AN ECONOMIC ANALYSIS OF ALTERNATIVE PEANUT GRADING SYSTEMS AND THE POTENTIAL IMPACT ON THE U.S. PEANUT INDUSTRY – PART II
FY 2008

The U.S. peanut industry is undergoing many changes. Government programs to manage supply have been discontinued, and global competition is on the rise. Increasing bottlenecks at peanut buying points--key players in moving peanuts from the farm to peanut shellers--are due to several developments including an increase in peanut acreage, especially in Georgia and the Southeast; a shortening of the peanut harvest period due to improved technology; and disease management practices which have shortened the time window for planting, harvesting and delivering peanuts to buying points. Compared to other crops, peanut grading is costly and has remained virtually unchanged. The peanut grading system dates from the 1960s and it is expensive, and time-consuming, and fails to provide an adequate measure of quality at each stage--from grower to buying point to sheller, through to manufacturer. The goal of this two-part project was to investigate options for developing an accurate, effective and efficient grading system for U.S. farmer stock peanuts. Specific goals for Phase II were to:

- Continue to evaluate the current grading system and available data as to cost and time of grading a sample;
- Analyze and evaluate a portable microwave sensor that can determine kernel moisture content and bulk density;
- Analyze and evaluate the X-ray grading system;
- Analyze and evaluate other alternative grading systems and emerging grading technologies; and
- Evaluate the potential impacts of alternative systems on the U.S. peanut industry.

FINAL REPORT

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An Economic Analysis of Alternative Peanut Grading Systems and the Potential Impact on the U.S. Peanut Industry

(USDA-Federal State Marketing Improvement Program)

FINAL REPORT

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BACKGROUND AND JUSTIFICATION

Peanut industry is undergoing many changes due to the passage of the 2002 FSRI Act. The 2002 FSRI Act symbolizes that the U.S. peanut industry has entered an era characterized as no supply management and increasing global competition. Overlaying this change in the U.S. peanut industry, there has been an increasing bottleneck at the peanut buying point in trying to move peanuts from the farm to the peanut shellers. This bottleneck has been created by several factors. One factor is the increase in peanut acreage, especially in Georgia and the Southeast, due to the change in the peanut program. A second key factor is the shortening of the peanut harvesting period due to improved peanut harvesting technology such as the switch from two row peanut combines to six row peanut combines. Furthermore, current disease management has shortened the time window for planting which leads to a shortening time window for harvesting and delivering the peanuts to the buying points. For example, TSWV (tomato spotted wilt virus) has significantly shortened the planting window for peanuts in the Southeast and is starting to impact the other peanut producing regions in the U.S. To properly manage this disease, the planting window has narrowed significantly. Peanut farmers in the Southeast, prior to TSWV, were able to plant peanuts during April and May. Now, the planting window has been narrowed to the last 3 weeks of May. Consequently, this has compacted the harvesting system time. While the current system may have been satisfactory with the longer harvesting system, it is definitely not satisfactory with the compacted time period.

The current grading and handling procedures and equipment date back to the 1960s when it was established for the old marketing quota peanut program which included a supply management component. Relative to other crops, grading is costly for peanuts. It cost approximately $5.25 per FSP ton to grade a sample of peanuts which is approximately 1.5% of the value of the ton of peanuts to the farmer. However, in the past couple of years, some states have had to increase their grading fees to the $8-$10 range. This grading cost as a percentage of value is significantly higher relative to cotton, corn, wheat and soybeans which range for these latter crops from .3% to .7%. Grading cost has remained virtually unchanged while the value of peanuts is approximately one half of what it was under the old marketing quota program. The grading system is archaic, expensive, time-consuming, and fails to provide the adequate measure of quality needed from the grower to buying point to sheller to manufacturer. Thus, one can readily understand why this system needs to be enhanced if the U.S. peanut industry is to maintain competitiveness.

To further elaborate, at buying points peanut trailers are sampled by probing with a pneumatic probe. Probing alone may take 15-20 minutes depending upon the size of the trailer. This current probe method does damage to the peanut, create LSK's (loose shell kernels) and damaged kernels. In addition, it will miss or under represent some types of foreign material. While the current grading system does adjust the grade to take this damage into account, yet it uses an average value. Other systems may be available that would provide a better sampling method plus reduce the time to take the sample.

A 1500 to 2000 gram sample is then collected from the probe of a peanut trailer at the buying point. Foreign materials (FM) and loose shelled kernels (LSK) are removed and weighed. From the remaining peanuts, a predetermined sub-sample is pre-sized and shelled and kernels are sized through slotted screens. Those damage-free kernels that ride the slotted screen are referred to as sound mature kernels (SMK) and these along with damage-free split kernels (SS) comprise the basis of the farmers' stock grade and value of the lot. Growers are penalized for excessive amounts of damage, splits, and foreign materials. Damage, split, and LSK are further examined visually for the presence of *a. flavus* spores. After shelling, kernels are sized and sold according the manufacturer's specification, typically as Jumbo, Medium, or No. 1 kernels that meet both a size and count per pound specification. Yet, while these different kernel sizes have different values, a farmer does not see these differences being reflected in his FSP grade value.

Technology is available to develop a superior grading system than currently in use. Quality analyses are available today such as near infrared measurements (NIR) for sugar, oil, and protein. Machine vision, ultrasound, and magnetic resonance imaging are used in grading other commodities and may have applications for peanuts. Research has been conducted in automating the pneumatic probe used in sampling, as well as mechanizing the shelling and sizing components in the grading process, but to date none have been adopted.

Another issue with the current grading system deals with labor. Adequate labor supply and quality of labor has become a critical issue. Historically, farmer wives served as a major labor pool for this seasonal work. Due to the economic situation on the farms, most wives now work full time in the town or surrounding areas. Thus, this qualified labor pool has shrunk significantly. The grade of a peanut lot is highly dependent on the quality of the labor. This statement is supported by the findings from past year's grading test done under the previous FSMIP peanut grading project. Thus, alternative grading systems need to be examined that will reduce the need for labor from the shrinking qualified labor pool. One alternative grading system previous examined in the prior FSMIP peanut grading project is the centralized grading approach. Rather than have grading equipment at each buying point, a centralized grading site would be established where several buying points based on tonnage handled would utilize the site. This concept was examined under the previous FSMIP grant during the 2007 crop grading season. Three centralized sites were established with 1 site located in each of the three growing regions (i.e., Virginia-Carolina area, Southeast area, and the Southwest area). Those results supported a centralized grading concept. This approach created keen discussion in the peanut industry. However, some segments of the peanut industry did not support this concept. The industry is not ready to move in this direction at the present time.

For U.S. peanut producers to maintain and enhance their competitiveness, cost factors of getting the peanuts from the farm to the consumer must be examined. Grading is one key component of this cost. Obtaining a more time efficient and cost effective grading system will enhance the competitiveness of U.S. peanuts relative to our competitors.

In view of these issues, the Georgia Department of Agriculture, Georgia Agricultural Commodity Commission for Peanuts, the American Peanut Shellers Association, the National Peanut Buying Points Association, the Georgia Federal-State Shipping Point Inspection Service, Inc. (a nonprofit corporation), and The University of Georgia College of Agriculture and Environmental Science combined resources with USDA-AMS-FSMIP to identify the key factors and potential solutions.

GOAL(S) and OBJECTIVES

The grading of farmer stock peanuts must be conducted in a manner that determines an accurate grade in a timely and cost efficient means. Specific objectives for research were:

1. Continue to evaluate the current grading system and available data as to cost and time of grading a sample.

2. Analyze and evaluate a portable microwave sensor that can determine kernel moisture content and bulk density.

3. Analyze and evaluate the X-ray grading system.

4. Analyze and evaluate other alternative grading systems and emerging grading technologies. and

5. Evaluate the potential impacts of alternative systems on the U.S. peanut industry.

WORK PLAN

The appropriate procedures were followed to adequately address each objective. The appropriate scientists like agricultural engineers, agricultural economists, food scientists and agencies (e.g., USDA-ARS, USDA-AMS) were involved with this project. Joint meetings were held among the scientists and the appropriate peanut industry personnel. The Georgia Department of Agriculture was the lead agency in this endeavor. Dr. Stanley Fletcher, Director of the National Center for Peanut Competitiveness with the University of Georgia, was the primary collaborator with the Georgia Department of Agriculture on this study. Dr. Fletcher was also the project coordinator.

The plan of work addressed both the short and long term goals for this project. A core group composed of a representative from the growers, buying points, shellers, Federal-State Inspection Service (FSIS), USDA-ARS, and USDA-AMS was organized to guide and provide on-going evaluations for the FSMIP project. Further, the project coordinator met with all of the state peanut supervisors. In those meetings, all issues, both present and future, pertaining to peanut grading were discussed. Similar meetings have been held at national peanut industry meetings.

For the longer term, the project attempted to analyze and evaluate other alternative grading systems and emerging grading technologies for their applicability to peanuts. Several other non-destructive technologies used in grading fruits and vegetables include machine vision system that can determine size and color. Nuclear magnetic resonance (NMR), magnetic resonance imaging (MRI), and ultrasound systems are capable of determining internal fruit characteristics. Near Infrared Reflectance (NIR) is used routinely for determining sugars, protein, and oil. Improvements on existing grading methodology and equipment, as well as promising new technologies were compared at selected buying points in each growing region for precision, accuracy, cost effectiveness, and time efficiency.

OUTCOMES and PROJECT EVALUATION

In order to aid this project in meeting its objectives and maintain communications with the industry, an industry committee was formed with representation from each of the segments of the peanut industry. There were representatives from the grower sector, buying points sector, shellers, and Federal State Inspection Service. This group met several times during the time of this project and has provided valuable insight and direction to the research. Presentations and discussions have also occurred at the U.S. State Peanut Supervisor’s annual meetings in 2009, 2010 and 2011. In depth discussions occurred at each of these meetings as to the results and what was going to be the next step in the project. The industry has been very supportive of this project and recognizes the complexity in solving the grading issues.

The outcomes and project evaluation are viewed specific to each of the short term and long term goals and objectives.

Objectives:

Current System: Samples were pulled from the various sizes of conveyances that deliver farmer stock peanuts from a farmer's field to a buying point. The conveyances delivering peanuts to the buying points are 14 ft, 21 ft and 28 ft trailers and semi-trailers with the 14 ft and 21 ft trailers having the same number of probes and the 28 ft and semi-trailers having the same number of probes. The average time to pull a sample from a 14 ft trailer was 4-6 minutes with many in the 6-8 minute range. For the 21 ft trailer, the average time was 6-8 minutes with many in the 8-10 minute range. For the 28 ft trailer, the average time was 7-10 minutes while for the semi-trailer the average time was 12-17 minutes. Thus, it seems that the larger the conveyance even with the same number of probes takes additional time to pull the sample. This did not include the time to prepare in taking the probes nor the delivery of the probe sample to the grading room. These two components add several minutes to the final average time in pulling a sample for grading. Even if a faster approach was found in the grading room, samples cannot be graded till they are pulled.

Portable Microwave Moisture Sensor: This technology has proven successful in measuring the moisture of peanuts in the shell. This will significantly increase the speed of peanut grading. A prototype machine was developed utilizing this technology. Tested were conducted for the 2008, 2009 and 2010 peanut crop seasons. The research was conclusive in its findings that this technology works. Appendix A has the report on the testing of this machine for the 2008, 2009 and 2010 peanut crop seasons.

Based on these results, a paper is being developed for submission to USDA-AMS Fresh Fruits and Vegetable branch for consideration of allowing the microwave moisture testing technology be officially accepted as a means of determining peanut moisture during the grading process. The plan is to have this paper submitted Spring 2012. A major U.S. company is in the process of licensing this technology in order to build and sell this type of machine to the peanut industry. The company also sees the potential of this technology in helping the tree nut industry in their grading and measurement of moisture. Excitement about this technology is growing within the peanut industry. Buying point managers see the benefit of this technology and would like to use it in their peanut drying sheds as well.

X-Ray Grading Machine: A protocol was established such that farmer stock peanuts were collected across the three peanut producing regions. The company providing the x-ray equipment provided 2 modified x-ray machines. The research was to take the peanut samples and run them through the x-ray machine. The same peanuts were then processed through the normal grading procedure. The intent was to compare the results of the x-ray machine to the official grading process. This comparison was done on the 2008 peanut crop. However, technical glitches occurred with the x-ray machine which required additional research. The x-ray images were saved which will allow the researchers to use those images after software modifications are completed. The company that is providing the technology and the machines dedicated a key personnel to address the glitches. The researchers and the company feel like they addressed the issues. Thus, the machine was tested again during the 2009 and 2010 peanut crop harvest.

The machine has had technical glitches for each peanut harvest season. The researchers and the company feel progress is being made in addressing the issues. Thus, the machine is going to be tested again during the 2011 peanut harvest season.

A key issue with the X-ray machine is the potential cost of the machine. Potential cost numbers provided by the company makes it not economically feasible for the average size buying point. However, if the industry moves to centralized grading, the cost could be justified.

Emerging Grading Technologies: Peanut damage issues were addressed during the 2008 peanut crop season. While the X-ray machine has potential, a major drawback is that it cannot detect damage nor visible A. flavus and/or Aflatoxin. Thus, two projects were developed. One project evaluated chemical tests. Some of these tests took up to 6 hours. Some of the tests did not show any difference between the damage samples and non-damage samples. Based on these results, a nondestructive NIRA method was explored and tested during the 2009 peanut harvest. This approach did not prove successful thus additional research was not directed in this direction either. The other project was utilizing the E-nose (electronic nose) technology. Two groups of shelled peanuts were measured with a breakdown of 4 replicates of damaged peanuts and 6 replicates on non-damaged peanuts. These results show that either a) healthy peanuts and damaged peanuts do not differ enough for the E-nose to differentiate between the two, or b) the amount of headspace gas released by peanuts is insignificant, and registers weakly on the E-nose's sensors. While the E-nose does not seem a viable alternative in determining damage in peanuts during the grading process, an alternative approach utilizing parasitic wasps was selected to be researched. Research has shown that parasitic wasps are more sensitive to odors than the E-nose technology. Preliminary research results indicate that the parasitic wasps can distinguish certain damage at given threshold levels. The research was expanded for the 2011 peanut harvest season.

Evaluate potential impacts on the industry: Given the complexity and timing of this study, this objective was not completed. Yet, this project has shown the complexity of peanut grading. A simple and more efficient approach is not on the horizon for the peanut industry. This may be the reason why peanut grading has not changed since the 1950s. One key technology has been identified and has the potential of a major impact on the peanut industry. The use of a portable microwave moisture sensor machine is economically feasible. Instead of having the grading process determine the moisture content at the end of the grading process, it can be determined at the beginning. This will eliminate a significant number of no-sells due to moisture. This will allow a buying point to handle larger quantity of peanuts in a given day. Furthermore, the use of this technology will allow the buying point to determine whether a peanut trailer should be sampled and graded in the first place. The efficiency of a buying point will increase dramatically. This technology will also allow confidence in green weight grading to increase which will also speed up the grading process which in turn improves the efficiency of a buying point. Finally, the microwave technology can be used to ensure that the moisture level of the peanuts being put into storage is at the correct level. This will eliminate the potential of a high moisture level peanut load being put into storage which can have a degrading effect on all of the peanuts in the storage facility.

For the other technologies considered, the peanut industry will need to fundamentally change the current method of collecting peanuts and grading. That is, given the current average size of a U.S. peanut buying points being less than 8,000 tons, the other considered technologies are economically infeasible.

Recommendations for Future Work: Without a dramatic shift in the mindset of the peanut industry as to how peanuts move from the farm to grading to storage and shelling, current potential technologies are not economically feasible. The only technology that is feasible is the microwave technology in measuring moisture which has been researched extensively within this project. The next step for that technology is the commercialization which is occurring at the present time. The other technologies that have been analyzed within this project will require the concept of centralized grading to make them economically feasible. The peanut industry is not ready for that step. The X-ray machine has shown promise but each successive peanut harvest season has had some type of glitch. This may be due to the nature of the peanut crop where no two harvest seasons are the same. Variability seems to be the nature of peanuts. Given the nature of the 2010 and 2011 peanut crops, damage has become more prevalent. The E-nose did not show much promise nor chemical testing. The parasitic wasp seems to be a possibility but not all types of damage can be detected. As has been stated previously, centralized grading will need to be adopted for any of the potential technologies to have any impact.

For centralized grading to occur, a peanut farmer will need to accept the change. He will not be able to ask for a re-grade which would require a new sample to be pulled from his peanut trailer. Once a peanut trailer enters a buying point’s facility, a peanut farmer would lose control. Using the microwave moisture machine, the peanut trailer’s moisture level would be determined and dried down to the appropriate level before a sample is pulled. The microwave technology has the potential to determine bulk weight which could be used to determine level of foreign material in the peanut trailer. This technology would be used to determine if the peanut trailer load needs to be cleaned before a sample is pulled. Once the peanut trailer meets the moisture and foreign material requirements, a peanut sample is drawn. Immediately, the peanut sample would be tested for aflatoxin and freeze damage. A nondestructive quick test will need to be developed. If the peanut trailer passes the aflatoxin and freeze damage tests, the peanut load will be put into storage which frees up the trailer for another peanut load. The peanut sample will be shipped in an appropriate container to a centralized grading facility. A grade for that sample will be performed within a 2-3 day time framework. The results will be electronically transmitted back to the buying point. The peanut farmer would receive his USDA-FSA 1007 form which includes his grade for that load. This concept allows the centralized grading facility to economically afford the new technology like the X-ray, once it has been proven, and other technologies. However, further research on this concept with the associated technologies is not needed until the peanut industry is willing to accept the change.

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APPENDIX A

Field-Testing of Microwave Moisture Meter for Rapid and Nondestructive Determination of In-shell Kernel Moisture Content

Results for 2008 and 2009 Harvest Seasons

Introduction

Peanut grading is a labor-intensive process during which inspectors determine the meat content, size of pods, damaged kernels, foreign material, and kernel moisture content. At peanut buying stations, it is only after sorting, cleaning, and shelling that kernel moisture content is determined and a decision is made whether it meets the sale standard value (below 10.49%). It would be advantageous to determine kernel moisture content while they are still in the pods. This will expedite the grading process by allowing the buying point inspectors to make their decision at the beginning of the grading process and avoid unnecessary steps which results ultimately in reducing costs and improving peanut quality and consistency. A novel microwave moisture meter for rapid and nondestructive determination of kernel moisture content by microwave dielectric measurements on the pods was developed, calibrated and tested in the laboratory. The moisture meter, operating at a single microwave frequency of 5.8 GHz (Gigahertz), was built with off-the-shelf components and uses the principle of free-space-transmission measurement of the pods dielectric properties. A dielectric-based algorithm allowed determination of kernel moisture content is determined from these properties independent of bulk density changes and independent of the peanut variety.

During the harvest season of 2008, a prototype microwave moisture meter was installed and successfully used at a buying location at Bartow, GA. For the next harvest season (2009), five of these meters, including the one used at Bartow, were deployed at different buying locations in Georgia, Alabama, and South Carolina. A user-friendly interface guided the operator through step-by-step instructions to complete the measurements which in general required only a few seconds. Overall, feedback from operators of the microwave meters was positive and no problems were reported. Results obtained from the measurement campaigns for 2008 and 2009 harvest seasons are summarized in this report.

Microwave Moisture Meter

The measurement sequence is kept to a minimum consisting of initial measurement with the bucket empty and after it was filled with the pods. Figure 1 shows the microwave moisture meter used in 2008 at Bartow, GA and Figure 2 shows the newer version with stainless steel funnel used during the harvest season of 2009. Table 1 indicates the location and deployment and measurement dates for each microwave moisture meter. Table 2 shows the number of samples that went through the entire grading process and for which kernel moisture content was determined with both the GAC and microwave moisture meter. The kernel moisture content range in Table 2 is that obtained with the official moisture meter GAC 2100, except for microwave moisture meter MP5, the range shown is that obtained with the oven-drying method (drying for 6 hours at 130 ^oC). A total of 2283 samples were tested with both GAC and microwave moisture meter.

Figure 1. Microwave moisture meter with bucket filled with peanut pods.

Figure 2. Microwave moisture meter with stainless steel funnel.

Table 1. Dates for deployment and measurement campaigns with microwave moisture meters.

Microwave Moisture Meter	DATE DEPLOYED	MEASUREMENTS STARTING	MEASUREMENTS ENDING
MP5 Whitehall, Athens, GA	11/03/2009	11/03/2009	1/22/2010
MP2 Alabama	10/25/2009	10/29/2009	12/7/2009
MP3 Bartow, GA	10/9/2008	10/29/2008	12/5/2008
MP3 Bartow, GA	9/28/2009	10/12/2009	12/15/2009
MP2 Donalsonville, GA	9/15/2009	9/21/2009	10/24/2009
MP4 Orangeburg, SC	10/30/2009	10/30/2009	11/23/09

Table 2. Number of samples and corresponding kernel moisture range tested with both GAC and microwave moisture meter.

Buying Station	Number of Samples	Kernel Moisture Content, %
Simulation, MP5, **Whitehall, Athens, GA**	153	5.7 – 17.8
Alabama, MP2	555	5.2 – 17.5
Peanunt Producers LLC, MP3, **Bartow, GA**	406 (2008) 673 (2009)	6.5 – 22.9 5.4 – 23.4
GC Peanut Co., MP2 **Donalsonville, GA**	292	6.7 – 11.7
Palmetto Peanut Co, MP4 **Orangeburg, SC**	204	5.1 – 13.1
TOTAL	**2283**	**5.1 -23.4**

Results and Discussion

For all microwave moisture meters the kernel moisture content predicted from measurement on pods was compared with the kernel moisture content the inspectors obtained with the GAC 2100, except for MP5, it was also compared with kernel moisture content obtained with a Steinlite meter and the oven standard.

Performance of Microwave Moisture Meter MP5

Microwave moisture meter MP5 was tested at Whitehall station in Athens, GA which simulates the grading process at regular buying points. The samples were shipped to Athens in sealable buckets from Alabama FSIS, GA FSIS, NCDA & CS Coop. Grading Service, and Texas Coop. Inspection Service. First, kernel moisture content was determined with MP5 from measurements on a clean sample of pods, and then the pods were shelled and moisture content was obtained with the GAC 2100, Steinlite and the oven –drying standard. Figure 3 shows, kernel moisture content obtained with the three instruments against the kernel moisture content obtained with the oven standard method. The solid line indicates the ideal fit between predict and oven kernel moisture content. From this test, it appears that the GAC overestimates the kernel moisture content for samples of moistures above 12% while the Steinlite and MP5 remain close to the line representing the ideal fit. To evaluate performance of each instrument in comparison with the standard oven method, the standard error of performance (SEP) was calculated. Results are shown in Table 3.

Instrument	SEP, % Kernel Moisture Content equal or less than 12%	SEP, % Kernel Moisture Content above 12%	Overall SEP, %
GAC 2100	0.23	0.76	0.51
Steinlite	0.16	0.39	0.30
Microwave Moisture Meter	0.29	0.37	0.31

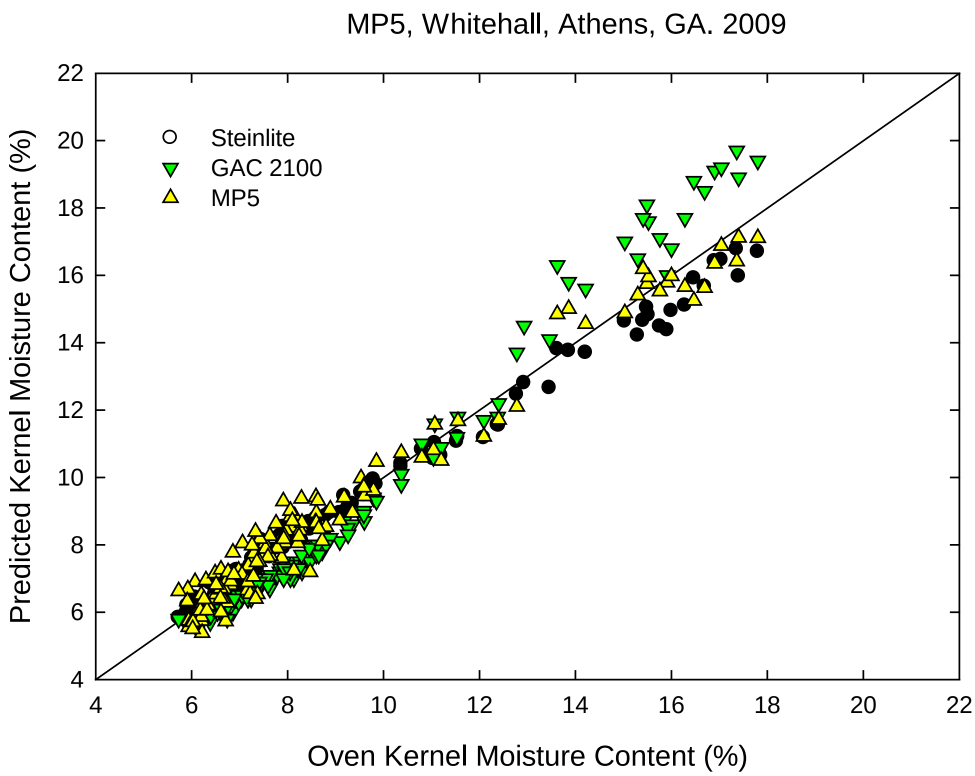


Figure 3. Kernel moisture content obtained with indicated instruments against kernel moisture content obtained with the oven standard method (drying kernels for 6 hours at 130 ^{o}C).

Performance of Microwave Moisture Meter MP3

For two consecutive years microwave moisture meter MP3 was deployed at a buying point in Bartow, GA. In this instance, performance of the microwave moisture meter is compared with that of the official meter, GAC 2100. Figure 4 and figure 5 show kernel moisture content predicted with MP3 against that determined with the official meter for samples tested at Bartow, GA, during the harvest season of 2008 and 2009, respectively. Measurements of 406 samples in 2008 provided a standard error of performance (SEP), in comparison with the GAC 2100, of 0.81%. During the harvest season of 2009, 673 samples were measured and the SEP was 0.93%. For the interpretation of these results, one should keep in mind the performance of the official meter above 12% moisture content as shown above.

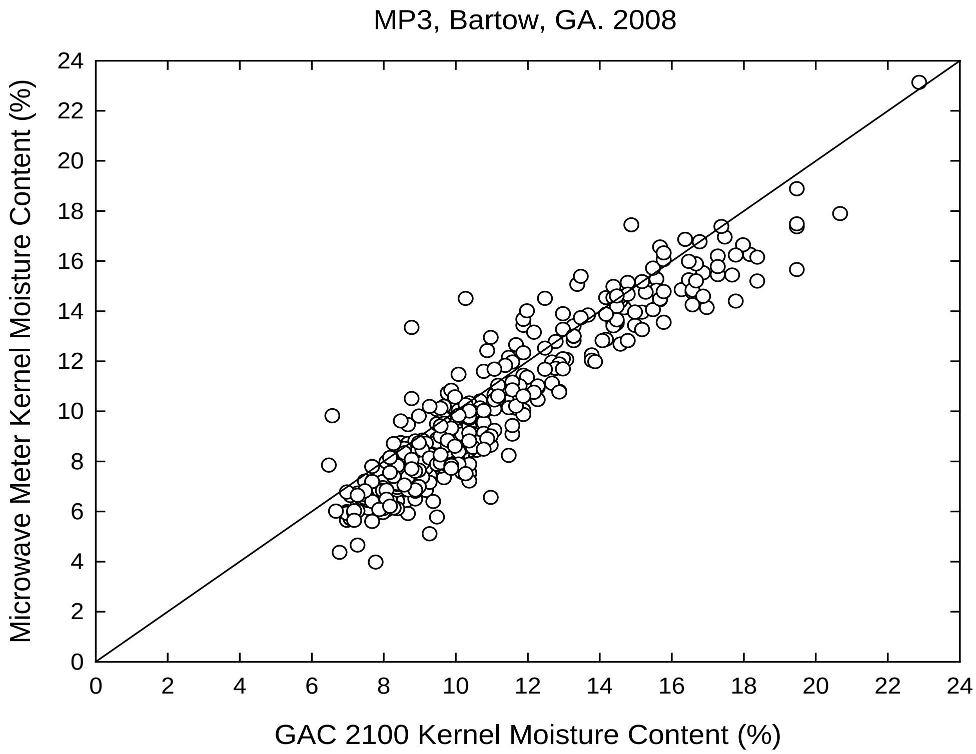


Figure 4. Kernel moisture content obtained with microwave moisture meter MP3 against kernel moisture content obtained with the official meter GAC 2100.

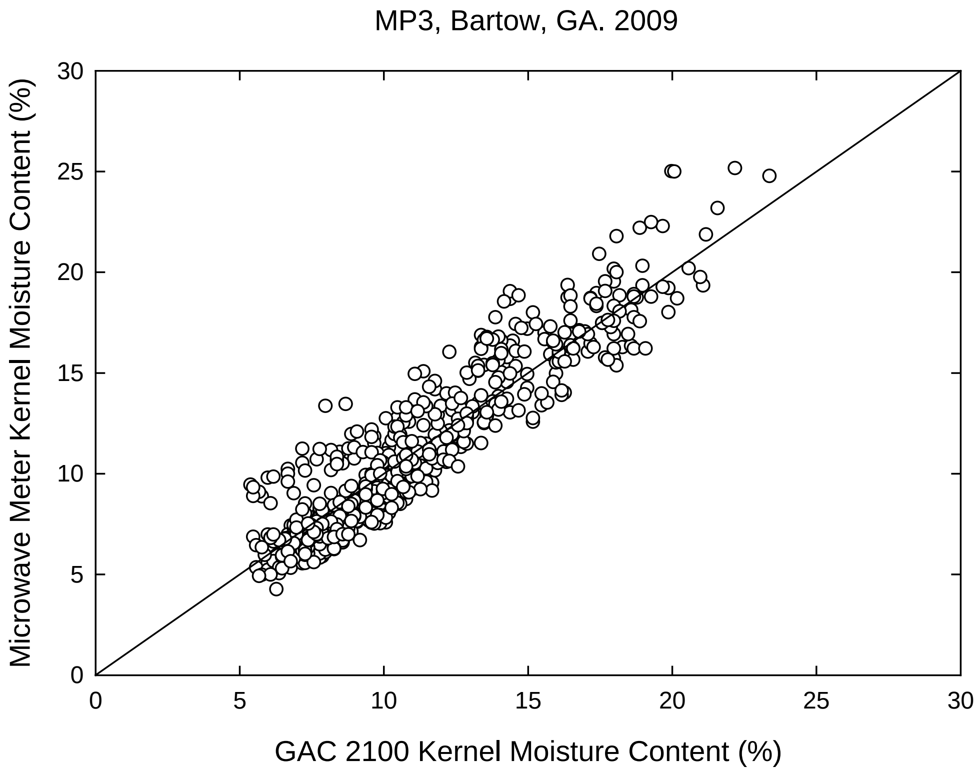


Figure 5. Kernel moisture content obtained with microwave moisture meter MP3 against kernel moisture content obtained with the official meter GAC 2100.

Performance of Microwave Moisture Meter MP2

During the 2009 harvest season MP2 was deployed first to a buying point at Donalsonville, GA and then to a buying point in Alabama. Figure 6 and figure 7 show kernel moisture content predicted with MP2 against that determined with the official meter for samples tested at Donalsonville, GA and Alabama. The standard errors of performance (SEP) for kernel moisture content prediction from measurement on pods with MP2, in comparison with the official meter, were 0.66% for samples tested at Donalsonville, GA and 0.64% for samples tested in Alabama.

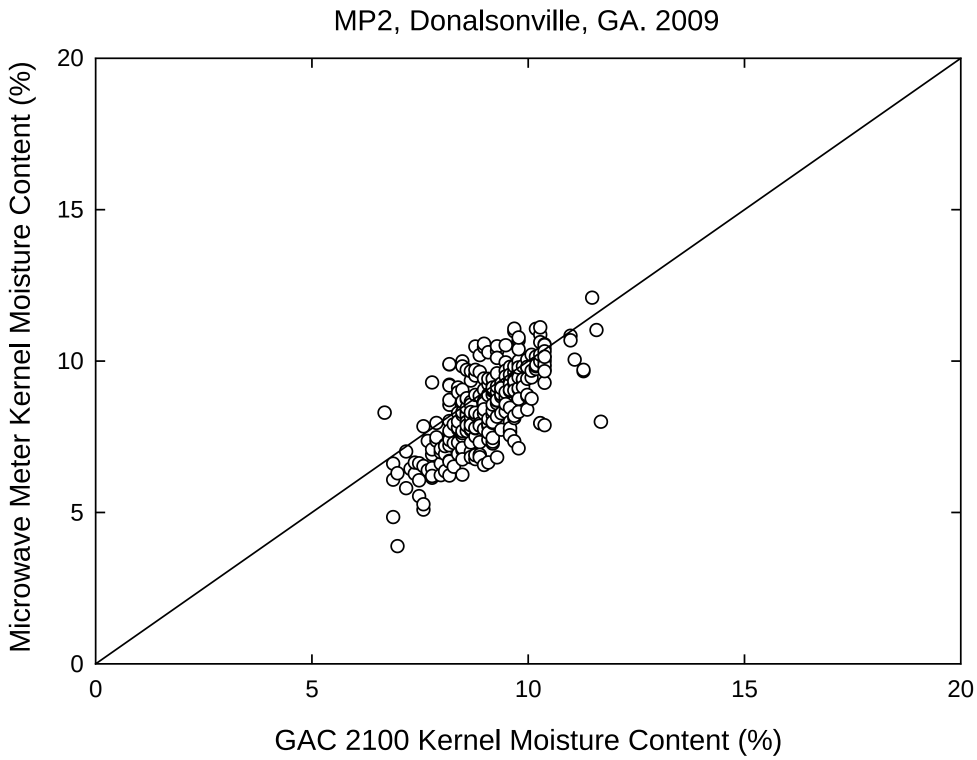


Figure 6. Kernel moisture content obtained with microwave moisture meter MP2 against kernel moisture content obtained with the official meter GAC 2100.

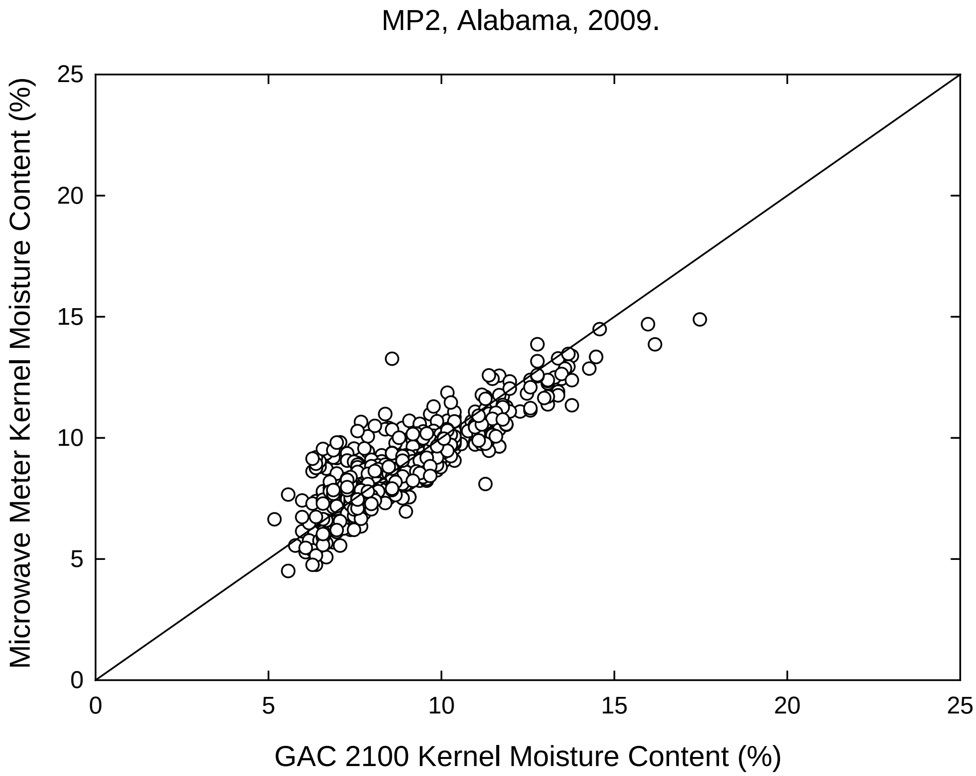


Figure 7. Kernel moisture content obtained with microwave moisture meter MP2 against kernel moisture content obtained with the official meter GAC 2100.

Performance of Microwave Moisture Meter MP4

Microwave moisture meter MP4 was deployed at a buying point in Orangeburg, SC. The total of samples tested was 204 with moisture content ranging from 5.1% to 13.1%. Here, the standard error of performance (SEP), in comparison with the official moisture meter, was 0.95%.

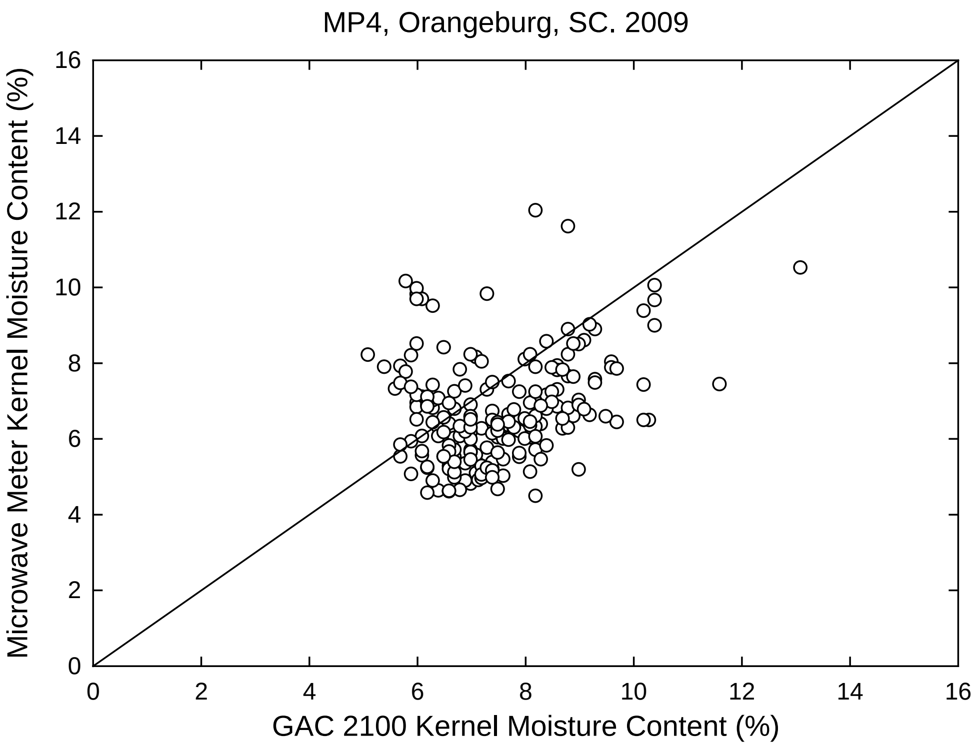


Figure 8. Kernel moisture content obtained with microwave moisture meter MP4 against kernel moisture content obtained with the official meter GAC 2100.

Conclusions

For two consecutive harvest seasons microwave moisture meters for kernel moisture content determination from measurements on pods were deployed and tested at different buying points in Georgia, Alabama, and South Carolina. Results show stability and consistency of microwave moisture meters in predicting kernel moisture content over a broad moisture range. In particular, a comparison between microwave sensing technology and official meters with the standard oven method revealed the effectiveness of microwave technology, especially for moistures above 12%. Also, it is to be noted that microwave sensing technology provide kernel moisture content while still in the pods and independent of the variety and growing location.

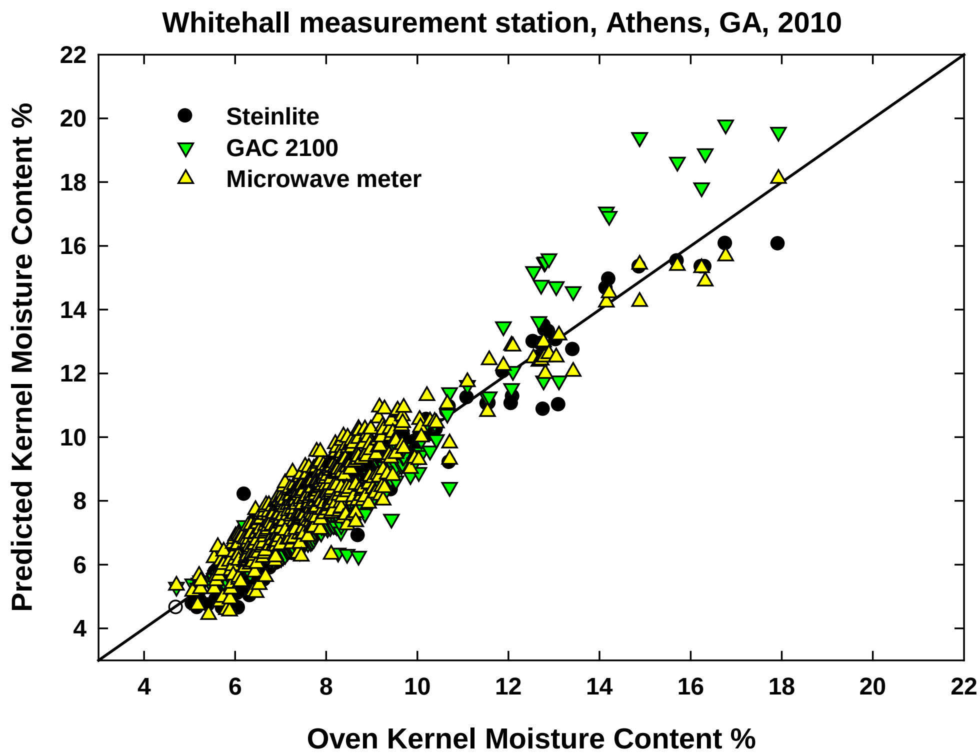
Results for 2010 Harvest Season

For the 2010 harvest season the emphasis was on collecting samples from different growing places and with a wide range of foreign materials. Samples from 10 States including Georgia, Alabama, South Carolina, North Carolina, Florida, Texas, Virginia, Mississippi, New Mexico, and Oklahoma were shipped to Athens, GA. This made the test a national test. A total of 543 samples were tested with the microwave moisture meter for determining kernel moisture content from dielectric measurements on clean pods and pods mixed with foreign material. Table 1 shows the number of samples received from each State.

Table 1. Number of samples received from each State.

STATE	**# Received**	**# Expected**
GA	231	228
AL	76	62
SC	21	21
NC	36	34
FL	69	44
TX	99	85
VA	7	7
MS	4	7
NM	5	4
OK	8	8

Results obtained with the microwave moisture meter were compared to those obtained with the GAC 2100, Steinlite and the oven –drying standard. The plot below shows the kernel moisture content predicted with the microwave moisture meter, the Steinlite, and GAC 2100 against kernel moisture content obtained with the oven-drying method. Out of the 543 peanut pod samples 522 samples had a kernel moisture content below 12% and 21 samples had a kernel moisture content above 12%.



To evaluate performance of each instrument in comparison with the standard oven method, the standard error of performance (SEP) was calculated. Results are shown in Table 2.

Table 2. Comparison of standard error of performance (SEP)

Instrument	SEP, % Kernel Moisture Content less than 12%	SEP, % Kernel Moisture Content equal to or above 12%
Steinlite	0.26	0.58
GAC2100	0.29	1.16
Microwave Moisture Meter	0.41	0.41

In an attempt to investigate the effect of foreign material, the moisture calibration equation used to predict kernel moisture content from dielectric measurements on clean samples was used to predict kernel moisture from dielectric measurements on pod samples mixed with foreign materials. The overall SEP was 0.62% for foreign material ranging from 1% to 16%.

Conclusions

For two consecutive harvest seasons (2009 and 2010) kernel moisture contents predicted from measurements on pod samples with a microwave moisture meter were compared to those obtained with two official meters and the standard oven method. For 2010, the samples came from 10 States. Overall the microwave moisture meter was consistent over a broad moisture range and no effects related to variety or growing location were noticed. In particular, the microwave moisture meter performed better than the official meters above the 12% moisture level. Results obtained for samples including foreign material are promising and open the possibility for determining kernel moisture content without having to clean the pod sample. This will simplify further the peanut grading process in relation to moisture and will help in further reducing the cost and labor.

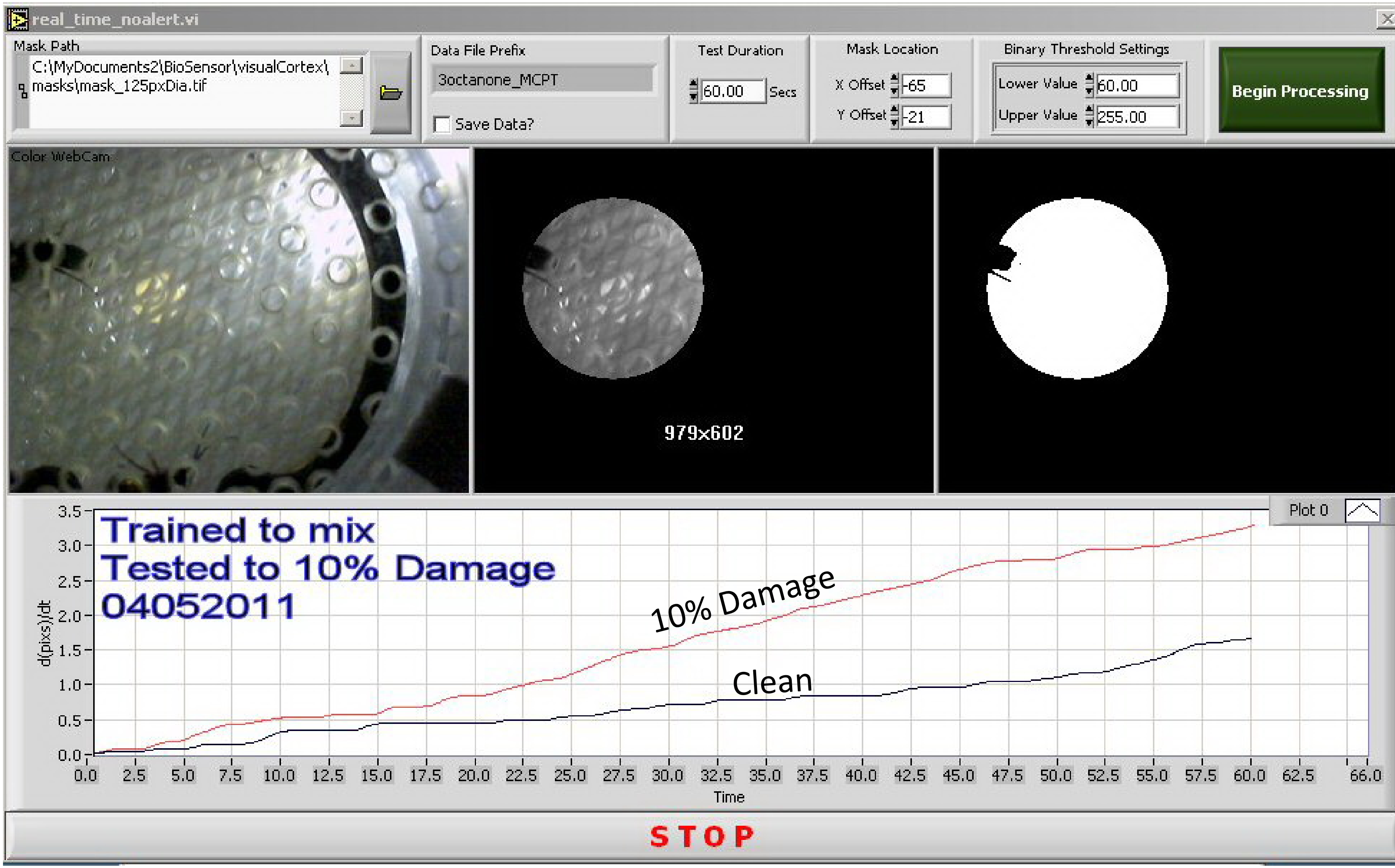
Peanut Grading Research

Detecting Damage Research: Wasps?

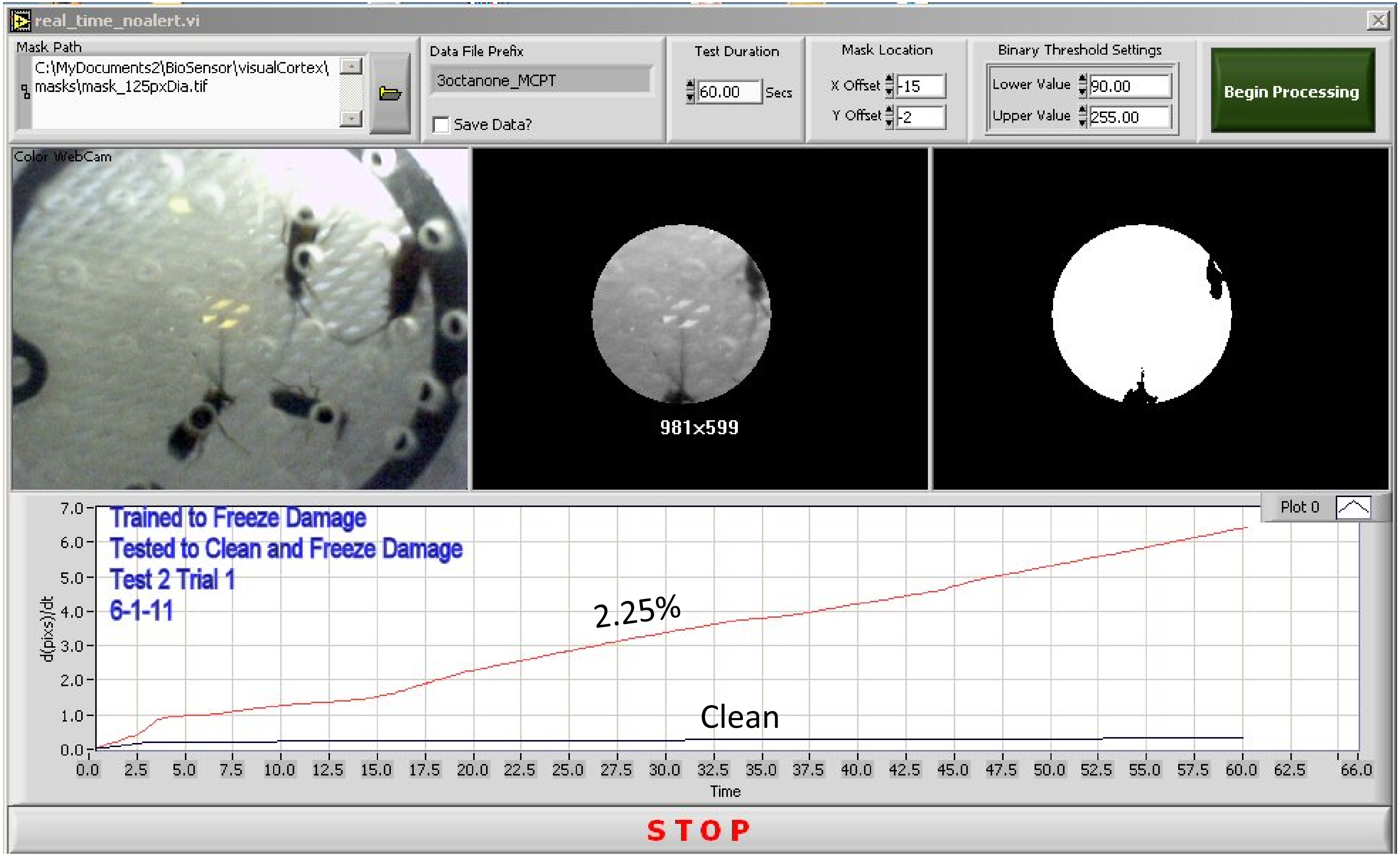
Wasp Hound

Wasp Hound Connected to Computer with Program Running on Screen

Wasp Hound Sample Analysis of 100 grams of shelled peanuts with 10% damage, Red line is Response to peanuts with 10% damage and Blue line is response to clean shelled peanuts

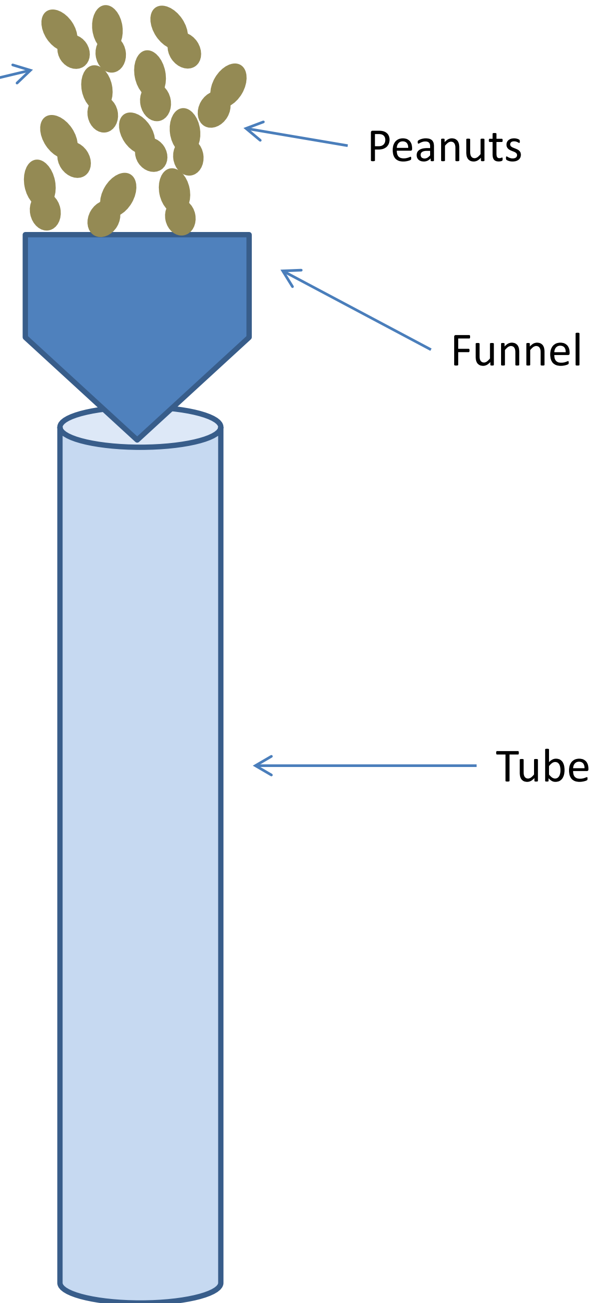


1-Quart Jar with 230 unshelled peanuts was clean (Clean)
1-Quaret Jar with 222 unshelled clean peanuts and 5 freeze and mold damaged unshelled Peanuts, 1-inch below Surface (about 2.25% damage)

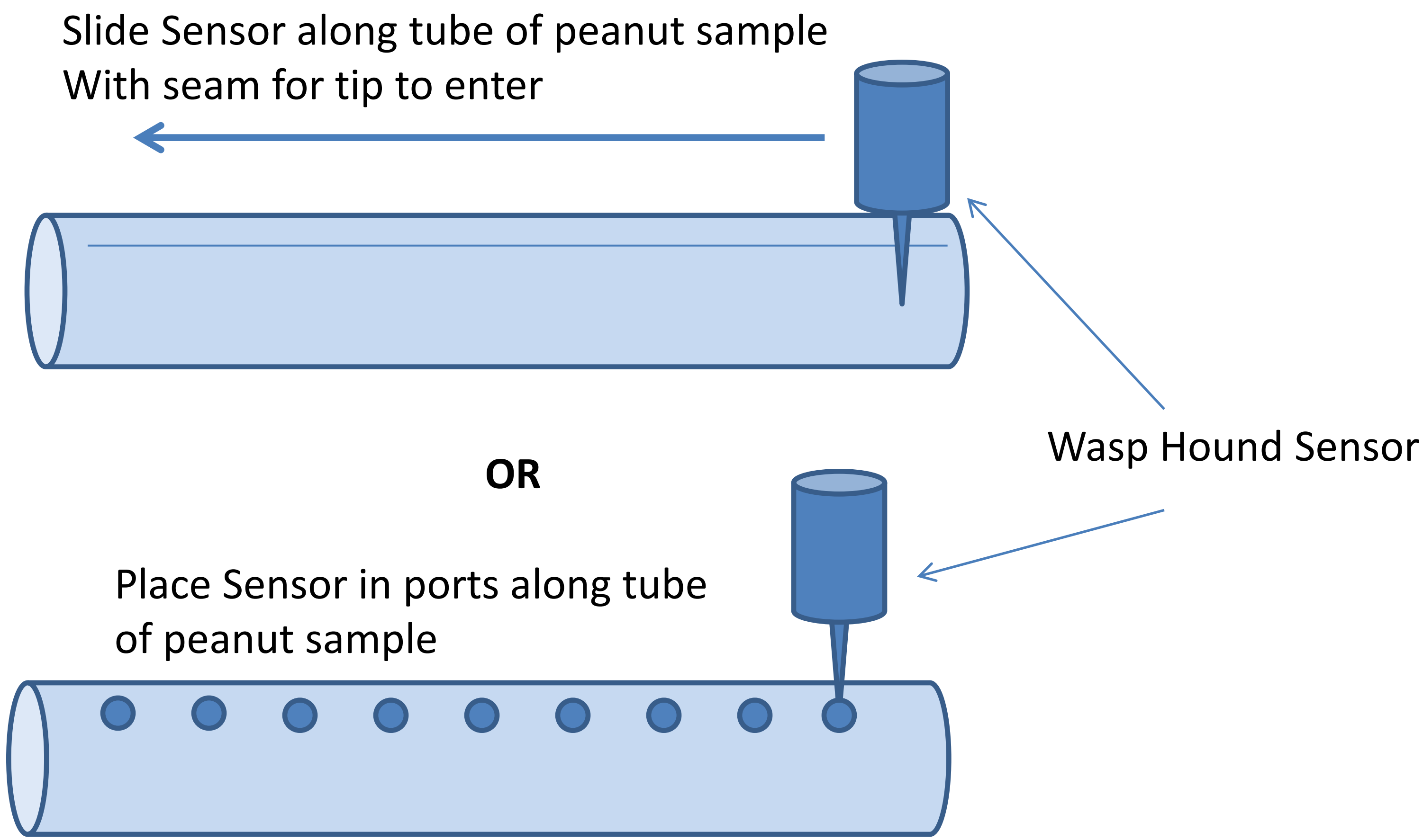


Potential Testing Method

Drop Peanut Sample into Tube



Potential Testing Method (Continued)



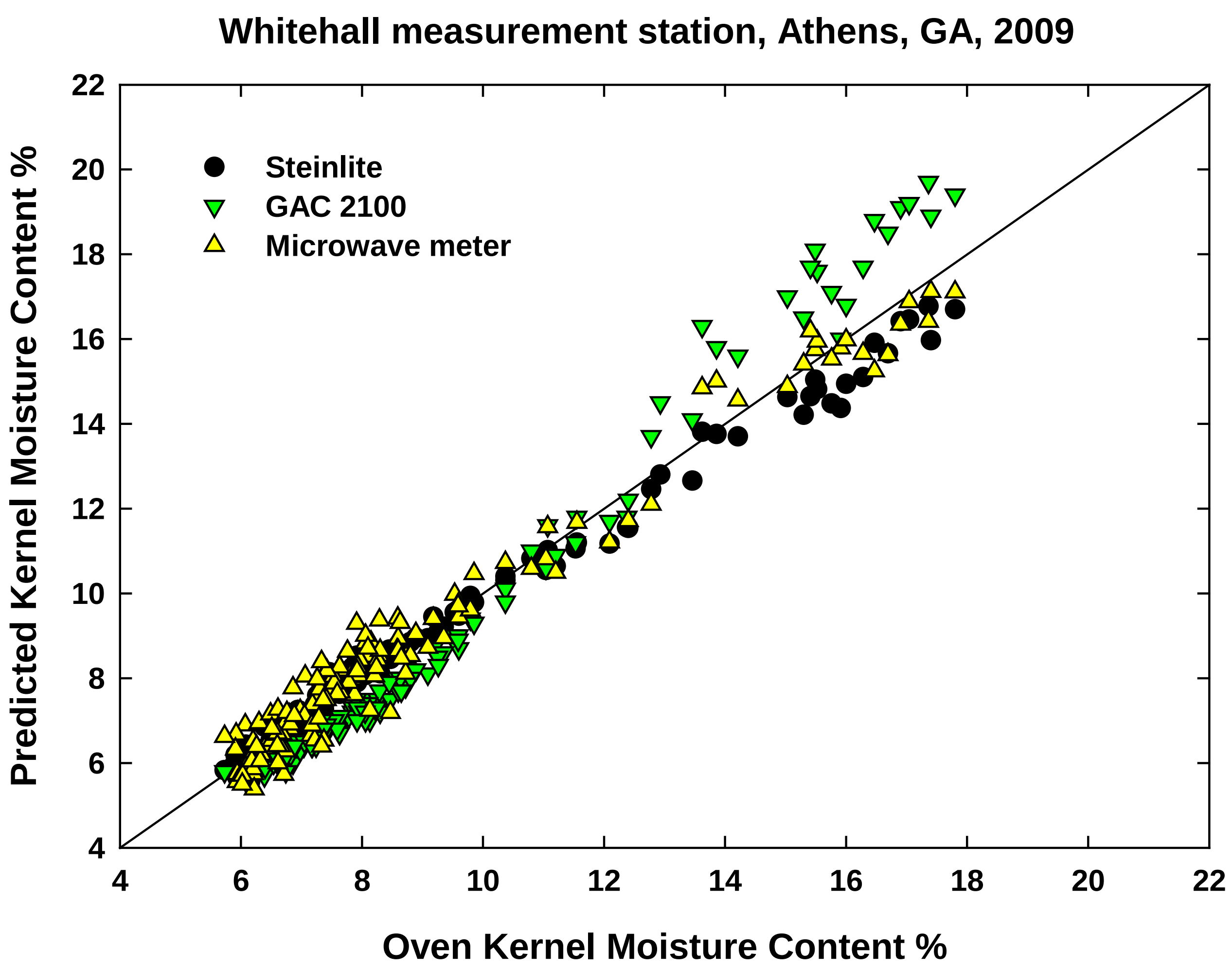
Microwave Moisture Research

2009: Whitehall measurement station, Athens, GA

- 137 total samples
- Samples from 4 states: AL, GA, NC, TX
- Comparison of performance of microwave moisture meter, GAC 2100, Steinlite, with standard oven technique

Comparison: Standard Error of Performance (SEP)

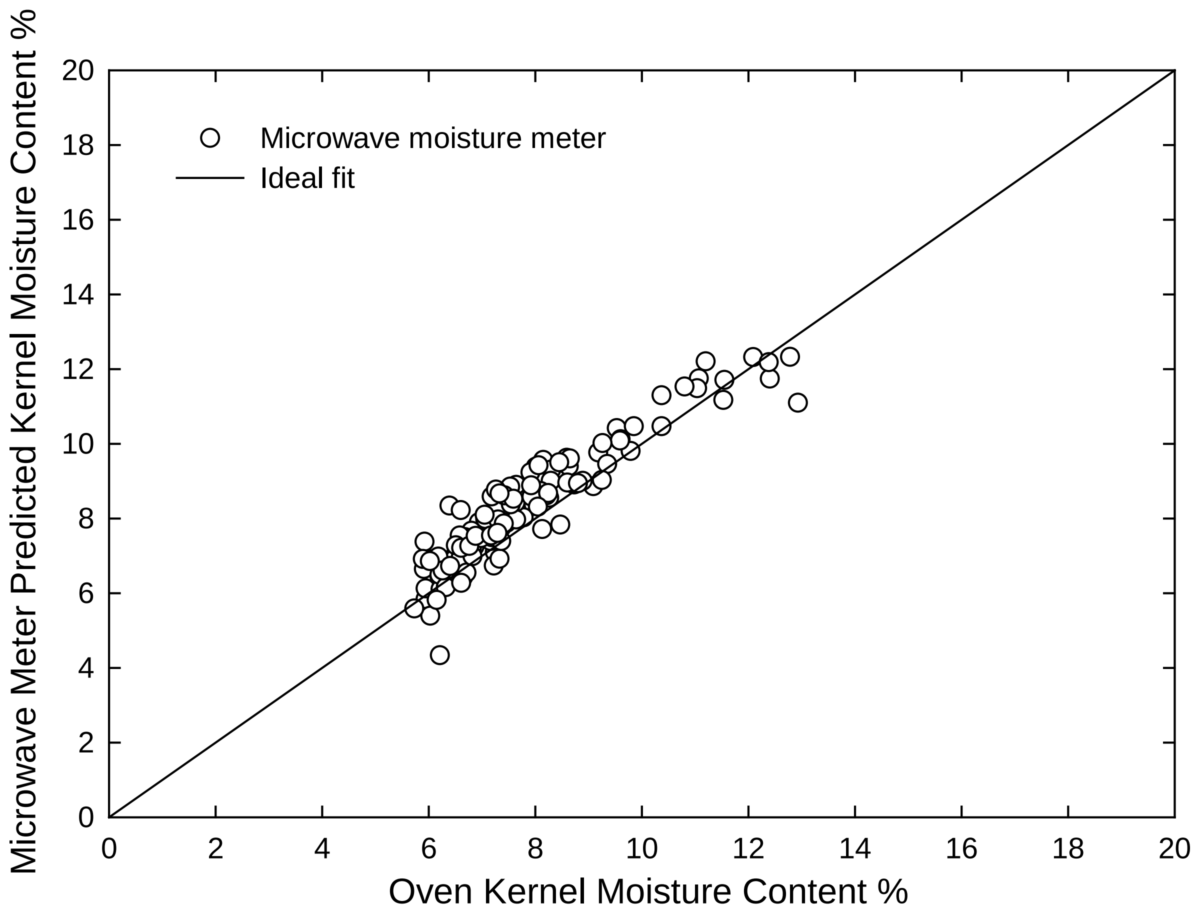
Instrument	SEP, % Kernel Moisture Content less than 12%	SEP, % Kernel Moisture Content equal or above 12%	Overall SEP, %
GAC 2100	0.23	0.76	0.51
Steinlite	0.16	0.39	0.30
Microwave Moisture Meter	0.29	0.37	0.31


Whitehall measurement station, Athens, GA, 2009
Steinlite
GAC 2100
Microwave meter
Predicted Kernel Moisture Content %
Oven Kernel Moisture Content %
4
6
8
10
12
14
16
18
20
22

2009: Measurements on samples including foreign material

- Moisture calibration equations of clean samples used to predict moisture in samples including foreign material
- SEP: 0.40
- FM % Range (within sample): 1 – 10%

Moisture prediction from measurements on samples including foreign material



SEP=0.4%
FM: 1 to 10%

2010 : Whitehall measurement station, Athens, GA

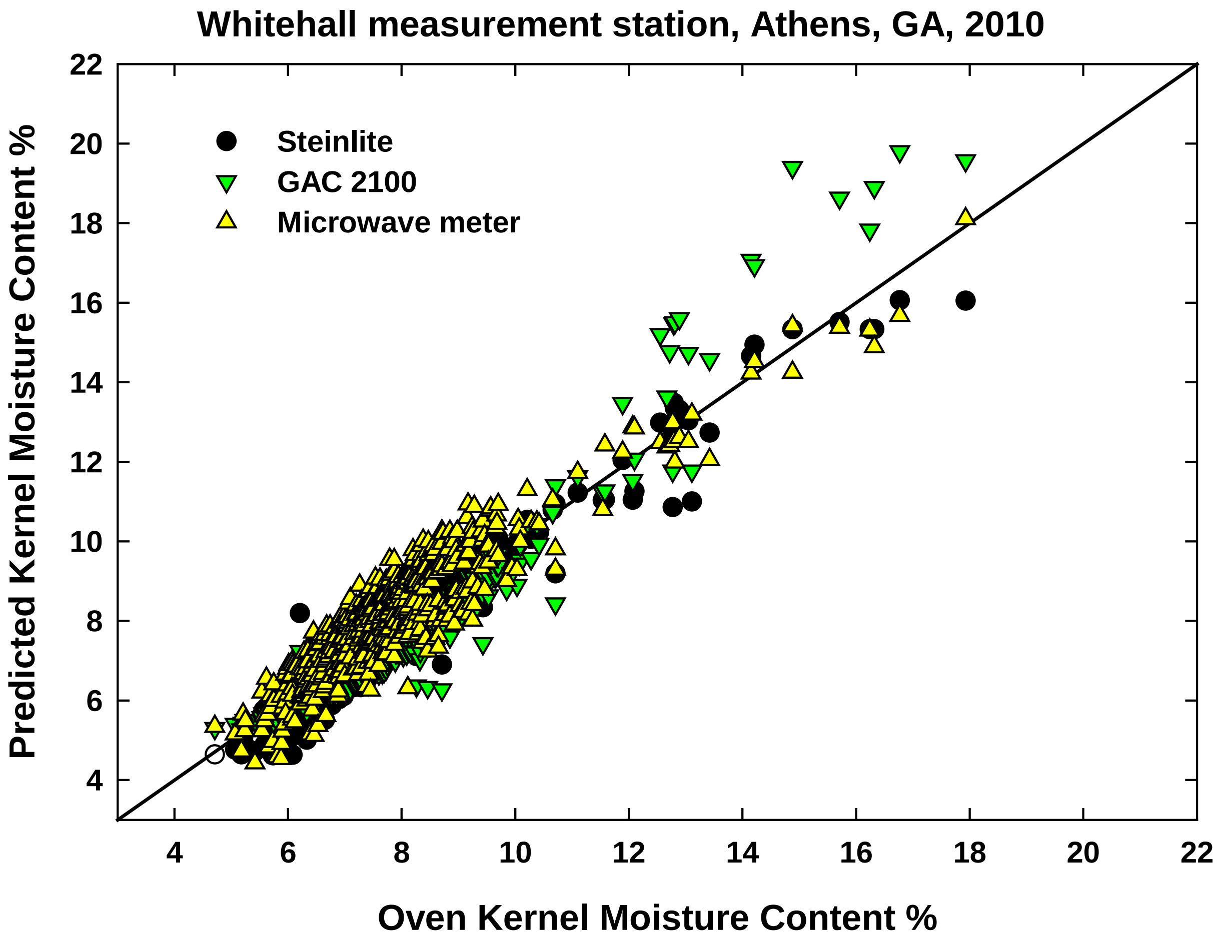
- 543 total samples
- Samples from 10 states: OK, NM, TX, FL, GA, AL, MS, SC, NC, VA
- 522 samples below 12% oven kernel moisture content
- 21 samples above 12% oven kernel moisture content

Samples by State
(Whitehall, Athens, GA, 2010)

STATE	# Received	# Expected
GA	231	228
AL	76	62
SC	21	21
NC	36	34
FL	69	44
TX	99	85
VA	7	7
MS	4	7
NM	5	4
OK	8	8

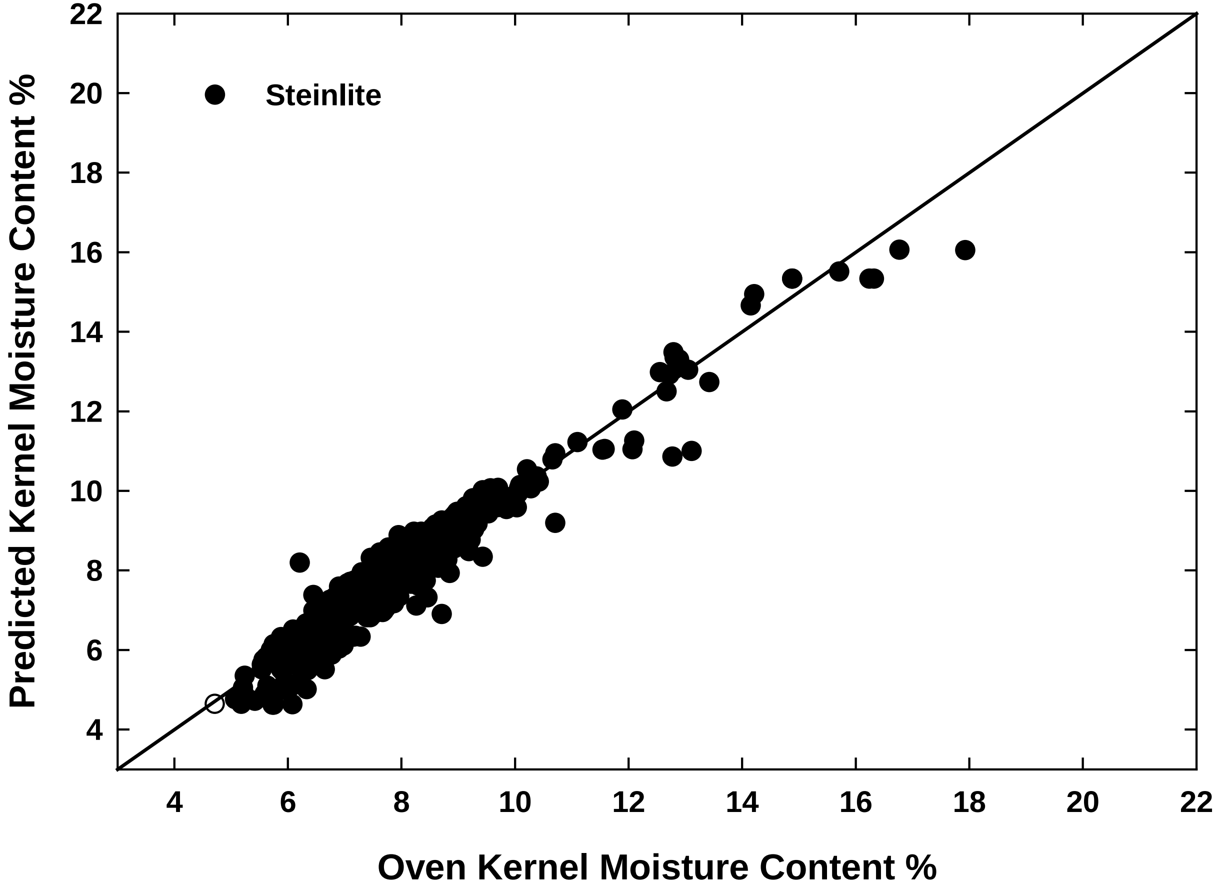
Comparison: Standard Error of Performance (SEP)

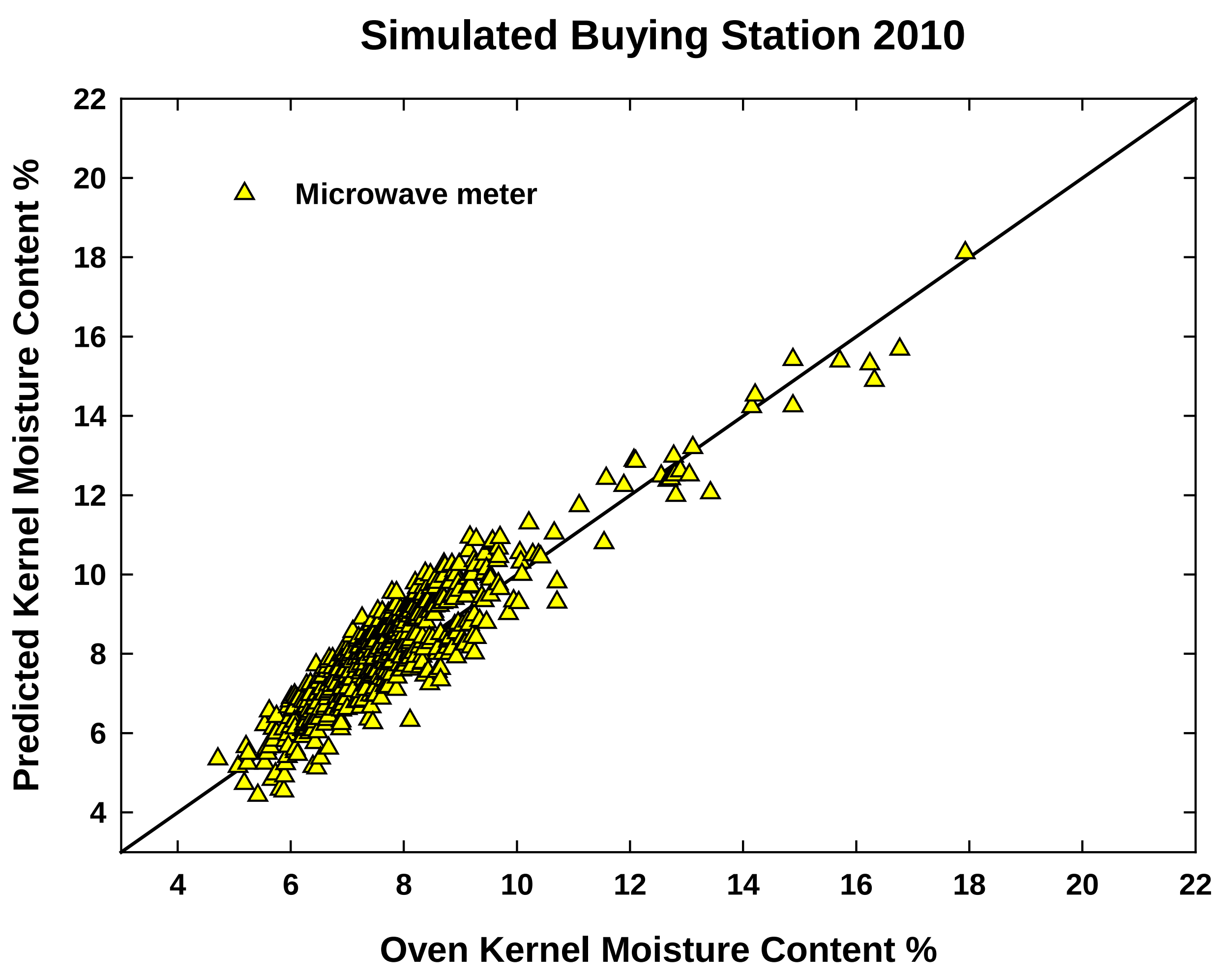
Instrument	SEP, % Kernel Moisture Content less than 12%	SEP, % Kernel Moisture Content equal or above 12%	Overall SEP, %
GAC 2100	0.29	1.16	0.48
Steinlite	0.26	0.58	0.29
Microwave Moisture Meter	0.41	0.41	0.41

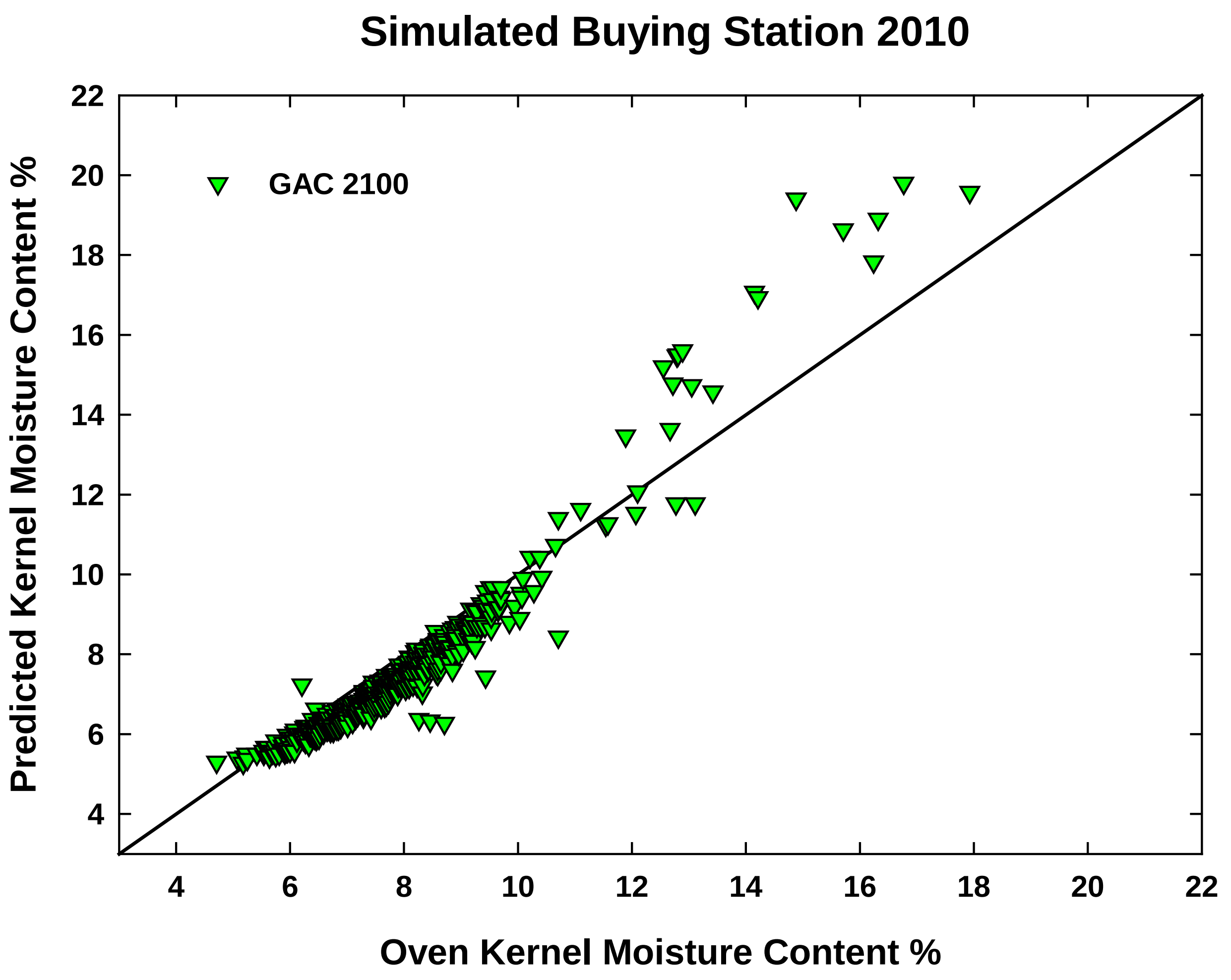


Whitehall measurement station, Athens, GA, 2010
Steinlite
GAC 2100
Microwave meter
Predicted Kernel Moisture Content %
Oven Kernel Moisture Content %
4
6
8
10
12
14
16
18
20
22

Simulated Buying Station 2010



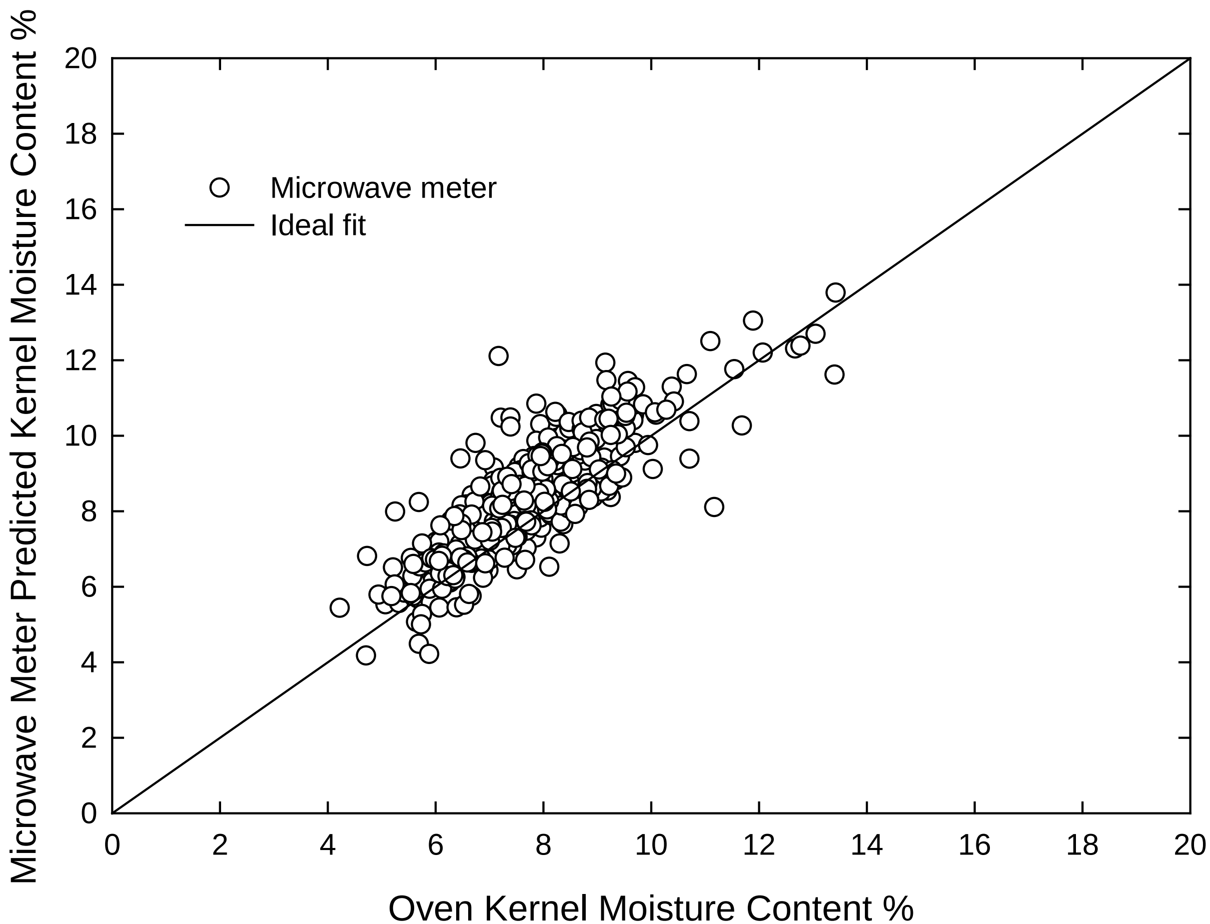

Simulated Buying Station 2010
Microwave meter
Predicted Kernel Moisture Content %
Oven Kernel Moisture Content %
4
6
8
10
12
14
16
18
20
22


Simulated Buying Station 2010
GAC 2100
Predicted Kernel Moisture Content %
Oven Kernel Moisture Content %
4
6
8
10
12
14
16
18
20
22

2010: Measurements on samples including foreign material

- Moisture calibration equations of clean samples used to predict moisture in samples including foreign material
- SEP: 0.62
- FM % Range (within sample): 1 – 16%

Moisture prediction from measurements on samples including foreign material



SEP=0.62%
FM: 1 to 16%

Microwave moisture meter 2011

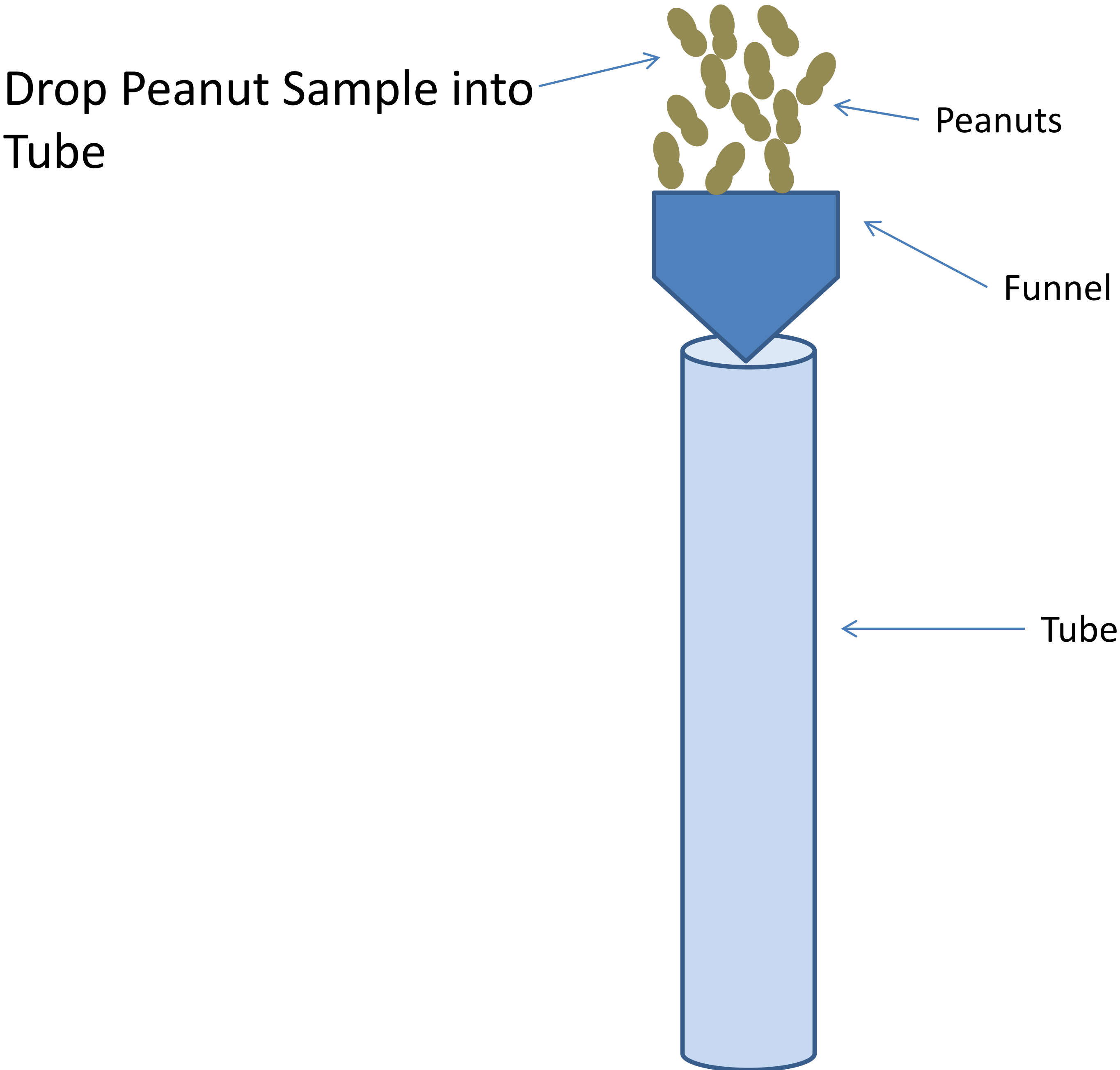

ANY
QUESTIONS

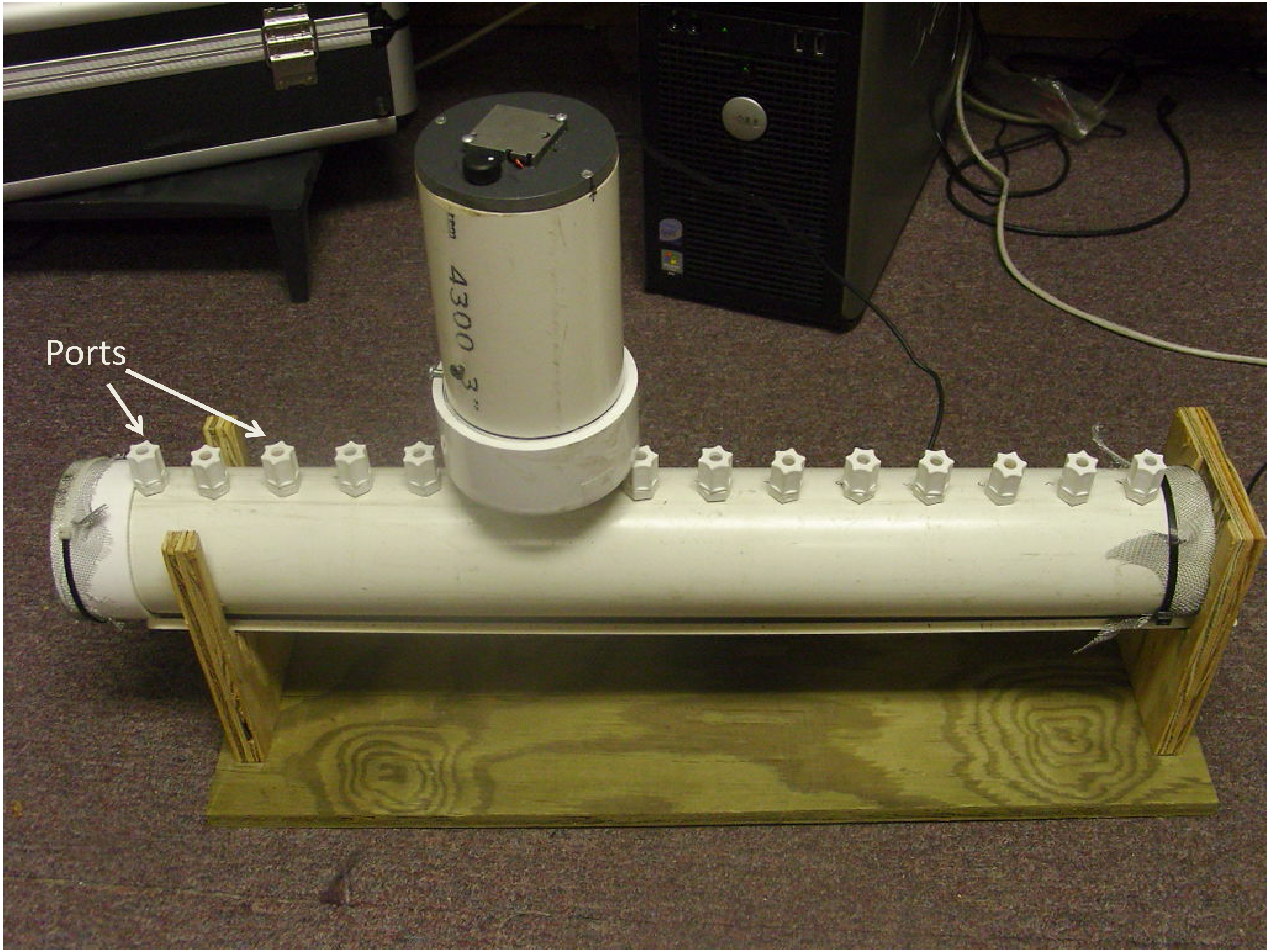
Peanut Grading Research


THANK YOU!!!!!!!!!

Detecting Damage Research: Wasps?

Testing Method

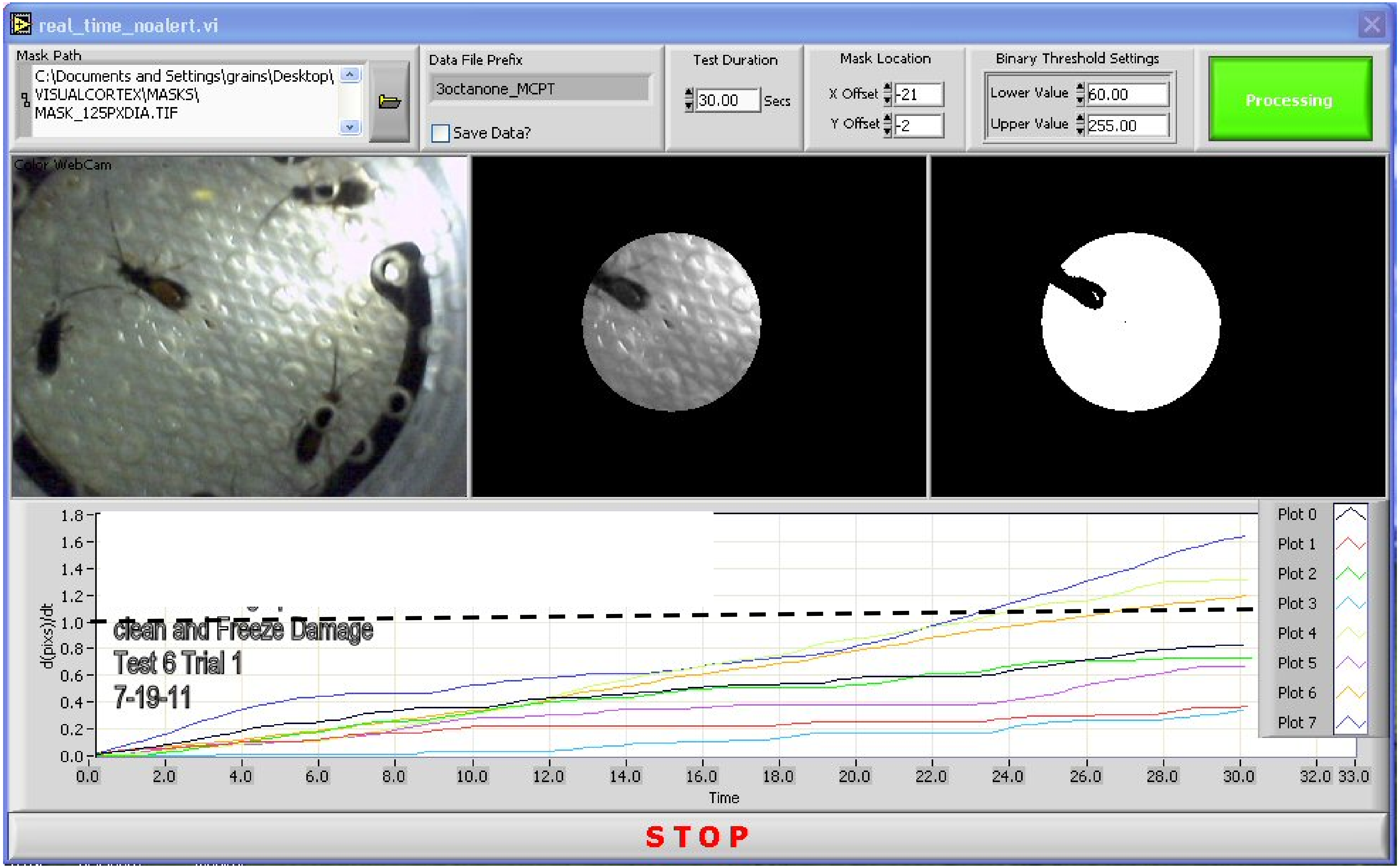




Peanuts are inside tube and Wasp Hound tests for damage odor at selected ports

Wasp Hound

Wasp Hound Connected to Computer with Program Running on Screen



Results from testing 4 ports of damaged peanuts and 4 ports of clean peanuts.
3 of 4 ports tested on damaged tube are above 1 by 30 seconds (see dashed line)
Plots 4 – 7 are damaged peanut sample, plots 0-3 are clean peanuts
(Plot 4 is hard to see)

Fall Testing

- Test one day a week at selected location for 8 weeks.
- Test with check samples at location using trained sets of wasps. (25 sample tests per day)
- Analyze results to determine which samples are identified as damaged.
- Compare Wasp response to actual graded data.
- Provide assessment after testing

Microwave moisture meter 2011

Submit Paperwork for Approval of Microwave Use on Clean Peanuts to USDA-AMS

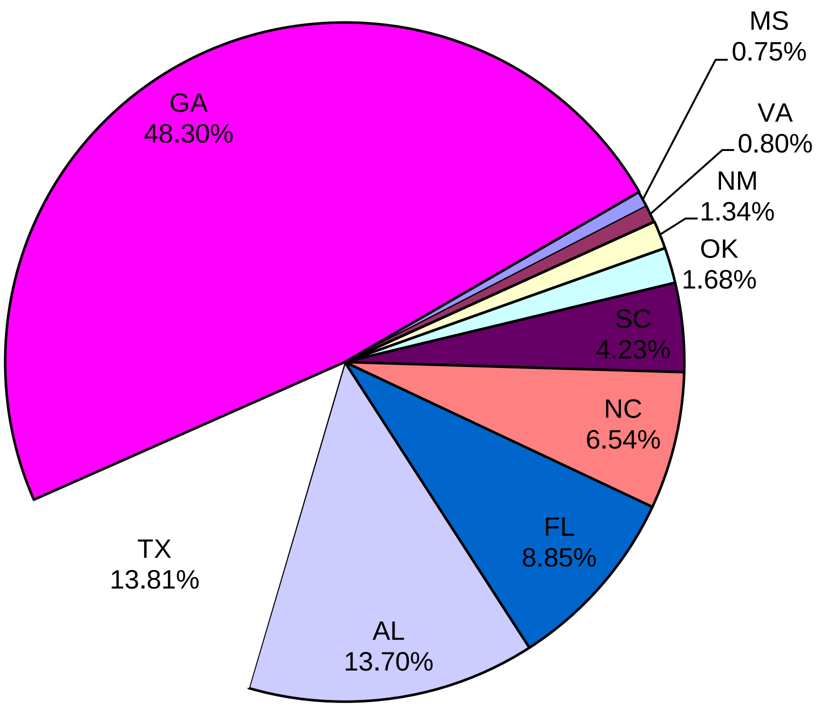
Commercialization

2011 Microwave Grading Research

2010 Buying Point Size

	2010 size (pounds)			
	Maximum	**Minimum**	**Mean**	**Median**
US	***42,745***	***18***	***6,033***	***4,174***
SE	***40,332***	***73***	***7,008***	***5,626***
AL	*40,332*	*73*	*6,313*	*2,995*
FL	*25,370*	*475*	*7,687*	*6,009*
GA	*27,122*	*562*	*7,053*	*5,984*
MS	*15,612*	*15,612*	*15,612*	*15,612*
SW	***42,745***	***32***	***7,112***	***4,785***
NM	*18,358*	*32*	*6,951*	*4,708*
OK	*13,301*	*234*	*3,529*	*2,465*
TX	*42,745*	*67*	*8,125*	*5,970*
V-C	***30,761***	***18***	***2,892***	***1,180***
NC	*19,320*	*37*	*2,659*	*1,471*
SC	*30,761*	*28*	*10,972*	*8,129*
VA	*2,772*	*18*	*694*	*522*

2010 US Peanut Tonnage Distribution (%)




ANY
QUESTIONS