containers as well. Restaurant boxes, paper bags, and clamshell containers with holes work well. Plastic bags, cellophane, or Styrofoam trap moisture and promote bacteria. Coolers with ice packs are fine for transporting the bins and packages. Measure the coolers before you buy them to be sure your bins fit into them well.

Optional Greenhouse

The grow rooms use a significant amount of energy to heat, cool, and humidify and the mushrooms put off a significant amount of CO2. Why not double your money by venting the exhaust air into a simple greenhouse on the side of your grow room? The cheapest and easiest way would be building a hoop house on the bare ground rather than pouring a slab and building a rigid greenhouse, though either would work. Be sure to orient your grow room so that the long side with the exhaust vents is facing south. Use metal bars curved 90°, attached at the top with metal brackets or plumbing drain couplings and anchored into the ground with stakes. Use wiggle wire channel to attach four mil, 4-year, greenhouse-grade polyethylene to the top and ends. Attach one or more horizontal braces down the length of the hoop house. A wood frame end with a storm door can serve as an entryway. See http://www.kerrcenter.com/publications/hoophouse/Hoophouse-Resources.pdf for simple designs and tips. You can also save your waste water and catch rainwater from your building. Guttering on the North side of the trailer and on a horizontal brace at head height on the hoop house could feed into barrels or poly water tanks under or beside the trailer. Water washed off of the inside of your grow rooms should be safe for plants so you may be able to catch and reuse it rather than feeding it into a sewer or septic tank. Considering the massive amount of compost that the mushrooms generate, it only makes sense to start filling pots and sell seedlings and/or vegetables along with your mushrooms.



Sketch of Greenhouse

Teacher's Name: _____ Identification Number: _____

Harvest of the Month Student Survey

2011-2012

Prepared by
Laura Matlock, Evaluation Coordinator
Center for the Advancement of Wellness
Oklahoma State Department of Health

Confidentiality information to be explained to students

We would like for you to complete this survey. You may skip questions you do not want to answer but we hope that you will answer all of them. Any information about who you are will be kept secret. We will not share your name or identification number. They will only be used for reports.

Directions: This is a survey to find out about what you know, like, think, and do about fruits and vegetables. Fill in the bubble (O) of the one best answer for each question. Do NOT write your name anywhere on this survey.

The questions in this section ask what your friends think about eating fruits and vegetables. Please bubble in one answer to each question.

	Yes	No	I don't know
1. Do most of your friends like to eat fruits and vegetables?	O	O	O
2. Do most of your friends eat fruits and vegetables every day?	O	O	O
3. Does your best friend eat fruits and vegetables every day?	O	O	O

The question in this section asks how often your family eats fruits and vegetables. Please bubble in one answer to each question.

	Never	Sometimes	Every day	I don't know
4. How often does your family eat fruits and vegetables?	O	O	O	O

The questions in this section ask about obtaining fruits and vegetables.

	Never	1 -2 times	3 or more	I don't know
5. How often do you go shopping for fruits and vegetables with your family?	O	O	O	O
6. How often does someone in your family make fruits and vegetables for a meal?	O	O	O	O
7. How often have you visited a Farmers Market?	O	O	O	O

The questions in this section are about what you think will happen if you eat fruits and vegetables. Please bubble in one answer for each question.

	Yes	No	I don't know
8. I will have more energy for playing.	O	O	O
9. I will be healthier if I eat fruits and vegetables.	O	O	O
10. Eating fruits and vegetables will help me grow.	O	O	O

11. If I eat breakfast, I will be able to think better in class.	O	O	O

The questions in this next section ask what your teacher tells you about eating fruits and vegetables. Please bubble in one answer to each question.

Does your teacher tell you…	Yes	No	I don't know
12. … that fruits and vegetables are good for you?	O	O	O
13. … that fruits and vegetables are healthy?	O	O	O
14. … that fruits and vegetables taste good?	O	O	O
15. … to eat fruits and vegetables every day?	O	O	O

The questions in this next section ask why you may or may not eat fruits and vegetables. Please fill in one answer for each question.

16. At your home do you have fruits to eat?

O Never
O Sometimes
O Everyday
O I don't know

17. At your home do you have vegetables to eat?

O Never
O Sometimes
O Everyday
O I don't know

The next set of questions is about how much you eat. Please bubble your answer.

18. Yesterday, did you eat any vegetables? ***(Do not count French fries or chips.)***

O No
O Yes, I ate vegetables 1 time.
O Yes, I ate vegetables 2 times.
O Yes, I ate vegetables 3 or more times.

19. Yesterday, did you eat fruit? ***(Do not count fruit juice.)***

O No
O Yes, I ate fruit 1 time.

O Yes, I ate fruit 2 times.
O Yes, I ate fruit 3 or more times.

Now we want to know how much you like some foods. Please bubble in your answer.

20. How much do you like these fruits and vegetables?	I like this a lot	I like this a little	I do not like this	I don't know what this is
Asparagus	O	O	O	O
Cabbage	O	O	O	O
Cucumbers	O	O	O	O
Grapes	O	O	O	O
Green Beans	O	O	O	O
Melons	O	O	O	O
Peaches	O	O	O	O
Spinach	O	O	O	O
Strawberries	O	O	O	O
Summer Squash	O	O	O	O
Sweet Potatoes	O	O	O	O
Tomatoes	O	O	O	O

In this section, we want you to tell us what you know about healthful eating.
Please bubble your answer.

21. Eating fruits and vegetables can help lower your chances of getting heart disease or cancer.

O True
O False
O I don't know

22. Almost all fruits and vegetables contain a lot of vitamins and _____.

O Protein
O Fiber
O Cholesterol
O Fat
O I don't know

23. Which of the following fruits and vegetables are grown in Oklahoma:

O Spinach
O Melons
O Peaches
O All of the above

24. Fruits and vegetables, like apples and cucumbers, are best when eaten with the peel because that is where most of the fiber and antioxidants are.

O True
O False
O I don't know

25. Are you a boy or a girl? (Fill in one answer.)

O Boy
O Girl

26. What is your race? (Select one or more responses.)

O American Indian or Alaska Native
O Asian or Pacific Islander
O Black or African American
O Hispanic

O White