

Bird Management in Fruit Crops: How We Make Progress

Catherine A. Lindell

Zoology Department and Center for Global Change and Earth Observations, Michigan State University, East Lansing, Michigan

Stephanie A. Shwiff

USDA APHIS Wildlife Services, National Wildlife Research Center, Fort Collins, Colorado

Philip H. Howard

Department of Community, Agriculture, Recreation and Resource Studies, Michigan State University, East Lansing, Michigan

ABSTRACT: Fruit producers have identified bird damage as a critical issue that has received limited attention from researchers. A USDA study estimated that birds cost producers in 7 states tens of millions of dollars through fruit loss and management efforts. Despite these costs, research has been uncoordinated and piecemeal, leaving producers with few, well-tested management options. We describe several objectives to strive for in order to achieve the goal of providing producers with region-specific, cost-effective, and environmentally sustainable bird management strategies. These objectives include 1) quantifying economic consequences of bird damage for producers, consumers, and regional economies, and determining costs and benefits of various management techniques; 2) identifying amounts of damage attributable to specific bird species across crops and regions; 3) determining how bird damage varies within and across spatial scales (orchard, landscape, region); 4) evaluating consumer responses to management strategies and potential effects on marketing; 5) integrating economic, biological, and consumer information, i.e. using a systems approach, to determine the management strategies that should be tested; and 6) testing management strategies for efficacy with replicated, well-controlled experimental designs. By focusing on these objectives and coordinating activities among researchers and extension personnel from different regions of the country and from different disciplines, we will maximize efficiency in addressing this issue on a national scale while providing individual producers with region-specific information to guide their bird management efforts. Communication among researchers, extension personnel, and producers will be critical to minimize the costs of bird damage.

KEY WORDS: benefits, bird damage, bird management, consumers, coordination, costs, fruit crops, landscape, netting, sustainability

Proc. 25th Vertebr. Pest Conf. (R. M. Timm, Ed.)
Published at Univ. of Calif., Davis, 2012. Pp. 235-239.

INTRODUCTION

Fruit production is a critical component of the global economy. For example, production of blueberries, cherries, and grapes continues to increase (FAO 2010) and 'Honeycrisp' apple supply and demand are climbing. The top 10 cherry-exporting nations produce a collective annual yield valued at more than \$1 billion (FAO 2007). In addition, increasing human fruit and vegetable consumption is a goal of the Food and Agriculture Organization of the United Nations (FAO 2003) and the World Health Organization (2010) because of the strong positive effects of fruits and vegetables on health (e.g., Lock et al. 2005). Thus, addressing threats posed by fruit crop pests and improving productivity and profitability is of great economic and social importance.

Fruit loss to birds is a long-standing and costly problem (Virgo 1971, Dolbeer et al. 1994, Simon 2008), affecting producers across the globe (Somers and Morris 2002, Ahmad 2010, Ribot et al. 2011). U.S. producers lose tens of millions of dollars each year through direct losses and often ineffective efforts to deter birds (USDA 1998). In addition to outright consumption, birds damage fruit, leading to increased susceptibility to other pests and pathogens (Pritts 2001, Duffy and Schaffner 2002, Holb and Scherm 2008) and reduced product quality; cherry crops, for example, with high proportions of damaged

fruit receive low grades from processors and generate less income because they are sold for juice, rather than more profitable end products.

Few techniques, with the exception of netting, consistently deter pest birds from fruit. Scaring birds with acoustics such as cannons and wailers varies in effectiveness (e.g., Summers 1985, Cook et al. 2008). In addition, cannon noise can be a source of friction between producers and their neighbors. Although chemical repellents have been developed for some crops (Werner et al. 2007), the standard repellent for fruit (Mesurol®) is no longer labeled for use on food crops. Visual deterrents like reflecting ribbons range from ineffective to moderately effective, depending on the circumstances (Belant and Ickes 1997, Ahmad 2010). Other repellents are not consistently effective and/or affect fruit quality. Netting can be used to exclude birds from grapes (e.g., Curtis et al. 1994, Somers and Morris 2002) but it is perceived as too costly by many producers and may be impractical for tree fruits like cherries. A theme that emerges from the literature is the lack of consistency in results; various techniques sometimes work in some situations but not consistently and not for long periods.

Apart from the technical difficulties of bird management, there are the challenges of doing so within an environmentally sustainable framework. Although

some pest species like the European starling (*Sturnus vulgaris*) are invasive, others are native songbirds that are part of the cultural value of rural, fruit-growing regions and provide recreational activities. In 2006, 48 million Americans spent \$36 billion on bird watching trips and equipment. This economic activity generated 670,000 jobs (USFWS 2006). Birds also play important roles in ecosystems by, for example, eating insects that damage leaves and dispersing seeds of native plants (Sekercioglu 2006, Jedlicka et al. 2011). Thus, in a best-case scenario, bird management techniques would be environmentally beneficial and, at a minimum, relatively benign in their environmental impacts.

Below we discuss gaps in knowledge and approach that have hindered progress in bird management in fruit crops. By addressing these gaps, and building on previous work in agricultural bird management (e.g., Tobin et al. 1991, Avery et al. 1992, Curtis et al. 1994, Tracey et al. 2007, Werner et al. 2007, Linz et al. 2011), we should make more rapid progress in providing fruit producers with effective, environmentally sustainable bird management strategies, based on clearly identified costs and benefits.

We use the term “management technique” to describe a specific technique, for example, a chemical repellent. We use the term “management strategy” to describe a management plan that may include more than one technique and may include spatial patterns of management. We often use the terms fields, orchards, or vineyards to refer to fields, orchards, and vineyards collectively.

GAPS IN KNOWLEDGE AND APPROACH

Standardized Information on the Economic Impact of Bird Damage and Costs and Benefits of Management Techniques

Previous work on the economics of bird damage has generally focused on damage caused by single bird species or to single crops (e.g., Cummings et al. 2005). Rarely have studies quantified regional variation in damage across a range of crop types. Gebhardt et al. (2011) estimated bird and rodent pest damage to California agriculture at \$168 million to \$504 million. Although only a portion of this damage was caused by birds, the study showed that damage levels are geographically diverse, even within a single state. Similar work has not been conducted in other production regions of the country and the apparent geographic variation makes it difficult to extrapolate damage levels to other regions.

In addition, producers make decisions about bird management using a trial and error approach in the absence of adequate information about the economics of the techniques under consideration (Tracey et al. 2007) because previous work to estimate economic impacts of alternative management methods is limited (e.g., Avery et al. 1993). By filling these knowledge gaps we will be able to 1) estimate costs of bird damage to producers and regional economies, in terms of dollars and employment, and 2) estimate the benefits and costs of alternative bird management strategies. Without these types of information, government entities, industry groups, and producers are not able to prioritize resources for the problem or make sound choices about how to address the issue in the most cost-effective manner.

Region-Specific Information on the Relative Importance of Different Pest Bird Species and Their Foraging Behavior

Identifying the relative impact of different pest species is a critical step in developing effective management strategies. Many previous studies have conducted traditional surveys and recorded the types and numbers of birds flying into orchards or perched in fruit trees but have not documented whether birds were actually consuming fruit or the damage caused by different species (Guarino et al. 1974, Tobin et al. 1991, Curtis et al. 1994). Inferences based on these types of presence/absence or abundance data could be misleading. For example, American robins, *Turdus migratorius*, were the most commonly observed bird species in Michigan cherry orchards during traditional surveys in 2010, yet observations of foraging behavior showed that cedar waxwings, *Bombycilla cedrorum*, actually consumed more fruit than robins (Lindell et al. 2012). Additionally, the most important bird pests on a particular crop may vary across regions. Cedar waxwings are not as abundant in western North America as eastern North America (Gough et al. 1998) and so likely play less of a role as a pest in fruit crops in the West compared to the East.

Understanding the behavioral ecology of pest species is another key component of wildlife damage-management efforts (Dolbeer et al. 1994). When, how, and where species forage will determine differences in crop impacts and provide information about which management strategies should be tested (Virgo 1971, Boudreau 1972, Tracey et al. 2007). For example, birds foraging in groups often cause greater losses than birds foraging alone; effective management strategies for flocking species versus solitary foragers will likely differ (Tracey et al. 2007). As another example, bird damage may be greater at field edges than interiors, indicating that management efforts should be concentrated at edges (Somers and Morris 2002). Much of this basic behavioral biology of pest bird species in fruit crops has not been collected and should be a priority in future research.

Influence of Landscape Context

We commonly hear anecdotes about the influence of landscape context on fruit damage, usually that isolated orchards, i.e., those surrounded by non-orchard land covers, experience greater damage than orchards surrounded by other orchards. Grapefruit groves farther from other groves showed greater bird damage than groves close to other groves (Johnson et al. 1989). Studies in non-orchard settings demonstrate landscape effects on fruit removal (Manuel Herrera and Garcia 2010). In addition, work documenting greater flamingo (*Phoenicopterus ruber roseus*) use of French rice fields (Tourenq et al. 2001) suggests the importance of avoiding a one-size-fits-all assumptions with regard to landscape characteristics and crops. This study found less flamingo use of fields with greater amounts of wooded areas in the landscape and with wooded field edges although common wisdom holds that these characteristics increase risk of bird damage to fruit crops (Tourenq et al. 2001).

There is increasing awareness of the importance of landscape context to agricultural systems (Robertson et al.

Table 1. Biological, economic, and consumer information that should be considered in a systems approach to indicate the types and intensity of bird management that should be tested.

Crop characteristics	Bird characteristics	Damage level	Spatial patterns of damage	Consumer responses to techniques
Value relative to cost of management technique	Solitary vs. social foragers	Low	Orchard scale — edge vs. interior	Positive
Tree vs. bush or vine structure	Invasive vs. native	High	Landscape scale — high vs. low orchard cover	Negative
Fast-ripening vs. slow-ripening	Migratory			Neutral

2007), yet no work to date has systematically investigated landscape effects on bird damage across a range of fruit crops. Investigating these effects is important to understanding mechanisms leading to bird damage and directing management strategies. For example, if isolated orchards experience greater bird damage than orchards in landscapes with many other orchards, this indicates that management strategies must include planning at the landscape scale, including cooperation among producers, and information dissemination to producers about where and where not to cultivate.

Potential Impacts of Bird Management on Consumer Choices

Bird damage-management strategies have the potential to influence sales of specialty crops. Consumer interest in food production practices is rising, as evidenced by the exponential growth of eco-labels such as “organic” and “fair trade” (Howard 2010). Knowledge of damage-management strategies embodied in production practices may increase or decrease willingness to buy a product, or even willingness to pay an additional premium for a product. Bird damage-management strategies may have larger market impacts than those employed for other pests (e.g., insects), due to the greater charismatic appeal of birds (Sergio et al. 2006); 21% of the U.S. population engages in bird watching as a recreational activity (Carver 2009). It is important to provide fruit producers and marketers with accurate information about the potential marketing impacts of bird damage-management strategies when they are making decisions about whether or not to adopt them.

Researchers are beginning to measure consumer preferences and willingness to pay for foods that embody specific production practices, such as use/avoidance of genetically engineered organisms (Costa-Font et al. 2008) and organic standards (Batte et al. 2007). Nothing is known about the potential consumer response to bird management strategies, however. In the short term, identifying strategies that receive positive consumer interest may help foster niche markets, and possibly garner price premiums, for participating producers. This knowledge may encourage more producers to adopt such management techniques. In the long term, better understanding of consumer preferences will inform efforts to broaden the appeal of existing or new “wildlife-friendly” eco-labels (Treves and Jones 2010).

Using a Systems Approach in Bird Management Research

A systems framework necessitates considering how

system components interact rather than considering them in isolation. Key components of the production system related to fruit crops include crop and pest bird characteristics, levels and spatial patterns of bird damage, and economic constraints of producers. Components of the consumer and markets system include the cultural/recreational value of birds and potential consumer preferences for some types of bird management. Considering these components together will indicate the types and intensity of management that should be tested in robust experimental investigations. Thoughtful application of such a systems approach will improve the efficiency of our research programs because we will test management techniques and strategies that are most likely to be 1) effective given the biological characteristics of the system and 2) accepted by producers and consumers.

Table 1 contains the types of economic, biological, and consumer characteristics that should be considered in concert when determining the intensity and types of management techniques that should be tested. For example, consider a high-value crop that grows on bushes and is slow-ripening. Imagine that observational work has shown that a native, migratory bird species that forages socially (in flocks) is the most important consumer of the crop. Social foragers tend to cause more damage than solitary foragers. Thus, management intensity will need to be high to deter the species. Because this is a high-value crop that grows on bushes and is slow-ripening, netting has support as a potential management technique; the costs of netting are likely to be offset by the potentially costly damage that the crop could experience over the long ripening period. In addition, netting is feasible for crops that grow on bushes. Some other management techniques would be contraindicated; because the primary damaging bird species is native and migratory, consumer responses to a technique such as population reduction would likely be negative. In addition, native, migratory bird species are subject to the restrictions of the Migratory Bird Treaty Act (Executive Order 13186 2001).

Spatial patterns of damage is an important consideration in these types of analyses. The cost of a particular management technique may appear prohibitively high for a crop, if the technique is applied over the entire spatial extent of the crop. However, if bird damage is concentrated at field edges, testing to determine whether the technique is effective when applied only at edges would be justified. If the spatially applied technique reduces damage enough to be cost-effective, it could be recommended as a useful strategy. By systematically considering bird and crop characteristics, along with potential consumer responses

and spatial patterns of damage, progress to determine effective management techniques will occur more rapidly and efficiently.

Well-Replicated, Controlled Studies to Systematically Test the Effectiveness of Bird Management Techniques and Strategies

Testing bird management strategies is challenging in that birds are more mobile than many other types of pests and use large areas. Previous work has often been limited by a lack of a replication and appropriate controls (Bomford and O'Brien 1990), a continuing problem today. Despite the technical and economic challenges, well-replicated field trials are critical. Thus, a key component of future research is cooperating with producers to insure that researchers can conduct trials over large enough areas, with large enough sample sizes, for robust statistical analyses. Although management techniques for insect pests may be adequately tested within the area of a typical agricultural research station, this is unlikely to be true for birds, because of their great mobility. This, in turn, necessitates the availability of resources to conduct such large-scale trials, which will continue to be challenging with present economic circumstances.

CONCLUSION

The great abundance of cultivated fruit species that humans enjoy today is perhaps matched only by the great abundance of birds eager to take advantage of these fruits. Previous researchers have begun the process of developing bird management strategies that are effective and sustainable. Our task at this juncture is to build on previous work in a coordinated and thoughtful manner to maximize the impact of future research in providing producers with efficacious bird management techniques. We believe the suggestions above will help us achieve that goal.

ACKNOWLEDGEMENTS

We thank previous investigators who brought us to the present point through their hard work and innovative thinking and the fruit growers who cooperated with them.

LITERATURE CITED

- AHMAD, S. 2010. Sustainable control measures for rose-ringed parakeet (*Psittacula krameri*) on maize, sunflower, citrus, guava and mango damage in some selected agro-ecosystems in central Punjab, Pakistan. Ph.D. thesis, University of Agriculture, Faisalabad, Pakistan. 113 pp.
- EVERY, M. L., J. L. CUMMINGS, D. G. DECKER, J. W. JOHNSON, J. C. WISE and J. I. HOWARD. 1993. Field and aviary evaluation of low-level application rates of methiocarb for reducing bird damage to blueberries. *Crop. Prot.* 12(2):95-100.
- EVERY, M. L., J. W. NELSON, and M. A. CONE. 1992. Survey of bird damage to blueberries in North America. *Proc. East. Wildl. Damage Cont. Conf.* 5:105-110.
- BATTE, M. T., N. H. HOOKER, T. C. HAAB, and J. BEAVERSON. 2007. Putting their money where their mouths are: Consumer willingness to pay for multi-ingredient, processed organic food products. *Food Policy* 32(2):145-159.
- BELANT, J. L., and S. K. ICKES. 1997. Mylar flags as gull deterrents. *Gt. Plains Wildl. Damage Cont. Workshop Proc.* 13:73-79.
- BOMFORD, M., and P. H. O'BRIEN. 1990. Sonic deterrents in animal damage control: A review of device tests and effectiveness. *Wildl. Soc. Bull.* 18(4):411-422.
- BOUDREAU, G. W. 1972. Factors related to bird depredations in vineyards. *Am. J. Enol. Viticul.* 23(2):50-53.
- CARVER, E. 2009. Birding in the United States: A demographic and economic analysis. Report 2006-4, U.S. Fish and Wildlife Service, Arlington, VA. 18 pp.
- COOK A., S. RUSHTON, J. ALLAN, and A. BAXTER. 2008. An evaluation of techniques to control problem bird species on landfill sites. *Envir. Manage.* 41(6):834-843.
- COSTA-FONT, M., J. M. GIL, and W. B. TRAILL. 2008. Consumer acceptance, valuation of and attitudes towards genetically modified food: Review and implications for food policy. *Food Policy* 33(2): 99-111.
- CUMMINGS, J. L., S. A. SHWIFF, and S. K. TUPPER. 2005. Economic impacts of blackbird damage to the rice industry. *Proc. Wildl. Damage Manage. Conf.* 11:317-322.
- CURTIS, P. D., I. A. MERWIN, M. P. PRITTS, and D. V. PETERSON. 1994. Chemical repellents and plastic netting for reducing bird damage to sweet cherries, blueberries, and grapes. *HortScience* 29(10):1151-1155.
- DOLBEER, R. A., N. H. HOLLER, and D. W. HAWTHORNE. 1994. Identification and control of wildlife damage. Pp. 474-506 in: T. Bookhout (Ed.), *Research and Management Techniques for Wildlife and Habitats*. The Wildlife Society, Bethesda, MD.
- DUFFY, S., and D. W. SCHAFFNER. 2002. Monte Carlo simulation of the risk of contamination of apples with *Escherichia coli* O157:H7. *Int. J. Food Microbiol.* 78(3):245-255.
- EXECUTIVE ORDER 13186. 2001. Responsibilities of federal agencies to protect migratory birds. *Federal Register* 66(11):3853-3856.
- FAO (FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS). 2003. Increasing fruit and vegetable consumption becomes a global priority. Accessed 6 Dec 2010 <http://www.fao.org/english/newsroom/focus/2003/fruitveg1.html>.
- FAO (FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS). 2007. Food and agricultural commodities production. Accessed 4 Nov 2010. <http://faostat.fao.org/site/339/default.aspx>.
- FAO (FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS). 2010. FAOSTAT. Accessed 30 Nov 2010. <http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor>.
- GEBHARDT, K., A. M. ANDERSON, K. KIRKPATRICK, and S. A. SHWIFF. 2011. A review and synthesis of bird and rodent damage to select California crops. *Crop Prot.* 30(9):1109-1116.
- GOUGH, G. A., J. R. SAUER, and M. ILIFF. Patuxent Bird Identification Infocenter. 1998. Version 97.1, Patuxent Wildlife Research Center, Laurel, MD. <http://www.mbr-pwrc.usgs.gov/id/framlst/infocenter.html>.

- GUARINO, J. L., W. F. SHAKE, and R. W. SCHAFER. 1974. Reducing bird damage to ripening cherries with methiocarb. *J. Wildl. Manage.* 38(2):338-342.
- HOLB, I. J., and H. SCHERM. 2008. Quantitative relationships between different injury factors and development of brown rot caused by *Monilinia fructigena* in integrated and organic apple orchards. *Phytopathol.* 98(1):79-86.
- HOWARD, P. H. 2010. Eco-labeling. Pp. 139-141 *in*: D. R. Mulvaney (Ed.), *Green Food: An A-to-Z Guide*. Sage Publications, Thousand Oaks, CA.
- JEDLICKA, J. A., R. GREENBERG, and D. K. LETOURNEAU. 2011. Avian conservation practices strengthen ecosystem services in California vineyards. *PLoS ONE* 6(11):e27347. doi:10.1371/journal.pone.0027347.
- JOHNSON, D. B., F. S. GUTHERY, and N. E. KOERTH. 1989. Grackle damage to grapefruit in the lower Rio Grande Valley. *Wildl. Soc. Bull.* 17(1):46-50.
- LINDELL, C. A., R. A. EATON, E. M. LIZOTTE, and N. L. ROTHWELL. 2012. Bird consumption of sweet and tart cherries and implications for bird control techniques. *Human-Wildl. Interact.* 6:283-290.
- LINZ, G. M., H. J. HOMAN, S. J. WERNER, H. M. HAGY, and W. J. BLEIER. 2011. Assessment of bird management strategies to protect sunflower. *BioScience* 61(12):960-971.
- LOCK, K., J. POMERLEAU, L. CAUSER, D. R. ALTMANN, and M. MCKEE. 2005. The global burden of disease attributable to low consumption of fruit and vegetables: Implications for the global strategy on diet. *Bull. W.H.O.* 83(2):100-108.
- MANUEL HERRERA, J., and D. GARCIA. 2010. Effects of forest fragmentation on seed dispersal and seedling establishment in ornithochorous trees. *Conserv. Biol.* 24(4):1089-1098.
- PRITTS, M. P. 2001. Bye bye birdie: Repelling birds from fruit plantings. *New York Quarterly* 9(4): 5-7.
- RIBOT, R. F. H., M. L. BERG, K. L. BUCHANAN, and A. T. D. BENNETT. 2011. Fruitful use of bioacoustic alarm stimuli as a deterrent for Crimson Roseallas (*Playcercus elegans*). *Emu* 111(4):360-367.
- ROBERTSON, G. P., L. W. BURGER, JR., C. L. KLING, R. LOWRANCE, and D. J. MULLA. 2007. Methods for environmental management research at landscape and watershed scales. Pp. 27-51 *in*: M. Schnepf and C. Cox (Eds.), *Managing Agricultural Landscapes for Environmental Quality*. Soil and Water Conservation Society, Ankeny, IA.
- SEKERCIOGLU, C. H. 2006. Increasing awareness of avian ecological function. *Trends Ecol. Evol.* 21(8):464-471.
- SERGIO, F., I. NEWTON, L. MARCHESI, and P. PEDRINI. 2006. Ecologically justified charisma: Preservation of top predators delivers biodiversity conservation. *J. Appl. Ecol.* 43(6):1049-1055.
- SIMON, G. 2008. A short overview of bird control in sweet and sour cherry orchards – Possibilities of protection of bird damage and its effectiveness. *Intl. J. Hort. Sci.* 14(1-2): 107-111.
- SOMERS, C. M., and R. D. MORRIS. 2002. Birds and wine grapes: Foraging activity causes small-scale damage patterns in single vineyards. *J. Appl. Ecol.* 39(3):511-523.
- SUMMERS, R. W. 1985. The effect of scarers on the presence of starlings (*Sturnus vulgaris*) in cherry orchards. *Crop Prot.* 4(4): 520-528.
- TOBIN, M. E., R. A. DOLBEER, C. M. WEBSTER, and T. W. SEAMANS. 1991. Cultivar differences in bird damage to cherries. *Wildl. Soc. Bull.* 19(2):190-194.
- TOURENQ, C., S. AULAGNIER, L. DURIEUX, S. LEK, F. MESLEARD, A. JOHNSON, and J.-L. MARTIN. 2001. Identifying rice fields at risk from damage by the greater flamingo. *J. Appl. Ecol.* 38(1):170-179.
- TRACEY, J., M. BOMFORD, Q. HART, G. SAUNDERS, and R. SINCLAIR. 2007. *Managing Bird Damage to Fruit and Other Horticultural Crops*. Bureau of Rural Sciences, Government of Australia, Canberra, Australia. 268 pp.
- TREVES, A., and S. M. JONES. 2010. Strategic tradeoffs for wildlife-friendly eco-labels. *Front. Ecol. Environ.* 8(9):491-498.
- USFWS (U.S. FISH AND WILDLIFE SERVICE). 2006. Birding in the U.S.: A demographic and economic analysis. U.S. Fish and Wildlife Service Report 2006-4. Available from: http://library.fws.gov/pubs/birding_natsurvey06.pdf.
- USDA. 1998. Fruit wildlife damage. National Agricultural Statistics Service, U.S. Dept. of Agriculture, Washington, D.C.
- VIRGO, B. B. 1971. Bird damage to sweet cherries in the Niagara Peninsula, Ontario. *Can. J. Plant Sci.* 51(5):415-423.
- WERNER, S. J., J. L. CUMMINGS, S. K. TUPPER, J. C. HURLEY, R. S. STAHL, and T. M. PRIMUS. 2007. Caffeine formulation for avian repellency. *J. Wildl. Manage.* 71(5): 1676-1681.
- WORLD HEALTH ORGANIZATION. 2010. Global strategy on diet, physical activity and health. Accessed December 6, 2010. <http://www.who.int/dietphysicalactivity/fruit/en/index2.html>.