DEVELOPMENT OF NEW STANDARDIZED PACKAGE SYSTEM AND INTERFACING GMA PALLET THAT ALLOWS A PAPER CORRUGATED TRAY WITH A 4 KG WEIGHT CAPACITY FOR IMPORTED MANGOS

FINAL REPORT

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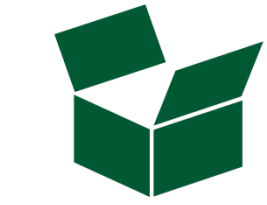

EXECUTIVE SUMMARY

This is the final report prepared in response to the Request for Proposal titled "Common Packaging Footprint for Mangos" provided by the National Mango Board (NMB). The NMB is a national promotion and research organization supported by assessments from both domestic and imported mangos with oversight by the U.S. Department of Agriculture (USDA). The NMB board members identified a need to develop a new corrugated paperboard tray that allows the shipment of an approximate minimum weight of 4 kg of fresh mangos from various countries in Central and South America.

The study included evaluation of mango trays currently being used by packinghouses in Central and South America. The researchers visited a total of 15 mango packinghouses to understand the needs of a packing process. This assisted the researchers to identify critical design elements which were used to develop a standardized corrugated tray for mangos. In addition, the researchers conducted a survey of the retailers and buyers associated with purchasing mango trays in palletized loads, to assess the impact of the proposed tray design on the mango industry.

The results of the study indicated that a 14 down common footprint tray does not fit into a 40 X 48 GMA pallet. It is capable of holding slightly less than the required 4 kg of mangos and the cooling efficiency is compromised. Whereas the two proposed designs 12 down and 15 down trays were capable of holding 5 and 3.75 kg of mangos, without affecting their cooling efficiency. The survey results further indicated that the retailers are willing to consider a tray design which can hold more than 4 kg/tray and prefers the proposed 12 down mango tray design.

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1.0 INTRODUCTION

This is the final report prepared in response to the Request for Proposal titled ***"Common Packaging Foot Print for Mangos"*** provided by the National Mango Board (NMB). The NMB is a national promotion and research organization supported by assessments from both domestic and imported mangos with oversight by the U.S. Department of Agriculture (USDA). Recently the NMB's board members have identified a **need to develop a new corrugated paperboard tray that allows the shipment of an approximate minimum weight of 4 kg of fresh mangos from various countries in Central and South America.**

Originally from India, mangos imported to the U.S. predominantly come from Mexico, Central and South America as well as Puerto Rico. According to the U.S. Census Bureau's Foreign Trade Statistics, import volumes are approaching 300 million metric tons and less than 1% comes from countries outside the Americas. The main import country is Mexico accounting for nearly 63% of the mango import volume in the last three years. In the same period, Brazil, Ecuador, Guatemala, Haiti, and Peru accounted for nearly 36% of the remaining imports. The availability of mangos per capita has increased from 1.88 to 2.53 from 2005 to 2011 respectively. The NMB wants to increase the consumption of mangos in the U.S. by uniting the industry and strengthening the mango market through various programs outlined in www.mango.org.

2.0 OBJECTIVES

The following were the objectives of the new research project that were identified by the NMB and are the subject of this report.

To design a 15 down–4 kg tray for mangos that fit into a 40x48 GMA pallet with the most favorable attributes being cost, strength, cooling rates, shipping density, and protective mango qualities. If a 15 down tray cannot stack at least 18 rows high, then a 14 down–4 kg tray should be developed.

a) To design a 14-15 down common footprint tray for mangos that fit into a 40 X 48 GMA pallet with the most favorable desire attributes regarding cost, strength, cooling rates, shipping density, and protective qualities.

b) Evaluate how this common footprint tray will impact the mango industry at the different levels of the mango supply chain (producers, packers, exporters, importers, and retailers) regarding volume, equipment, cost, environmental issues, sanitation and safety, etc.

c) Review of total cost associated with size and weight of the different mango varieties.

d) Define and identify the strategies or system to move from a price per tray or count to a price per pound, kilogram or weight.

e) Ask the 10 major mango trays suppliers in the main importing countries (Mexico, Ecuador, Peru, Brazil, Guatemala, and Haiti) if they will be capable to make the new common foot print tray and the cost.

In summary, the new tray will be used to standardize 14-15 paper based corrugated trays per layer on a standard 1000 mm x 1200 mm footprint sized wood based Grocery Manufacturers Association (GMA) pallet that delivers improved cooling and overall quality of fresh mangos to consumers in the U.S.

Currently a wide range of different sizes and configurations of packaging are used to ship and sell fresh mangos. The mango producing countries and U.S. importers and retailers have for several decades conducted trade based on a tray with a 4 kg fixed weight quantity. The purpose of this research project is to evaluate current packaging methods used for mangos to distribute and sell in the U.S.

In addition, the project will include developing a standardized package system that provides better quality of fresh fruit at the end of the distribution chain and also improves sales at retail stores.

3.0 METHODOLOGY

During this project the following critical steps were followed:

a) Identify the various types of packaging currently used by exporters, importers, wholesalers and retailers for mangos.
b) Identify the challenges imposed by major and small retailers for distribution and sales of mangos in the U.S.
c) Develop criteria for new packaging method that meets the standardization and retail objectives.
d) Design new packaging method.
e) Test and compare performance of existing and new packaging methods.
f) Modify and redesign if needed for improving performance of new standardized package system.

3.1 PRELIMINARY INVESTIGATION FINDINGS

In a preliminary study based on the requirements of the request for proposal (RFP), the researchers investigated what a 15 down footprint could hold with an approximate 18 high stack requirement with mango fruit being imported. This test was conducted in the California market and the results are shown below (Figure 1). It was interesting to note that there is a larger size fruit being imported that results in a low pack density in the tray. As a result some trays when fully packed will result in being slightly under the 4 kg requirement. Smaller size fruit and varieties such as *Ataulfo* result in higher pack density and trays carrying more fruit.

This is also the reason why the investigators of this study visited both Brazil and Peru that have - longer distances involved and a double wall corrugated tray is used. A double wall tray has smaller inside available volume than a single wall tray with the same outside foot-print.

12 count, 3.25 Kg

8 count, 4 Kg

12 count, 3.95 Kg

Figure 1: Preliminary Investigation of 15-down Footprint Trays

4.0 REVIEW OF BRAZIL AND PERU MANGO PACKINGHOUSES

In a previously funded project the team had reviewed operations from Mexico and Guatemala in 2010. However, shipments from South America, originating from countries such as Brazil and Peru use double-wall corrugated materials for trays as compared to single wall used to make similar trays coming from Mexico, Guatemala and other Central American nations. While the trays may look similar, the strength required to withstand the longer shipping time from South America, as well as additional cushioning protection, makes the choice of double wall corrugated necessary at the present time. There are new technologies available in U.S. and Europe that allow for strengthening of single wall corrugated board, but these may not be widely available to countries in Latin America at the present time.

In October 2011, two of the investigators on this project consisting of Dr. Paul Singh (Michigan State University) and Dr. Koushik Saha (Cal Poly State University) visited Brazil to review the packaging methods and packinghouses used to ship fresh mangos to the U.S. A similar visit was conducted in Peru by Dr. Paul Singh in January 2012. In addition, Dr. Paul Singh visited the largest corrugated manufacturer in Peru, which also is the largest producer of maximum trays for export to U.S., Europe and South America.

Similar to postharvest operations in Mexico and Guatemala. The operations in the Brazilian and Peruvian mango packinghouses are fairly automated. The incoming mangos are washed (Figure 2) and graded, sorted by size or weight using manual or automated check weighers and cameras (Figure 3), and then sent in batches through heat treatment immersion tanks that have chlorinated water. After this postharvest process in accordance with Hazard Analysis & Control Points (HACCP) practices, the dried mangos are hand packed in trays based on their size, weight and quality (Figure 4). The growers and packers, try to meet the primary criteria of a filling a designated 4 kg tray.

A particular shipment was observed in a packaging house at Peru, where an APL intermodal container was loaded with pallets of unitized mango fruit in corrugated trays (12 per layer, 21 layers high). The container was then moved on the flat-bed truck to the port of Talara, Peru and then by ship across the Panama Canal to a distributor in New York, U.S.

Figure 2: Incoming Fresh Mangos Received in Plastic Totes, Washed and Hydro-Cooled

Figure 3: Automated check weighers and cameras

Figure 4: Packing of Sorted and Graded Mangos in Trays

The trays are then stacked in a 4 x 3, or 12 trays per layer configuration on wooden stringer style pallets (Figure 5), 21 layers high, and unitized using 10-11 horizontal plastic straps with vertical

(extruded plastic) corner angle boards (Figure 6). These are then subjected to either a forced air cooling system, or just placed for longer times in cold air warehouses. Palletized loads are then loaded inside pre-cooled ISO intermodal containers for shipment by truck (Figure 7) to the port, and then by ship to the U.S. where they are sent to regional distributors.

Figure 5: Wooden Stringer Pallet

Figure 6: Palletizing of Trays and Use of Plastic Bands to Secure Loaded Pallets

Figure 7: Palletized Loads Inside Pre-Cooled ISO Intermodal Container

5.0 REVIEW OF CURRENT MANGO PACKAGING SYSTEM

Based on trips to all four countries, the research team has concluded the following critical items with reference to the mango shipments:

1. The trays used to ship mangos come in a range of different designs and shapes, varying sizes, different quality of wood pallets, all aimed at maximizing and optimizing the shipment in a standard ISO intermodal container or truck trailer. Depending on the tray size, design and corrugated board material there is a variation in compression strength of these trays. This was seen in the three sets of sample trays that were procured from packinghouses in Brazil and Peru (Table 1 & 2).

2. A very small percentage of wood pallets currently being used for mangos are designed to meet U.S. GMA pallet standards.

3. The various designs of trays are either designed with interlocking or nesting tabs; however, these features provide very little pallet stability during transit. A strong tray (high compression strength) with bottom sections of the load having more horizontal straps is necessary for long intermodal shipments that include truck and sea voyage. Ideal designs need 10-11 horizontal straps and corner posts for long intermodal container shipments from South America (Figure 6), to 5-7 straps and corner posts for shorter truck shipments from Mexico.

4. The design of the tray should utilize forced air cooling to save energy and reduce time required to pre-cool fruit, and thereby extend the shelf-life. The new tray design (Figure 12, Appendix C & D) with a 12 or 15 down footprint will allow forced air cooling at a reduced time. Whereas for the 14 down footprint with a new tray design will not be as effective.

5. The horizontal opening in trays on the sides for cooling is more critical than vertical openings in bottom of the tray i.e., temperature should be lowered and controlled before loading the palletized fruit inside the trailer or ISO container.

6. A 4 kg tray is impossible to accommodate all varying sizes for the 5-18 count fruit (that includes all Keitt, Kent Ataulfo, and Tommy Atkins varieties)(Figure 8) using a 40 x 48 GMA footprint. The reason for this is that the 5 count fruit is large and will not meet the 4 kg requirement, and the 12-18 count will result in almost 5 kg of fruit per tray. While the tray may be standardized, the smaller fruit will significantly exceed the tray weight requirement whereas large fruit will not meet weight requirement.

Figure 8: Varying Size of Mango Variety

7. A 9-12 count tray meeting a minimum 4 kg is highly likely on a GMA pallet footprint with the tray designed in 2010, for a 4 x 3 tray configuration stacked approximately 21 high.

8. The new tray for a 40 x 48 pallet will impact total shipment (Table 4) (12 down: 144/pallet & 15 down: 195/pallet) for trade per inter-modal container, and require additional stabilization due to open spaces (Figure 9).

9. The total number of trays per shipment will go down using a GMA 40 x 48 pallet due to the space created in the longitudinal direction as the pallets are loaded into containers in the 40 inch dimension as compared to existing pallets with a 45 inch wide footprint (Figure 9).

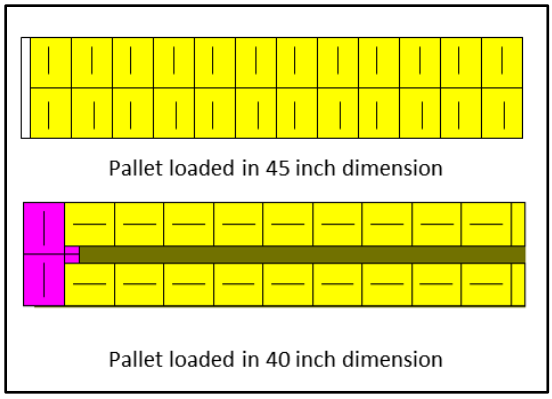


Figure 9: Palletized Load in a 40 ft. Container

10. An alternative is to use a 45 x 48 inch pallet, or 45 x 45 pallet size similar to the automotive industry that best optimizes both container and truck shipments with minimum additional blocking and bracing for load stability.

Table 1: Compression Strength Sample Trays from Brazil

Sample 1		
S.No.	Force (lb.)	Deflection (in)
1	709.9	0.31
2	715.8	0.51
3	643.9	0.29
Avg.	**689.9**	**0.37**
S.D.	**39.9**	**0.10**

Sample 2		
S.No.	Force (lb.)	Deflection (in)
1	750.5	0.29
2	621.0	0.35
3	922.0	0.35
Avg.	**764.5**	**0.33**
S.D.	**151.0**	**0.03**

Sample 3		
S.No.	Force (lb.)	Deflection (in)
1	1033.0	0.37
2	1106.0	0.45
3	1660.0	0.46
Avg.	**1266.3**	**0.43**
S.D.	**342.9**	**0.05**

Table 2: Compression Strength Sample Trays from Peru

Sample 1		
S.No.	Force (lb.)	Deflection (in)
1	1201	0.42
2	115	0.21
3	1385	0.38
Avg.	**1234**	**0.34**
S.D.	**137.9**	**0.11**

Sample 2		
S.No.	Force (lb.)	Deflection (in)
1	1158	0.29
2	1256	0.27
3	1131	0.24
Avg.	**1182**	**0.27**
S.D.	**65.8**	**0.03**

Sample 3		
S.No.	Force (lb.)	Deflection (in)
1	1218	0.29
2	1427	0.28
3	1251	0.25
Avg.	**1299**	**0.27**
S.D.	**112.4**	**0.02**

6.0 PROPOSED MANGO PACKAGE DESIGN

A recommendation from Brazil was to consider the 14 down pallet configuration shown in Figure 10. While this is feasible for a smaller size fruit and count, it will not permit 4 kg trays with fruit sizes in the 5-9 count that are widely marketed from Mexico and other Central American suppliers previously examined in 2010/2011. It also does not allow efficient pre-cooling using forced air facilities, where the venting in the packaging has to align with the air flow direction. The longer shipment time from South America allows for a smaller tray in a 14 down layout to properly cool the fruit and maintain temperature due to the bottom holes and the use of high quality ISO containers that provide vertical air flow.

Figure 10: 14 down Foot Print on a Non-GMA Pallet

Based on the findings of the current mango packaging system, two tray designs (Figure 11) were proposed for a 40 x 48 standard GMA pallet. The outside dimension of the 12 and 15 down tray design are **12.875 x 11.75 x 4 inches** and **13.2 x 9.5 x 4 inches** respectively. The specification sheet of these tray designs are shown in *Appendix A* and *Appendix B*. For these tray designs the minimum requirement is a **C-flute** corrugated board with a **200 lb. burst strength**. The maximum allowable numbers of trays that can be palletized to fill a 40 and 53 ft. container for both tray designs are shown in Table 3 and 4. A palletized load of the 12 and 15 down tray are shown in *Appendix C, D, E & F*.

According to U.S. Department of Transportation, the federal commercial vehicle maximum standards on the interstate highway system[1], a tandem axle truck has a payload weight limit of 34,000 lb. of freight in 40 ft. container. For a 53 ft. container the typical payload limit is 56,890 lb.[2]. A containerized load for both tray designs in a 40 ft. and 53 ft. container is shown in Figures 12 & 13 in accordance to the above weight limits.

New 12 Down Tray- 5 Kg

New 15 Down Tray- 3.75 Kg

Figure 11: Proposed Tray Designs for a 12 and 15 down Footprint on 40 x 48 Pallet

Table 3: Maximum Allowable Number of Trays in a 40ft. Container

Footprint	Wt. Capacity (Kg)	Layout	Layers/ Pallet	Total No. of Trays/Pallet	Wt. of Pallet Load (Kg)	Pallets / 40 ft. Container
12 down	5	4 x 3	12	144	750	20
15 down	3.75	5 x 3	13	195	762	20

[1] http://ops.fhwa.dot.gov/freight/sw/overview/index.htm
[2] http://www.pacer.com/Intermodal/IntermodalContainers.aspx

Table 4: Maximum Allowable Number of Trays in a 53 ft. Container

Footprint	Wt. Capacity (Kg)	Layout	Layers/ Pallet	Total No. of Trays/Pallet	Wt. of Pallet Load (Kg)	Pallets / 53 ft. Container
12 down	5	4 x 3	12	144	750	46
15 down	3.75	5 x 3	12	180	706	46

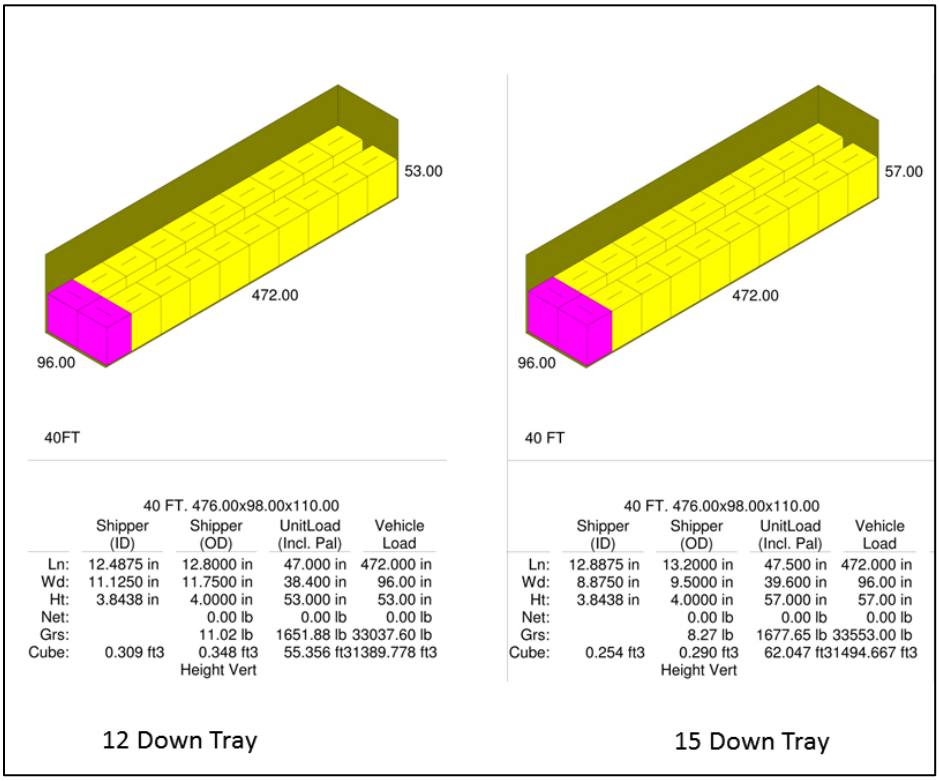


Figure 12: Palletized Load of Mango Trays in a 40ft. Container

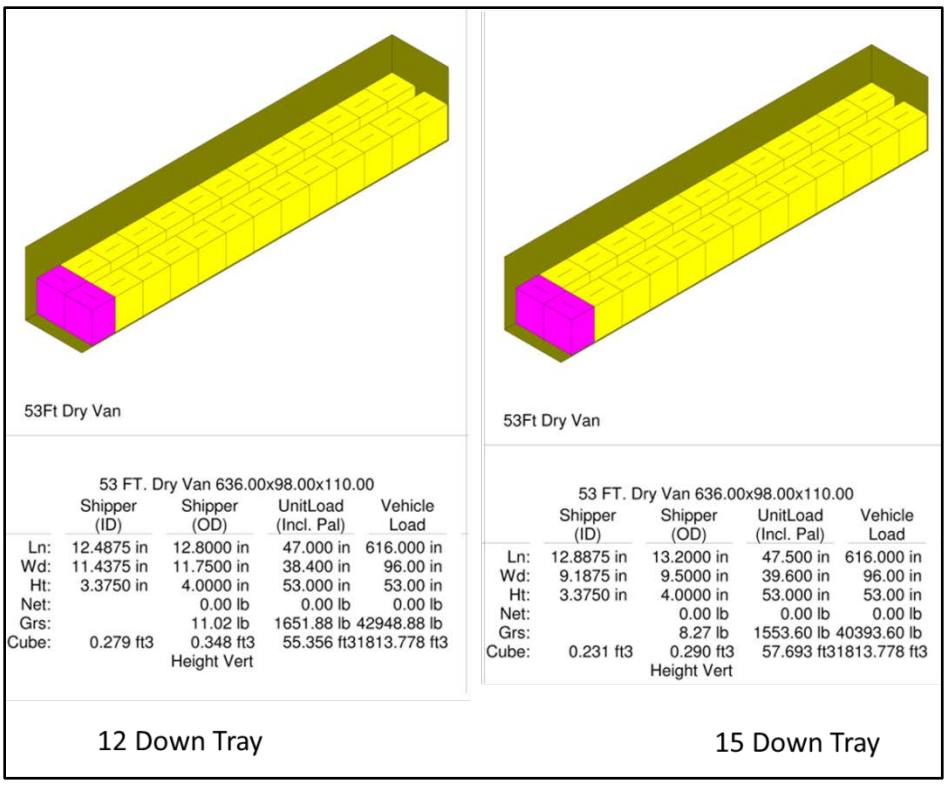


Figure 13: Palletized Load of Mango Trays in a 53ft. Container

7.0 SURVEY FOR NEW MANGO PACKAGE SYSTEM

The NMB's Research and Executive Committees, and the authors participated in a teleconference discussion on Thursday, July 12th, 2012 about the proposed tray designs. Upon the instructions of the NMB the authors were directed to conduct a survey specifically of the retailers and buyers associated with purchasing mango trays in palletized loads.

A total of 88 contacts were provided by NMB of different retailers. Each candidate was emailed a survey form (Appendix G) and was contacted by phone calls. This exercise was repeated 3 times (email and phone call) over a period of two weeks to accumulate the survey responses. A total of 49 out of 88 participants responded to our emails/phone calls, of which 26 agreed to participate in the survey and 23 declined (a few were unreachable due to wrong telephone number).

The survey consisted of 4 questions and the results are shown below:

1. **Would you prefer mangos shipped on a standard GMA (40x48 inch) pallet?**

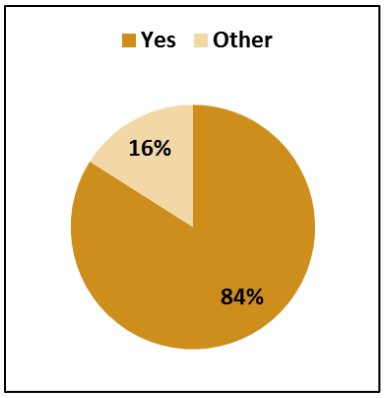


Figure 14: 84% (22/26) of the respondents preferred mangos being shipped on the standard GMA pallet.

2. **Will you consider the weight per tray of fruit in a new tray other than 4 kg?**

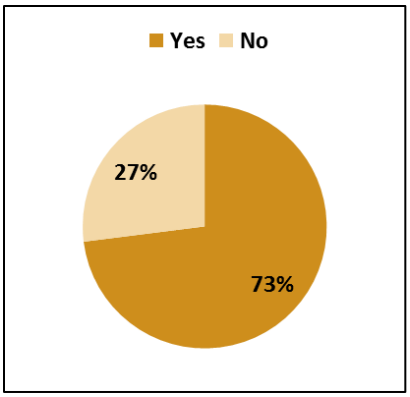


Figure 15: 73% (19/26) will consider weight per tray of fruit in a new tray other than 4 kg

3. **Please rank your preference of a 12 down or 15 down tray.** ***1 is most favorable and 5 is least favorable***

- 15% respondents (4/26) prefer either designs

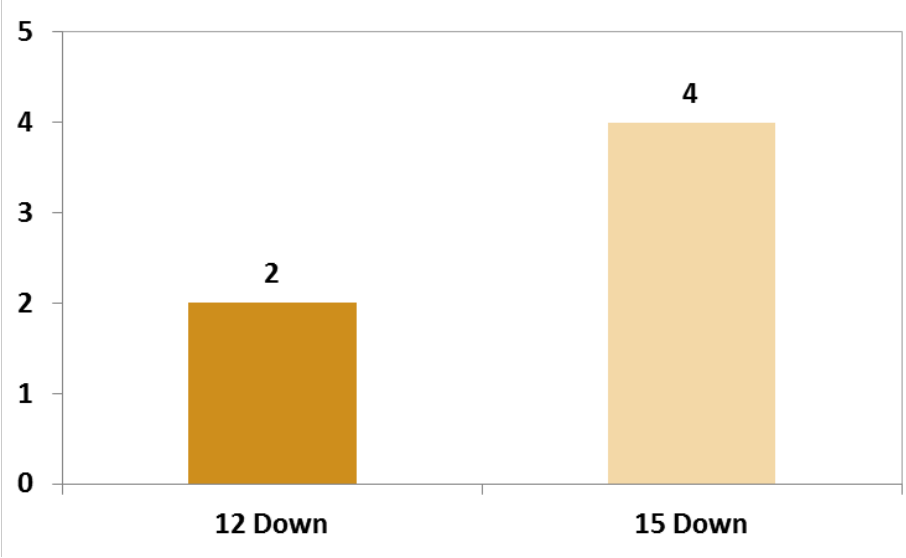


Figure 16: Average rank of 12 down and 15 down tray

4. Do not make any changes in the pallet or tray size.

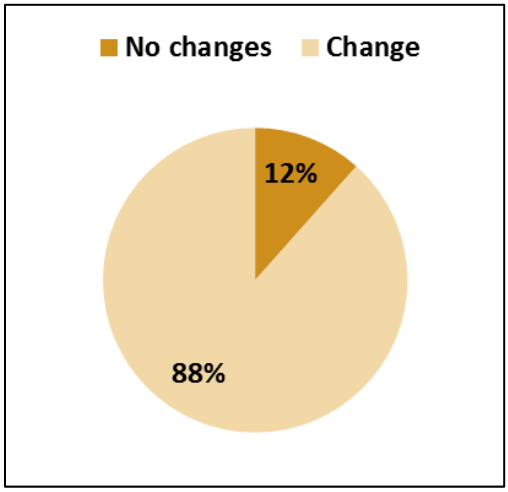


Figure 17: 12% of the respondents (3/26) did not want any changes in the pallet or tray size

8.0 CONCLUSIONS AND RECOMMENDATIONS

The key findings of this study are provided below:

a) A 14 down common footprint tray does not fit into a 40 X 48 GMA pallet and is capable of holding slightly less than 4 kg of mangos. The cooling efficiency of a 14 down tray is lower than the recommended 12 and 15 down tray (Figure 11). The 12 and 15 down tray dimensions enables a pallet pattern (Appendix C-F) which creates clear cooling channels for a palletized load of mango trays, as compared to a 14 down pallet pattern (Figure 10).

b) To evaluate the impact on the mango industry of the proposed tray design, a survey of the retailers and buyers associated with purchasing mango trays in palletized loads was conducted.

   As expected, the survey results showed that the majority (84%) of the retailers and buyers contacted preferred mango trays to be shipped on a standard GMA (40 X 48 inch) pallet (Figure 14). About 73% of the total respondents are willing to consider a new tray design which can hold more than 4 kg/tray (Figure 15). The respondents further indicated that they prefer the 12 down tray design holding 5 kg/tray compared to the 15 down tray design holding 3.75 kg/tray (Figure 16). Also, it should be noted that only 12% of the respondents surveyed (Figure 17) did not want to make any changes to their current mango tray design. This shows that the major stakeholders are ready to adopt the proposed mango tray design to accommodate their mango packaging needs. Most packinghouses will be capable of erecting the new tray design on their current carton erecting machines. Therefore there will be minimal cost increase in adopting this tray design in their packing facilities

c) Based on the estimated material use of the tray as compared to trays currently being manufactured to ship mangos from Mexico, Guatemala, Peru and Brazil, where manufacturing equipment for corrugated trays were also reviewed, there should be no increase in cost of new trays. There may be however one-time equipment setup costs to transition to the new tray configuration. These are likely to range between $1,000 to $5,000.

d) The NMB at its last meeting with the scientists (Dr. Singh, MSU, Dr. Singh, Cal Poly and Dr. Saha, Cal Poly) clearly decided not to pursue 'Objective d' as mentioned in Section 2.0 of this report. Instead it was decided to conduct a survey retailers and buyers, to identify the best common footprint and weight of tray that would be acceptable for merchandising mangos in U.S. The results of this survey have already been presented and discussed earlier in this report.

e) The new tray designs were discussed in Mexico and Peru with corrugated tray manufacturers and their equipment can manufacture the new design.

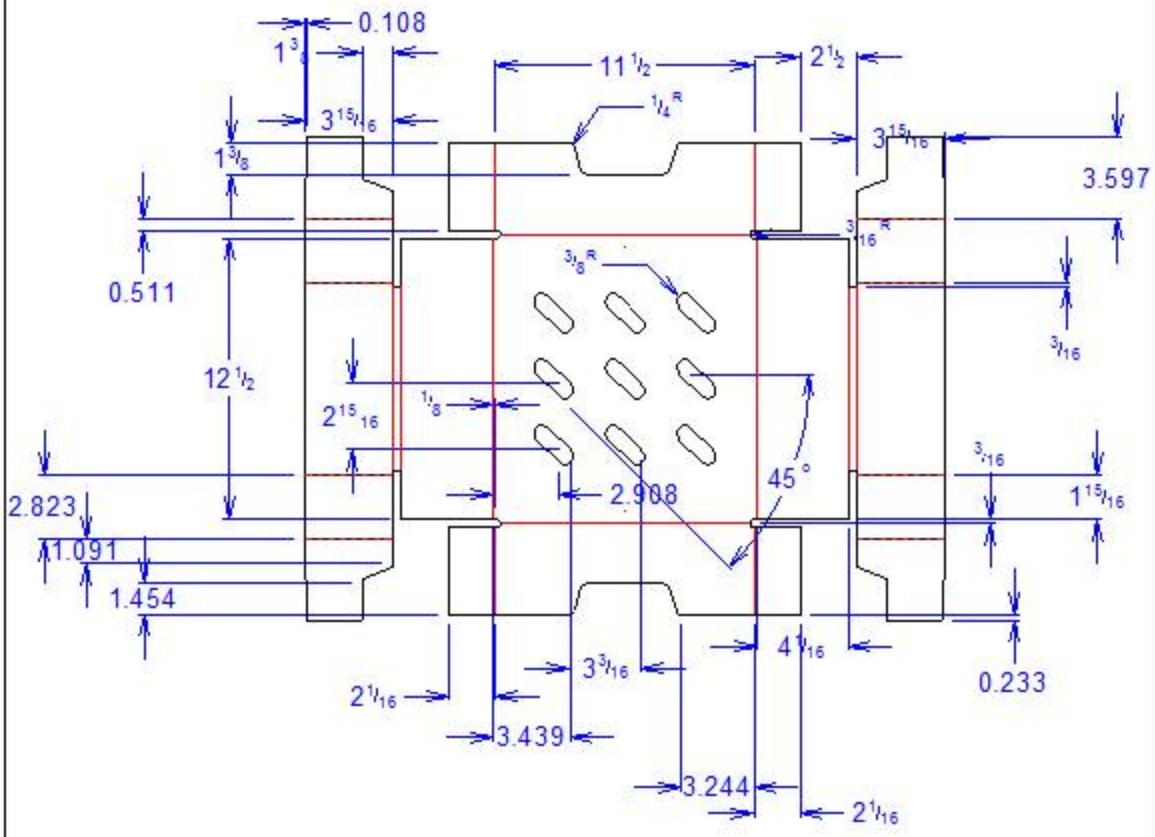
APPENDIX A

ArtiosCAD Specification Sheet

Customer:
Description:

Date: 02/12/2013

Design:	12 DOWN 12.8 X 11.75 X 4 _Dimensions.ARD		
Side shown:	Printed side	Grain/corr:	Vertical
Board:	I-200 C Kraft	L x W x D:	
Area:	13.26	Blank width:	28+1/2
Total Rule Length:	343+19/32	Blank height:	21.467



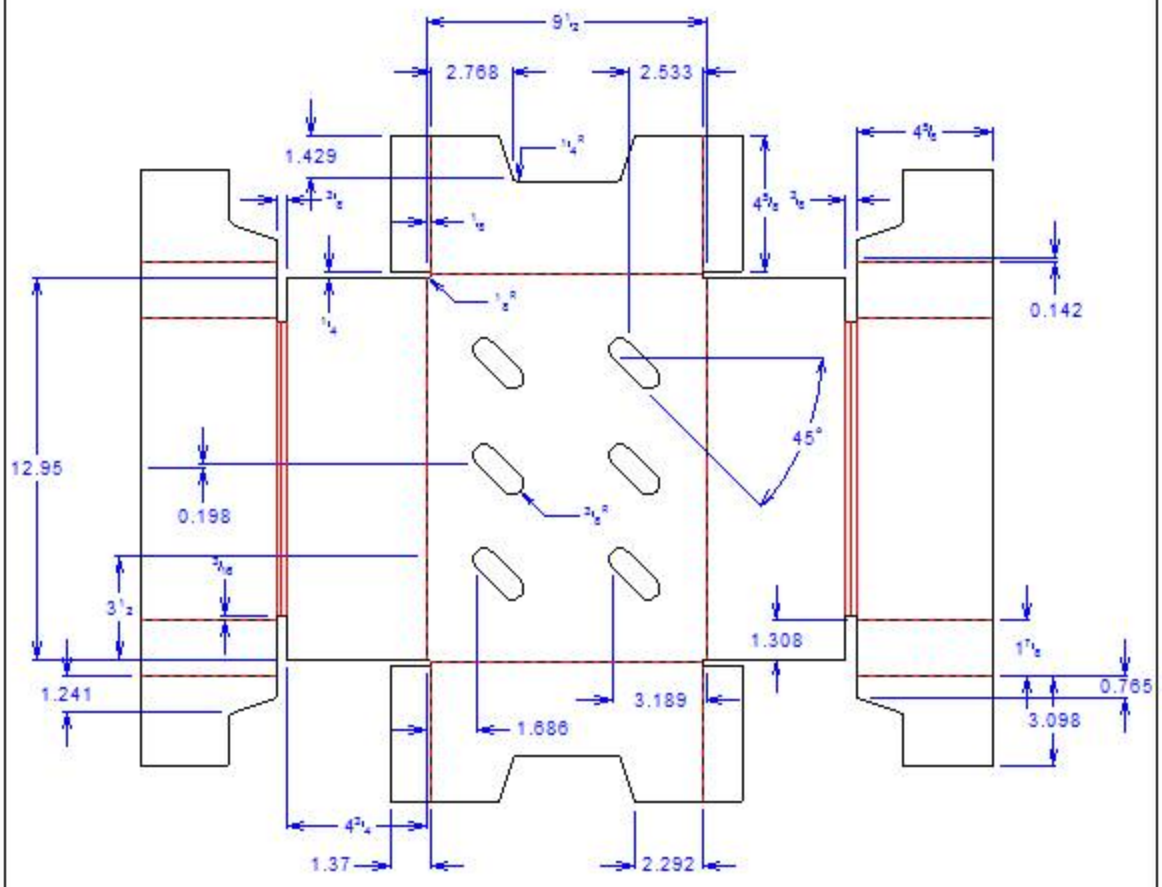
APPENDIX B

ArtiosCAD Specification Sheet

Customer:
Description:

Date: 02/12/2013

Design:	15 DOWN-13.2 X 9.5 X 4_DIMENSIONS (1).ARD		
Side shown:	Printed side	Grain/corr:	Vertical
Board:	I-200 C Kraft	L x W x D:	
Area:	530.28	Blank width:	29
Total Rule Length:	374.559	Blank height:	22.7



APPENDIX C

Spec ID:
12DOWN_12Layers

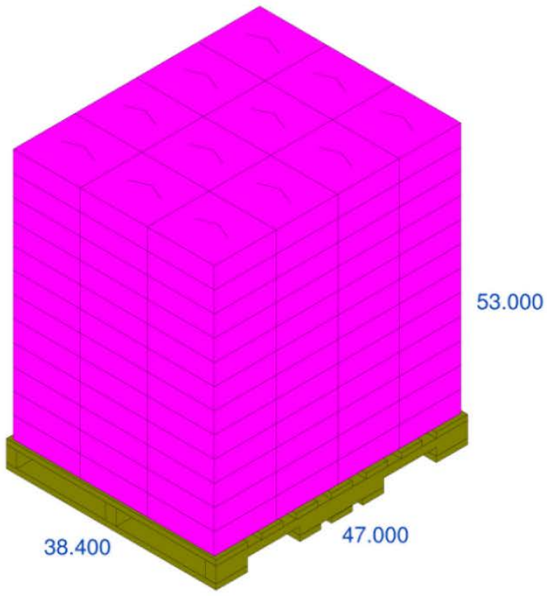
Modified / Saved Date:
2/13/2013

Analysis: **40FT**

UNITLOAD - Outside Dimesions with Bulge

	Metric (mm)			English (inches)		
	Depth	Width	Height	Depth	Width	Height
Shipcase	325.1	298.4	101.6	12.80	11.75	4.00
Pallet Only	1219.2	1016.0	127.0	48.00	40.00	5.00
Load Minimum:	1193.8	975.4		47.00	38.40	
Load Maximum	1193.8	975.4		47.00	38.40	
Pallet & Load	1219.2	1016.0	1346.2	48.00	40.00	53.00

Shipcases/layer	12
Layers/Unitload	12
Shipcases/Unitload	144
Slipsheets/Unitload	0
Area Efficiency:	94.0 %



APPENDIX D

Spec ID:
15DOWN_13Layers

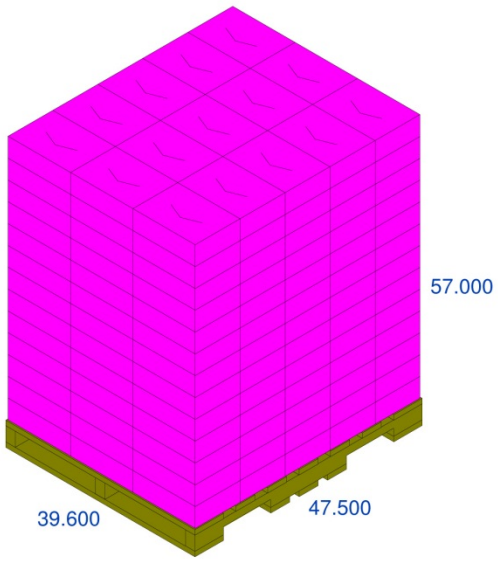
Modified / Saved Date:
2/13/2013

Analysis: **40 FT**

UNITLOAD - Outside Dimesions with Bulge

	Metric (mm)			English (inches)		
	Depth	Width	Height	Depth	Width	Height
Shipcase	335.3	241.3	101.6	13.20	9.50	4.00
Pallet Only	1219.2	1016.0	127.0	48.00	40.00	5.00
Load Minimum:	1206.5	1005.8		47.50	39.60	
Load Maximum	1206.5	1005.8		47.50	39.60	
Pallet & Load	1219.2	1016.0	1447.8	48.00	40.00	57.00

Shipcases/layer	15
Layers/Unitload	13
Shipcases/Unitload	195
Slipsheets/Unitload	0
Area Efficiency:	98.0 %



APPENDIX E

TOPS

53 Ft. Dry Van

Spec ID:
12DOWN_12Layers

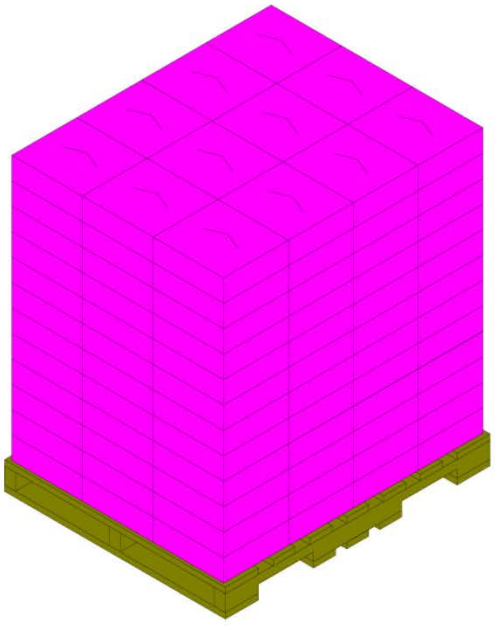
Modified / Saved Date:
3/14/2013

Analysis: **53Ft Dry Van**

UNITLOAD - Outside Dimesions with Bulge

	Metric (mm)			English (inches)		
	Depth	Width	Height	Depth	Width	Height
Shipcase	325.1	298.4	101.6	12.80	11.75	4.00
Pallet Only	1219.2	1016.0	127.0	48.00	40.00	5.00
Load Minimum:	1193.8	975.4		47.00	38.40	
Load Maximum	1193.8	975.4		47.00	38.40	
Pallet & Load	1219.2	1016.0	1346.2	48.00	40.00	53.00

Shipcases/layer	12
Layers/Unitload	12
Shipcases/Unitload	144
Slipsheets/Unitload	0
Area Efficiency:	94.0 %



APPENDIX F

TOPS

53 Ft. Dry Van

Spec ID:
15DOWN_12Layers

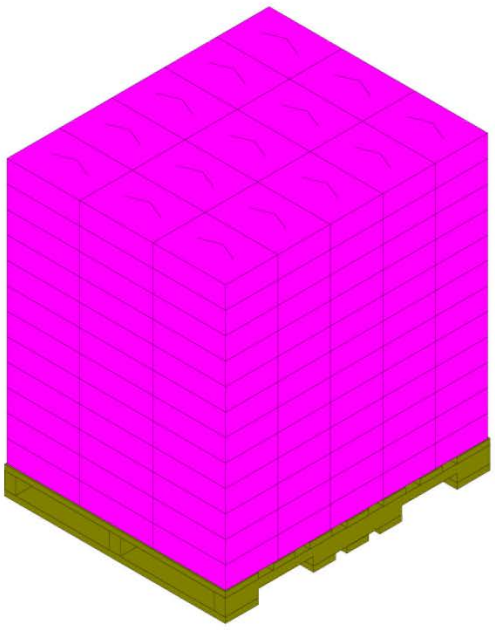
Modified / Saved Date:
3/14/2013

Analysis: **53Ft Dry Van**

UNITLOAD - Outside Dimesions with Bulge

	Metric (mm)			English (inches)		
	Depth	Width	Height	Depth	Width	Height
Shipcase	335.3	241.3	101.6	13.20	9.50	4.00
Pallet Only	1219.2	1016.0	127.0	48.00	40.00	5.00
Load Minimum:	1206.5	1005.8		47.50	39.60	
Load Maximum	1206.5	1005.8		47.50	39.60	
Pallet & Load	1219.2	1016.0	1346.2	48.00	40.00	53.00

Shipcases/layer	15
Layers/Unitload	12
Shipcases/Unitload	180
Slipsheets/Unitload	0
Area Efficiency:	98.0 %



APPENDIX G

SURVEY FOR NEW MANGO PACKAGE SYSTEM

The National Mango Board has been conducting research on new package trays to ship mangos with researchers from Cal Poly State University and Michigan State University over the past two years. The intent is to use **a standard GMA pallet foot-print** (40 x 48 inch), **minimize damage and provide efficient cooling** both during post-harvest and transportation. We have not been able to create an efficient pallet pattern that would provide **both strength and allow efficient cooling** in a new tray design while keeping the 4 kg fruit/tray.

The researchers reviewed 25 different tray designs from Mexico, Brazil, Guatemala and Peru. Most growers from various countries in South America are shipping 4 kg trays, in various configurations on non-GMA pallets. The shippers and growers are optimizing a fruit size (or count) to deliver a 4 kg tray that is sized and palletized to a non-GMA foot-print. As a result, the mangos need to be re-palletized in U.S. The research team has developed two new trays using a 12 down or 15 down configurations for a GMA pallet.

The following questions are designed for retailers to investigate the market opportunities that a new tray will offer **with better strength and pre-cooling values**.

Please see pictures and additional information on the next page!

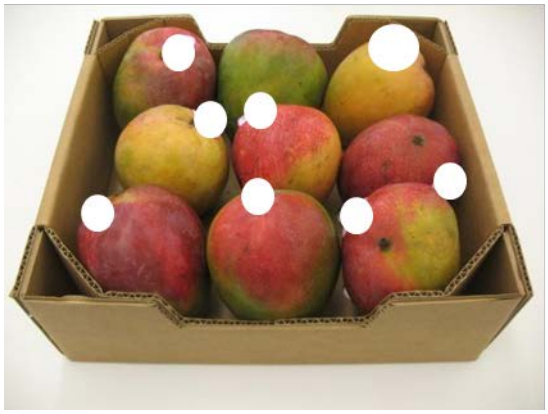
1. Would you prefer mangos shipped on a standard GMA (40x48 inch) pallet? (Yes/No)

2. Will you consider the weight per tray of fruit in a new tray other than 4kg?
   (Yes/No)

3. In the new design, the 12 down will use less corrugated, provide faster pre-cooling, deliver more fruit per shipment, and be more stable than a 15 down option. However the 12 down will have **approximately 5 kg or at least 10 lb.** of fruit and the 15 down **will have 3.75 kg.** Please rank your preference of a 12 down or 15 down tray. *1 is most favorable and 5 is least favorable.*

   1. 12 down (1, 2, 3, 4, 5)
   2. 15 down (1, 2, 3, 4, 5)
   3. Will prefer either

4. Do not make any changes in the pallet or tray size.
   (Yes)



New 12 down tray with 5 kg fruit

New 15 down tray

The 12 down tray provides a 5 kg fruit per tray and will be more stable, uses less paper corrugated per shipment, more sustainable, allows faster pre-cooling, uses GMA footprint, and less bruising. It will offer a slightly bigger display at retail, and will use less labor to fill and pack at origin. **The critical factor for retailers will be to account for the 20% additional fruit and re-price future mango tray purchases with this incentive.**

Shown above is also the new 15 count tray which is much smaller and will hold 3.5 – 3.75 kg fruit depending on size and variety, and is smaller than the existing 4 kg trays.

Shown below is the non GMA pallet size tray in comparison with the two new trays on either side.

5 kg 4 kg 3.75 kg

New 12 down tray, Existing non GMA trays, New 15 down tray