

CURRICULUM VITAE

Duke M Bulanon

Physics and Engineering Department
Northwest Nazarene University, Nampa, ID 83686
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TEACHING AND RESEARCH INTERESTS AND EXPERTISE

Agricultural robotics and automation, control systems, machine learning, machine vision, machine design, mechatronics , precision agriculture

EDUCATION

- 2000 - 2003 Ph.D. Bioresources Technology Iwate University (Japan)
Dissertation “Development of Machine Vision System for the Apple Harvesting Robot”
Adviser: Prof. Yoshinobu OTA
- 1998 - 2000 M.S. Agricultural Engineering Iwate University (Japan)
- 1990 - 1995 B.S. Mechanical Engineering University of San Carlos (Philippines)
(Graduated *Magna Cum Laude*)

PROFESSIONAL APPOINTMENTS

- 2023-Present Professor at Northwest Nazarene University (Idaho, USA)
- 2016 – 2023 Associate Professor at Northwest Nazarene University (Idaho, USA)
- 2011 - 2015 Assistant Professor at Northwest Nazarene University (Idaho, USA)
- 2006 - 2011 Postdoctoral Research Associate at the University of Florida
- 2005 - 2006 Assistant Professor at the University of San Carlos (Philippines)
- 2003 - 2005 Postdoctoral Research Fellow at Hokkaido University (Japan)
- 2003 - 1997 Research Student at Iwate University (Japan)
- 1995 - 1997 Assistant Instructor at University of San Carlos (Philippines)
- 1995 Case Design Engineer, Timex (Philippines)

TEACHING EXPERIENCE

- 2011 – Pres Northwest Nazarene University
Courses: Agricultural Automation, Control Systems, Engineering Design and Build, Machine Design, Mechatronics, Materials & Thermal Lab, Agricultural Automation
- 2006 - 2011 University of Florida
Courses: Electro-hydraulic Circuits & Controls, Power & Machinery Design for Agricultural Engineering, Instrumentation in Agricultural Engineering Research
- 2005 - 2006 University of San Carlos (Philippines)
Courses: Machine Design, Differential Equations
- 2004 Hokkaido University (Japan)
Course: Introduction to Machine Vision and Its Applications
- 2003 University of San Carlos (Philippines)
Courses: Machine Design, Fluid Mechanics
- 1995 - 1997 University of San Carlos (Philippines)
Courses: Advanced Algebra, Calculus, Differential Equations, Fluid Mechanics, Thermodynamics, Machine Design

PROFESSIONAL AFFILIATIONS

- 2011 – Pres. American Society for Engineering Education
- 2005 – Pres. American Society of Agricultural and Biological Engineers
- 1998 - 2005 Japanese Society of Agricultural Machinery

1995 - Philippine Society of Mechanical Engineers

HONORS AND AWARDS

- 2013 American Society for Engineering Education – Computing and Information Technology Division – 2013 Best Paper Award
- 2003 - 2005 Japan Society for the Promotion of Science Postdoctoral Fellowship Grant
- 1997 - 2003 Monbusho (Japan's Ministry of Education) Scholarship
- 1995 - 1997 Philippines Department of Science and Technology (DOST) Scholarship
- 1995 Graduated *Magna Cum Laude* (BS Mechanical Engineering)
- 1990 - 1995 Mandaue City Government Scholarship

ACCREDITATION AND OTHERS

- 2015 – Pres. Professional Engineer (State of Idaho)
- 2014 FANUC *Certified Education Robot Training Instructor*
- 2003 – Pres. Peer Reviewer (*Biosystems Engineering, Transactions of the ASABE, Computers and Electronics in Agriculture, Postharvest Biology and Technology, Trends in Food Science and Technology*)
- Grant Reviewer (Idaho Specialty Crop Block Grant)
- 1995 Registered Mechanical Engineer (Philippines)

PEER-REVIEWED PUBLICATIONS

- 2023 Compher, I. and **Bulanon, D.M.**, "Improving The Performance of OrBot The Fruit Picking Robot," *2023 IEEE International Opportunity Research Scholars Symposium (ORSS)*, Atlanta, GA, USA, 2023, pp. 78-81, doi: 10.1109/ORSS58323.2023.10161735.
- 2021 **Bulanon, D.M.**; Burr, C.; DeVlieg, M.; Braddock, T.; Allen, B. Development of a Visual Servo System for Robotic Fruit Harvesting. *AgriEngineering* 2021, 3, 840-852. <https://doi.org/10.3390/agriengineering3040053>
- 2020 **Bulanon, D.M.**; Braddock, T.; Allen, B.; Bulanon, J.I. Predicting Fruit Yield Using Shallow Neural Networks. Preprints 2020, 2020090022 (doi: 10.20944/preprints202009.0022.v1).
- 2018 Radcliffe, J.; Cox, J.; **Bulanon, D.M.** Machine Vision for Orchard Navigation. *Computers in Industry*. Vol.98, June 2018, 165-171
- 2017 Barrows, C.; **Bulanon, D.** Development of a low-cost multispectral camera for aerial crop monitoring. *Journal of Unmanned Vehicle Systems*. Published on the web 28 August 2017, <https://doi.org/10.1139/juvs-2017-0008>
- Cano, E.; Horton, R.; Liljegren, C.; **Bulanon, D.M.** Comparison of Small Unmanned Aerial Vehicles Performance Using Image Processing. *J. Imaging* **2017**, 3, 4.
- Horton, R.; Cano, E.; **Bulanon, D.**; Fallahi, E. Peach Flower Monitoring Using Aerial Multispectral Imaging. *J. Imaging* **2017**, 3, 2.
- 2016 **Bulanon, D.M.**; Lonai, J.; Skovgard, H.; Fallahi, E. Evaluation of Different Irrigation Methods for an Apple Orchard Using an Aerial Imaging System. *ISPRS Int. J. Geo-Inf.* **2016**, 5, 79.
- 2014 Sichenze, M., Myers, B., **Bulanon, D M.** (2014) Tree Detection Using Computer Vision and Machine Learning. *Journal of Idaho Academy of Science* (Accepted for publication)

- 2013 **Bulanon, D M**, Burks T F, Kim, D G, Ritenour, M A. (2013) Citrus Blackspot Detection Using Hyperspectral Analysis. *Agricultural Engineering International: the CIGR Journal*. Vol. 15(3) 2013
- Horton M, Salvador P, **Bulanon, D M**. (2013) Estimating the Volumes of Trees Using Machine Vision Systems, *Journal of the Idaho Academy of Science*, 49(1): 3
- 2010 **Bulanon, D M.**, Burks T F, Alchanatis V. (2010) A Multispectral Imaging System for Citrus Fruit Detection. *Environmental Control in Biology* 48(2), 81-91.
- Bulanon D M.**, Kataoka T. (2010) A Fruit Detection System and an End Effector for Robotic Harvesting of Fuji Apples. *Agricultural Engineering International: the CIGR Journal*. Vol.12(1), 203-210.
- 2009 Hannan, M, Burks T F, **Bulanon D M**. (2009) A Machine Vision Algorithm Combining Adaptive Segmentation and Analysis for Orange Fruit Detection. *Agricultural Engineering International: the CIGR Ejournal*. Manuscript 1281. Vol.XI. December, 2009.
- Bulanon, D M.**, Burks T F, Alchanatis V. (2009) Image fusion of visible and thermal images for fruit detection. *Biosystems Engineering*. Vol. 103(1), 12-22.
- Bulanon, D M.**, Burks T F, Alchanatis V (2009). Fruit Visibility Analysis for Citrus Harvesting. *Transactions of the ASABE*. 52(1): 277-283.
- Balasundaram, D, Burks, T, **Bulanon, D M.**, Schubert, T, Lee, W (2009) Spectral reflectance characteristics of citrus canker and other peel conditions of grapefruit. *Postharvest Biology and Technology*. Vol.51 (2), 220-226.
- Kim D G, Burks T F, Qin J, **Bulanon D M**. (2009) Classification of grapefruit peel diseases using color texture feature analysis. *International Journal of Agricultural and Biological Engineering* Vol. 2 (3), 41-50.
- 2008 **Bulanon, D M.**, Burks T F, Alchanatis V (2008). Study on temporal variation in citrus canopy using thermal imaging for citrus fruit detection. *Biosystems Engineering*. Vol. 101 (2), 161-171.
- 2006 **Bulanon, D M.**, Maja, J, Liggayu, A (2006). A Low-cost Machine Vision System for Mango Sorting. *Journal of Hokkaido Branch of the Japanese Society of Agricultural Machinery*. 46, 99-103.
- 2005 **Bulanon, D M.**, Kataoka, T, Okamoto, H, Hata, S (2005). A Real-time Image Processing Algorithm for Apple Fruit Detection. *Journal of Hokkaido Branch of the Japanese Society of Agricultural Machinery*. 45, 71-76.
- 2003 **Bulanon, D M.**, Kataoka, T, Ota, Y, Hiroma, T (2003). An Algorithm for the Recognition of Different Fruit Varieties. *Agricultural Engineering Journal*. 12(1&2), P79-94.
- 2002 **Bulanon, D M.**, Kataoka, T, Ota, Y, Hiroma, T (2002). A Segmentation Algorithm for the Automatic Recognition of Fuji Apples at Harvest. *Biosystems Engineering Journal (Formerly Journal of Agricultural Engineering Research)*. 83(4), 405-412.

- Bulanon, D M.**, Kataoka, T, Ota, Y, Hiroma, T (2002). A Color Model for Recognition of Apples by a Robotic Harvesting System. *Journal of the Japanese Society of Agricultural Machinery (JSAM)*. 64(5), 123-133.
- 2001 **Bulanon, D M.**, Kataoka, T, Ota, Y, Hiroma, T (2001). A Machine Vision System for the Apple Harvesting Robot. *CIGR ejournal*. Vo.III (2001).
- 1998 **Bulanon, D M.**, Kataoka, T, Ota, Y, Hiroma, T (1998). A Review of Agricultural Machine Vision Applications. *Journal of the Tohoku Branch of the Japanese Society of Agricultural Machinery*. 45.

BOOK CHAPTERS

- 2020 **Bulanon D.M.**, Hestand T., Nogales C., Allen B., Colwell J. (2020) Machine Vision System for Orchard Management. In: Sergiyenko O., Flores-Fuentes W., Mercorelli P. (eds) *Machine Vision and Navigation*. Springer, Cham. https://doi.org/10.1007/978-3-030-22587-2_7
- 2017 Burks, T., **Bulanon, D.**, Mehta, S. Opportunity of Robotics in Precision Horticulture. CAB International 2018. *Automation in Tree Fruit Production: Principles and Practice*.
- 2013 Burks, T F, **Bulanon D M.**, You, K S, Ni, Z, Sundararajan, A. (2013). *Orchard and Vineyard Production Automation. Agricultura Automation – Fundamentals and Practices*. CRC Press.
- 2011 **Bulanon, D M.** and Burks T F (2011). Visible and thermal images for fruit detection. *Encyclopedia of Agrophysics*. Springer, Dordrecht.
- 2010 **Bulanon, D M.**, Burks T F, Hannan, M (2010). *Robotic Harvesting of Citrus Fruits. Citrus Fruits: Properties, Consumption, and Nutrition*. Nova Science Publishers, Inc.

CONFERENCES AND OTHERS

- 2022 **Bulanon, D.M.**, Compher, I., Bauman, M., Allen, B. OrBot(Orchard Robot) – A Robotic Prototype Platform for Farm Work, The XX CIGR World Congress 2022, Dec 5-9, 2022, Kyoto, Japan
- Compher, I. **Bulanon, D.M.** Improving the Harvesting Speed of Fruit Harvesting Robot, Idaho Conference on Undergraduate Research (ICUR), July 2022, Boise State University
- 2021 Bulanon, J., Bulanon, D.M., Allen, B., Braddock, T. Blossom Counting App, Idaho Conference on Undergraduate Research (ICUR), July 2021, Boise State University
- Burr, C., Bulanon, D.M., Allen, B. Automated Orchard Harvesting Robot (OrBot), Idaho Conference on Undergraduate Research (ICUR), July 2021, Boise State University
- Braddock, T., Bulanon, D.M., Allen, B., Bulanon, J. Fruit Yield Estimation Using Deep Neural Network, Idaho Conference on Undergraduate Research (ICUR), July 2021, Boise State University
- 2019 Braddock, T., Roth, S., Bulanon, J.I., Allen, B., **Bulanon, D.M.** Fruit Yield Prediction Using Artificial Intelligence. 2019 ASABE Annual International Meeting 1900583.(doi:10.13031/aim.201900583)

- Roth, S., Braddock, T., Bulanon, J.I., Allen, B., **Bulanon, D.M.** Video Processing for Fruit Yield Prediction. Idaho Conference on Undergraduate Research (ICUR), July 2019, Boise State University
- Bulanon, J.I., Braddock, T., Roth, S., Allen, B., **Bulanon, D.M.** Blossom Detection Using Python and OpenCV. Idaho Conference on Undergraduate Research (ICUR), July 2019, Boise State University
- 2018 Braun, B., **Bulanon, D.M.**, Colwell, J., Stutz, A., Stutz, J., Nogales, C., Hestand, T. A Fruit Yield Prediction Method Using Blossom Detection. 2018 ASABE Annual International Meeting 1801542.(doi:10.13031/aim.201801542)
- Tracht, T., Nogales, C., Hestand, T., **Bulanon, D.M.**, Blossom Detection for Fruit Yield Prediction. Idaho Conference on Undergraduate Research (ICUR), August 2018, Boise State University
- 2017 Jack, H., Sligar, L., Stutz, J., Allen, B., **Bulanon, D.M.**, Stutz, A., Garner, M. Teaching Mechanics of Materials with Lost 3D Print Casting. Paper no. 19200, 2017 ASEE Annual Conference & Exposition
- Bulanon, D.M.** & Fallahi, E. A Smart Vision System for Monitoring Specialty Crops. Future Technologies Conference (FTC) 2017 29-30 November 2017| Vancouver, Canada
- 2016 **Bulanon, D.M.**, Cano, E., Horton, R., Fallahi, E. Peach Flower Monitoring Using Aerial Multispectral Imaging. ASABE Paper No. 162461520 St.Joseph, MI: ASABE
- 2015 **Bulanon, D.M.**, Cano, E. Comparison of Off-the-Shelf UAVs for Agricultural Application. 24th Annual Murdock College Science Research Conference, November 5, 2015, Vancouver, WA
- Lonai, J., **Bulanon, D.M.**, Skovgard, H., Cano, E., Liljegren, C., Fallahi, E. (2015) Automatic Detection of Individual Trees in an Apple Orchard Using Modified Watershed Algorithm. UAS Mapping 2015 Reno. ASPRS UAS Technical Demonstration and Symposium, September 29-30, 2015, Reno, NV
- Liljegren, C., Cano, E., Skovgard, H., Fallahi, E., **Bulanon, D M.**(2015) Flight Pattern Generation for Automated Aerial Imaging of Crops. Idaho Conference on Undergraduate Research (ICUR), July 29-30, Boise State University
- 2014 **Bulanon, D.M.**, Horton, M., Salvador, P., Fallahi, E. (2014) Apple Orchard Monitoring Using Multispectral Aerial Imaging. Accepted for oral presentation at the 2014 Annual International Meeting of American Society of Agricultural and Biological Engineers in Montreal, Canada on Jul 13-16, 2014
- Leber, D., Lonai, J., Salvador, P. Skovgard, H., **Bulanon, D M.**(2014) Targeted Crop Health Analysis visa UAV Photography. Idaho Conference on Undergraduate Research (ICUR), July 30-31, Boise State University
- 2013 **Bulanon D M.** and Parke, S (2013). Crop Monitoring Platform : A Case of Teaching Machine Vision through Undergraduate Research. Presented at the 2013 ASEE Annual International Conference, Atlanta, Georgia

- Bulanon D M.** (2013). Eye in the sky : Monitoring crops using aerial imaging systems. 2013 University of Idaho Snake River Sugar Beet Conference . December 17, 2013, Nampa, ID (Invited Speaker)
- Horton M, Salvador P, **Bulanon D M.** (2013) Farmer in the Sky: Orchard monitoring using aerial imaging system, 22nd Regional Conference on Undergraduate Research of the Murdock College Science Research Program, November 8-9, 2013, Lewis & Clark College, Portland, OR
- Salvador, P., Horton, M., **Bulanon, D M.** (2013) Machine Vision System for Agricultural Applications. Poster Presentation at the 2013 IEEE Workshop on Microelectronics and Electron Devices in Boise, ID
- 2009 **Bulanon, D M.**, Burks T F, Alchanatis V (2009). A Multispectral Imaging Approach to Citrus Fruit Detection. Presented at the 2009 ASABE Annual International Conference, Reno, Nevada.
- Bulanon, D M.**, Burks T F, Alchanatis V (2009). A Multispectral Imaging Analysis for Enhancing Citrus Fruit Detection. IFAC Bio-Robotics IV Workshop. September, 2009, Chicago, Illinois.
- 2008 Qin, J, Burks, T F, Kim D G, **Bulanon D M.** (2008). Classification of Citrus Peel Diseases Using Color Texture Feature Analysis. Food Processing Automation Conference Proceedings, 28-29, June 2008, Providence, Rhode Island.
- Bulanon, D M.**, Burks T F, Alchanatis V (2008). Improving Fruit Detection for Robotic Fruit Harvesting. Application of Precision Agriculture on Fruits and Vegetables, January 2008, Orlando, FL.
- Bulanon, D M.**, Burks T F, Alchanatis V (2008). Analysis of the Thermal Temporal Variation in the Citrus Canopy . ASABE paper no. 083024.
- Bulanon, D M.**, Burks T F, Alchanatis V (2008). Citrus Fruit Detection Using Image Fusion of Thermal and Visible Images. ASABE paper no. 0820724.
- 2007 Hannan M, Burks T F, **Bulanon D M.** (2007). A Real-time Machine Vision Algorithm for Robotic Citrus Harvesting. ASABE paper no. 073125.
- Bulanon, D M.**, Burks T F, Alchanatis V (2007). Study on Fruit Visibility for Robotic Harvesting. ASABE paper no. 073124.
- 2005 **Bulanon, D M.**, Kataoka, T, Okamoto, H, Hata, S (2005). Manipulator Control for the Apple Harvesting Robot. Proceedings of the Annual Conference of JSAM.
- Bulanon, D M.**, Kataoka, T, Okamoto, H, Hata, S (2005). Feedback Control of Manipulator Using Machine Vision for Robotic Apple Harvesting. ASAE paper 05-3114. American Society of Agricultural Engineers.
- Saito, M, Kataoka, T, Okamoto, H, Ehsani, R, **Bulanon, D M.** (2005) Development of an On-the-go Soil Sampling Machine. Proceedings of the Joint Meeting on Environment Engineering in Agriculture. P IC7-4 (2005).
- Saito, M, Kataoka, T, Okamoto, H, **Bulanon, D M.**, Ehsani, R (2005) Assessing field variability of soil and plant data at an experimental farm at Hokkaido University. First Asian Conference on Precision Agriculture, Japan, pp. 255-261.

- 2004 **Bulanon, D M.**, Kataoka, T, Okamoto, H, Hata, S (2004). Modeling and Motion Planning for an Apple Harvesting Manipulator. Proceedings of the Automation Technology for Off-Road Equipment (ATOE).
- Bulanon, D M.**, Kataoka, T, Okamoto, H, Hata, S (2004). Determining the 3-D Location of the Apple Fruit During Harvest. Proceedings of The 2nd International Symposium on Machinery and Mechatronics for Agriculture and Bio-systems Engineering.
- Bulanon, D M.**, Kataoka, T, Okamoto, H, Hata, S (2004) Development of a Real-time Machine Vision System for the Apple Harvesting Robot. SICE Annual Conference in Sapporo, August 4-6, 2004.
- 2003 Liggayu, A and **Bulanon, D M.** (2003) Mango Sorting Using Machine Vision System. Industrial Engineering Research Conference 2003. Phil. Institute of Industrial Engineers. Oct.16-18, 2003, Manila, Philippines.
- 2002 **Bulanon, D M.**, Hiroma, T, Kataoka, T, Ota, Y (2002). Segmentation of Apple Fruit Using Artificial Neural Network. Proceedings of the Annual Conference of JSAM.
- 2001 **Bulanon, D M.**, Kataoka, T, Zhang, S, Ota, Y, Hiroma, Y (2001). Optimal Thresholding for the Automatic Recognition of Apple Fruits. ASAE paper 01-3133. American Society of Agricultural Engineers.
- 2000 **Bulanon, D M.**, Kataoka, T, Ota, Y, Hiroma, T (2000). Machine Vision for Robotic Apple Harvesting. Proceedings of the 4th International Scientific Conference on Microprocessor System in Agriculture. CIGR-Section 3. P11-16. (Plock, Poland).
- Bulanon, D M.**, Kataoka, T, Ota, Y, Hiroma, T (2000). Estimation of Apple Fruit Location Using Machine Vision System for Apple Harvesting Robot. Proceedings of the World Congress of CIGR (Tsukuba, Japan).
- Bulanon, D M.**, Kataoka, T, Ota, Y, Hiroma, T (2000). Recognition of Apple Fruit Using Decision Theoretic Approach. Proceedings of the Annual Conference of JSAM
- 1999 **Bulanon, D M.**, Kataoka, T., Ota, Y., Hiroma, T. (1999). Analysis of Apple Tree Image Using RGB Model. Proceedings of the Annual Conference of JSAM.

GRANTS AND OTHERS

- | | | |
|------|---|-----------|
| 2021 | PI, Idaho State Department of Agriculture – Specialty Crop Block Grant, “Development of Fruit Yield Estimation App for Mobile Devices”
(November 2021 – November 2023) | \$68,000 |
| 2020 | PI, Idaho State Department of Agriculture – Specialty Crop Block Grant, “Development of a Fruit Harvesting Robot Prototype: OrBot (Orchard Robot)”
(November 2020 – November 2022) | \$131,784 |
| 2018 | PI, Idaho State Department of Agriculture – Specialty Crop Block Grant, “Improving Fruit Yield Estimates Using Artificial Intelligence Techniques”
(November 2018 – November 2020) | \$65,368 |
| 2017 | PI, M.J. Murdock Charitable Trust, Partners in Science Program – “Estimation of Fruit Crop Yield Using Unmanned Aerial Systems and Digital Image Processing” | |

	(May 2017 – May 2019)	\$15,000
2016	PI, Idaho State Department of Agriculture – Specialty Crop Block Grant, “Fruit Counter App: A Fruit Yield Estimation System for Specialty Crops in Idaho” (November 2016 – November 2018)	\$90,436
	PI, NASA EPSCoR – “Development of a Low-Cost Visual Feedback System to Guide IdaBot, an Agricultural Mobile Utility Robot” (August 2016 – August 2017)	\$27,500
2015	Co-PI, Idaho State Department of Agriculture – Specialty Crop Block Grant, “IdaBOT: An Autonomous Utility Robot for Managing Idaho Specialty Crops” (November 2015 – November 2017)	\$80,651
	Co-PI, Defense Logistics Agency, Small Business Innovation Research Program – Phase 1 “Lost 3D Printed Mold Casting”	\$99,000
2014	Co-PI, Binational Agricultural Research and Development Fund, “Minimizing Complexity of Robot Design and Crop Yield Estimation Methods Using New Rootstocks and Orchard Architectures” (Not Awarded)	\$280,000
	PI, Idaho State Department of Agriculture – Specialty Crop Block Grant, “Expanding the Applications of Crop Monitoring and Assessment Platform for Specialty Crops in Idaho” (November 2014 – November 2016)	\$76,000
	Co-PI, NASA Idaho Space Grant Consortium, “Development of Fire Mapping and Assessment Platform” (November 2014 – November 2015)	\$30,000
	Co-PI, Idaho State Department of Agriculture – Specialty Crop Block Grant, “Sunnyslope Soils Analysis” (November 2014 – November 2016)	\$72,000
2012	PI, Idaho State Department of Agriculture – Specialty Crop Block Grant, “Development of a Crop Monitoring and Assessment Platform for Specialty Crops in Idaho” (November 2012 – November 2014)	\$84,000
	PI, NASA Idaho Space Grant Consortium, “Earth Observation Using a Low Cost Remote Sensing Platform” (July 2012 – July 2014)	\$50,000
2011	PI, NNU Watson Research Fellowship	\$5,000
2010	Co-PI, National Institute of Food & Agriculture, Small Business Innovation Research Program – Phase 1 “Over the Top Citrus Harvesting Equipment for Juice Markets in High Density Groves”	\$99,000
2003	Co-Author, Japan Society for the Promotion of Science Postdoctoral Fellowship Grant “Study on Autonomous Apple Harvesting Machine System”	\$75,000
2003	Co-PI, University of San Carlos Research Council “Development of Machine Vision for Mango Sorting”	\$1,000

