# Impacts of EPA Proposed Buffer Zone Restrictions on Florida Strawberry Acreage and Production

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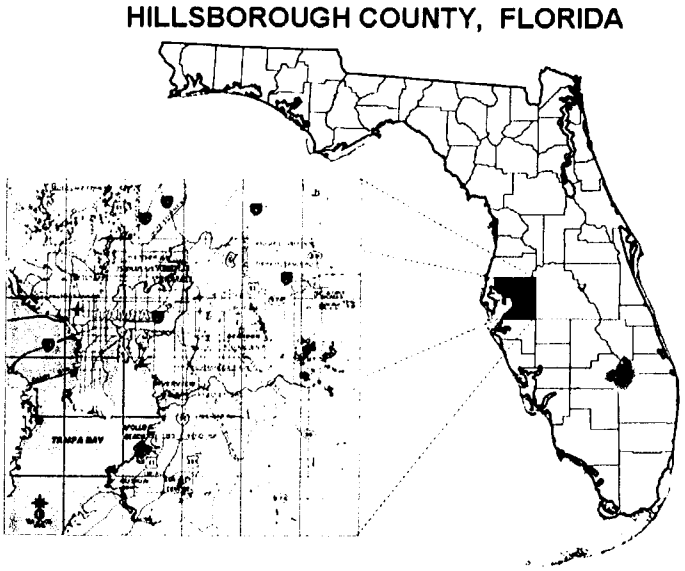
**Abstract:** The objective of studies reported herein were to characterize acreage and economic impacts from lost production for implementing buffer zone restrictions of 100, 200, 300, 400, 500, 1000, 2000, and 4000 feet surrounding each Hillsborough County Florida strawberry field. These analyses used ArcGIS mapping and buffer tool software to indicate that buffer zone requirements of 2000 feet or more will virtually eliminate 100% of strawberry production in Hillsborough County, FL. In general, and using adjusted centroid values, the results for imposing buffer zones of 100, 200, 300, 400, 500, 1000, 2000, and 4000 feet will cost Hillsborough County strawberry growers approximately $17.6, $37.8, $61.8, $89.3, $115.7, $187.4, $234.7, and $239.2 million dollars, respectively, by reducing available land by 7.4, 18.8, 25.8, 37.3, 48.4, 78.4, 98.1, and 100%, respectively. These analyses show that if acceptable regulatory changes in proposed buffer zone restrictions do not occur, Florida strawberry growers will either have to move to new production sites in which buffers are not at issue, or accept significant yield penalties following use of other, less effective, pest and crop management tactics.

Strawberry is the most important berry crop produced in Florida, producing 15 percent of the total U.S. crop, and 100 percent of the domestically produced winter crop. Approximately 95 percent of Florida's commercial strawberry production acreage is located in Hillsborough County, Florida (Fig. 1). The 2002 Census of Agriculture reported the presence of 217 individual farms growing strawberries in 2006 on over 7,300 acres. Most farms are family run (86.9%) with a median farm size of about 23 acres. In 2006, Florida produced over 200 million pounds of strawberries with a production value of over $239 million. Hillsborough County also produces a diversity of other agricultural crops, with some 2,600 farms producing other fruit and vegetable crops with an annual value of over 400 million dollars. This diversity of farm production includes not only strawberries, but citrus, tomatoes, cucumbers, eggplant, squash, okra, peppers, beans, dairy products, eggs, ornamental horticulture, tropical fish, beef cattle, swine and other related products. Of the nation's counties, Hillsborough County ranks number 5 in production of strawberries.

**Figure 1. Maps of Hillsborough County, Florida showing a west central state location and comprising a total land area of 1,266 mi², 215 mi² of which 17% is water.**




Hillsborough County, located in west central Florida (Fig. 1) is also a very populated county, particularly in and around Tampa. According to the U.S. Census Bureau census of 2000, there were 998,948 people, 391,357 households, and 255,164 families residing in the county with a total area of 1,266 $mi^2$, 1,051 $mi^2$ of it is land and 215 $mi^2$ of it (17.00%) is water. As of 2006, the population of

Hillsborough County is now estimated at 1,157,738, with 425,962 housing units at an average population density of 405 per $mi^2$.

**Production Practices**

Hillsborough County strawberry production starts in November and may continue through May of the following year, with highest production occurring around February and March. Because of the great value of the crop as well as the initial investment, it is strongly recommended that strawberries be grown only on full-bed plastic mulch, and that a multi-purpose soil fumigant be applied to the bed as the plastic is laid over it. In Florida, strawberries are grown as an annual crop in using the plastic mulch, raised bed system, with two rows of plants per bed. Methyl bromide, in combination with chloropicrin, is still extensively used at reduced rates with high barrier, gas impermeable plastic mulches. It is currently applied approximately two weeks prior to planting transplants for the management of soilborne diseases, nematodes, insects, and weeds.

**Methyl Bromide Alternatives for Chemical Control**

For over 40 years, methyl bromide and chloropicrin has been effectively used for broadspectrum control of soilborne pests and diseases. For many labeled crops, soil fumigation uses of methyl bromide was phased out of use January 1, 2005. For tomato, pepper, eggplant and strawberry, methyl bromide continues to be made available at progressively reduced annual levels of supply, via an international approval, Critical Use Exemption (CUE) process. During the methyl bromide phase-out and CUE period, field research has been ongoing to find suitable replacements for methyl bromide in Florida strawberry production. Currently, the most promising replacement for methyl bromide are the 1,3-dichloropropene products, used in combination with or as a second application of chloropicrin plus a herbicide just prior to laying the plastic mulch. After the effective CUE period for methyl bromide, chloropicrin is expected to play a critical role for disease control, and is considered the foundation component of any alternative strategy in strawberry, or any other methyl bromide CUE crop grown in the U.S..

At present, there is significant grower concern that the practical uses of chloropicrin (and other fumigants) as a pest management tool will be eliminated because the U.S. EPA has proposed the implementation of large buffer zones, as much as 1440 meters (4724 feet), surrounding fumigant treated fields (See EPA docket number EPA-HQ-OPP-2007-0350; *Chloropicrin: Revised HED Human Health Risk Assessment for Phase 3*). Based on measurable distance and regulatory requirement for specific methods and rates of fumigant use, buffer zones will restrict where fumigant field treatments and crop production, relative to any occupied structure or human activity, can legally occur.

At present only a few soil fumigant products have buffer zone restrictions which are required as a prerequisite for their use. For example, all soil fumigants containing 1,3-dichloropropene (Telone) cannot be applied within 100 feet of

occupied structure, such as a school, hospital, business, or residence. For all of the Telone products, buffer zones of 100 ft. from an occupied structure do not pose a particularly significant problem for most Florida fruit or vegetable growers, particularly where fields are remotely located in rural areas and at considerable distance from residential housing. However, not all growers are so fortunate to be farming in rural areas.

Since most Florida strawberry production is situated in the residential areas of Plant City, Florida, even a 100 foot buffer zone requirement (or that of other fumigants) can have a major impact on farmable (ie., treatable) acreage. In Plant City, many strawberry fields are rectangular in shape with residential housing situated on three sides and a road on the fourth. The average farm size is generally small, 25 acres or less. The farmable area of a 25-acre field can get very small when a sizeable buffer is imposed and even smaller if it is interpreted as commencing not from the actual dwelling but from the property line as it can be for methyl bromide buffer zone requirements in California.

**Objectives:** The objective of the studies reported herein were therefore to characterize acreage and economic impacts from lost production for implementing buffer zone requirements of 100, 200, 300, 400, 500, 1000, 2000, and 4000 feet surrounding each Hillsborough County Florida strawberry field.

**Methods and Materials:** Detailed aerial maps, acquired from the Hillsborough County Property Appraisers office in Tampa Florida, were downloaded to portable hard drive on May 14, 2007. The aerial photos were recent, taken during the period of January 18 through January 31, 2007. The entire directory (16 Gb) represented 1338 images of ½ foot resolution, each covering an area of 6,185 acres or approximately 9.67 square miles. Each aerial photo was carefully examined on computer screen to identify the presence of a planted strawberry field. The narrow row spacing, high plant density, overhead irrigation, and absence of drive rows and harvester walkouts provided the signature for positive identification. ArcGIS software was then used to create separate polygon shape files after the GPS coordinates for the boundaries of each strawberry field were manually referenced. Of the 7300 acres reported planted in 2006, the sum of the polygon shape files represent only 6625 acres or 91% of total reported acreage.

After the field boundary referencing step was completed, ArcGIS was use to construct another shape file which included the map coordinates for the center points (centroids) of residential parcels surrounding each strawberry field. It should be recognized that the centers of residential land parcels, ie., the center point of housing developments or trailer parks, were frequently used as the reference points for buffer zone calculations. Use of the centroid data points significantly underestimate buffer impacts because they do not measure from the centers of individual housing on the outer fridge of the development bordering a fumigant treated strawberry field. An E911 Point Feature dataset was also acquired from the Hillsborough County GIS Department to provide an ArcGIS layer of

approximate point location for each E-911 address (occupied structure) in the county. The point dataset was however only 80% complete, had not been validated for accuracy and reliability, and therefore was not used for any of the buffer zone analyses reported herein.

Using the ArcGIS buffer tool, impacts of proposed buffer restrictions were therefore first estimated from the 1338 aerial images comprising Hillsborough County using the centroid residential parcel point feature set as an epicenter from which to calculate buffer zone distances, and associated impacted field areas, of 100, 200, 300, 400, 500, 1000, 2000, and 4000 feet. The degree to which buffer zone impacts were being underestimated by the centroid method was then determined from a third shape file in which the GPS coordinates for each occupied structure was manually placed in each of eleven different aerial images with each image representing a 9.67 square mile area of Hillsborough County. The total strawberry acreage represented within the eleven images was 1345 acres, representing over 20% of the total strawberry production acreage of 6625 acres mapped from all 1338 aerial images.

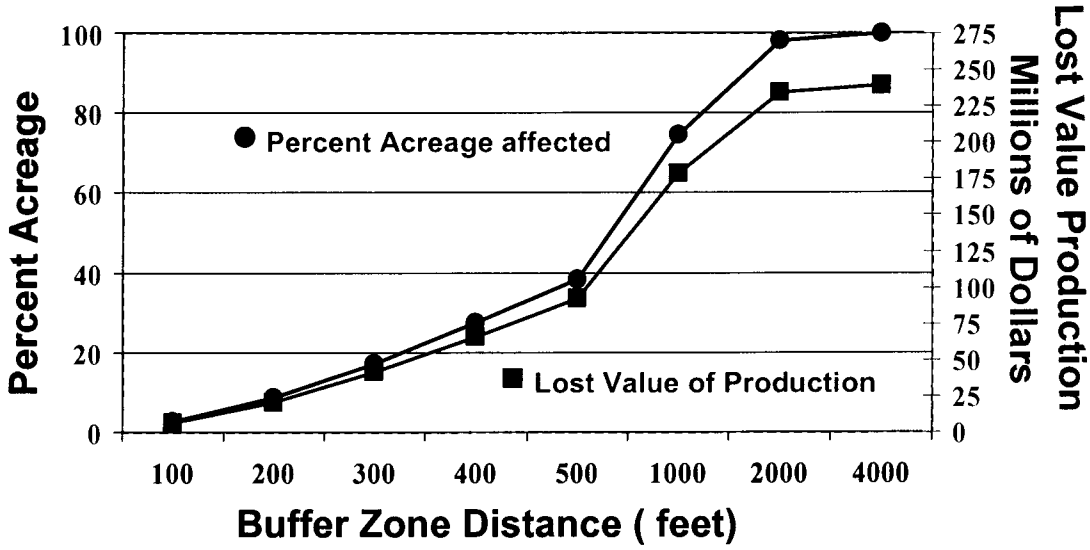
Again using the ArcGIS buffer tool, impacts of proposed buffer zone restrictions were reestimated using the point centers of occupied dwellings as the epicenter for which to calculate buffer zone distance and estimates of impacted field areas. The degree to which the centroid (C) was observed to underestimate the point center (PC) of occupied dwelling method was first computed by the formula ((PC – C) / PC ) x 100. A multiplier effect was also computed as the ratio of average percent acreage affected estimated by GPS coordinates for point centers (PC) of occupied dwellings and land / tax parcel centroids (C) for different buffer zone distances. The ratio (PC / C) is another measure of the degree to which the centroid method underestimates true buffer zone impacts compared to manual GPS referencing of center points of occupied dwellings. For Figures 2 – 5 and Tables 1 -3, each reported mean and or standard error value represents the average of 11 replications.

To estimate economic impacts, the Florida Agricultural Statistics Service indicated that for the 2005-06 season (the most recent season of record) there were 7,300 acres harvested and the value of production was estimated at $239,148,000. These values were divided to provide an estimate of net production value of $32,760 per acre. If it is assumed that fields must be fumigant treated to justify planting and sustain economic production, then the value of $32,760 estimates potential loss of buffer zone restricted strawberry acreage. Using estimates of the percentage of impacted fields, economic impacts for each buffer zone distance were then extrapolated from the 6225 acres cumulatively accounted for from the aerial images to the actual 7300 acres reported in 2006.

**Results**: The tax parcel centroid analysis indicates that buffer zone requirements of 2000 feet or more will effectively eliminate 100% of strawberry production in Hillsborough County, FL (Fig. 2). In general, the results for imposing buffer zones

of 100, 200, 300, 400, 500, 1000, 2000, and 4000 feet will cost Hillsborough County strawberry growers approximately $6.4, $20.6, $41.4, $66.0, $91.9, $178.5, $234.7, and $239.2 million dollars, respectively, by reducing available land by 2.7, 8.6, 17.3, 27.6, 38.4, 74.6, 98.1, and 100%, respectively (Fig. 2, Table 1).

**Fig. 2. Impact of new EPA proposed Buffer Zone restrictions on percentage Florida strawberry acreage affected and net value of lost production (millions of dollars) in Hillsborough County, FL using the tax parcel centroid values for buffer zone distance determinations. Lost production value is calculated as a percentage of 7300 acres harvested in 2006.**




A comparison of strawberry acreage and economic impacts using tax parcel centroids and GPS coordinates for point centers of occupied dwellings is presented in Table 2. This analyses revealed that with each of the eleven aerial images, acreage and economic impacts were consistently underestimated with use of the tax parcel centroid values for most of the buffer zone distances evaluated (Table 2; Fig. 3). The degree to which the tax parcel centroid underestimates the GPS point center of occupied dwelling method diminishes with buffer zone distance, such that at distances which encompass nearly 100% of strawberry acreage, there are virtually no differences between either method of impact assessment.

A multiplier effect was also calculated to convert the more global, countywide buffer zone impacts derived from the tax parcel centroid method to that of the more relevant point center of occupied dwelling method (Fig. 4.) The multiplier effect was observed to diminish from a value of 2.76 to 1.0 as buffer zone distance increased from 100 feet to 4000 feet. In this analysis, there were again virtually no differences between methods of estimation at buffer zone distance greater than or equal to 1000 ft.

Fig. 3. Comparison of economic impacts of implementing newly proposed EPA buffer zone restrictions of varying distance for fumigant use on percentage changes in strawberry production acreage estimated from eleven aerial images, each image representing 9.67 square mile areas of Hillsborough County, Florida using land / tax parcel centroids or GPS coordinates for point centers of occupied dwellings as reference for calculation of buffer zone distances. The degree to which the centroid (C) underestimates the point center (PC) of occupied dwelling method is computed by the formula ((PC – C) / PC ) x 100. Each point represents the average of 11 replications.

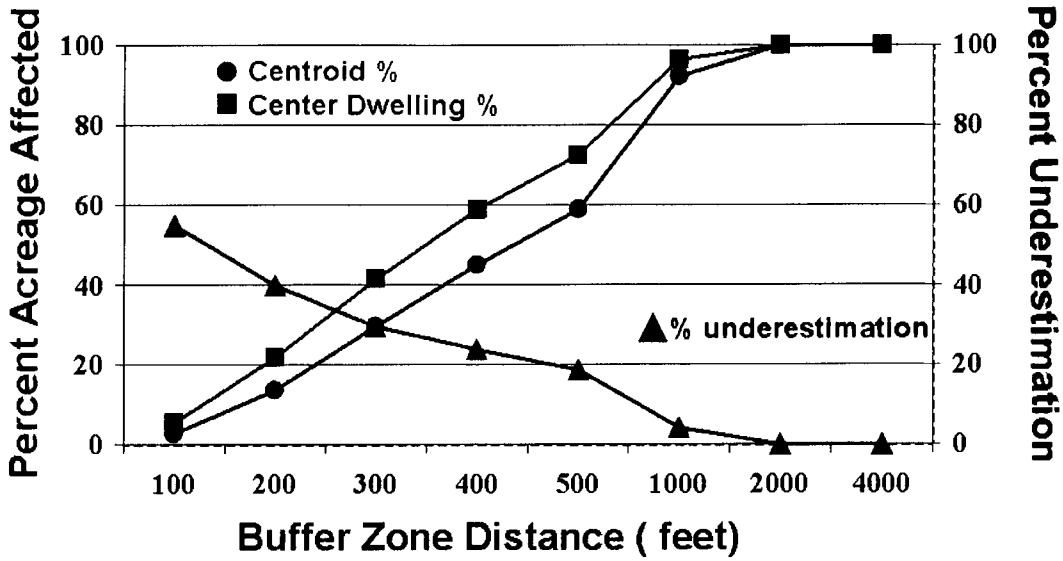
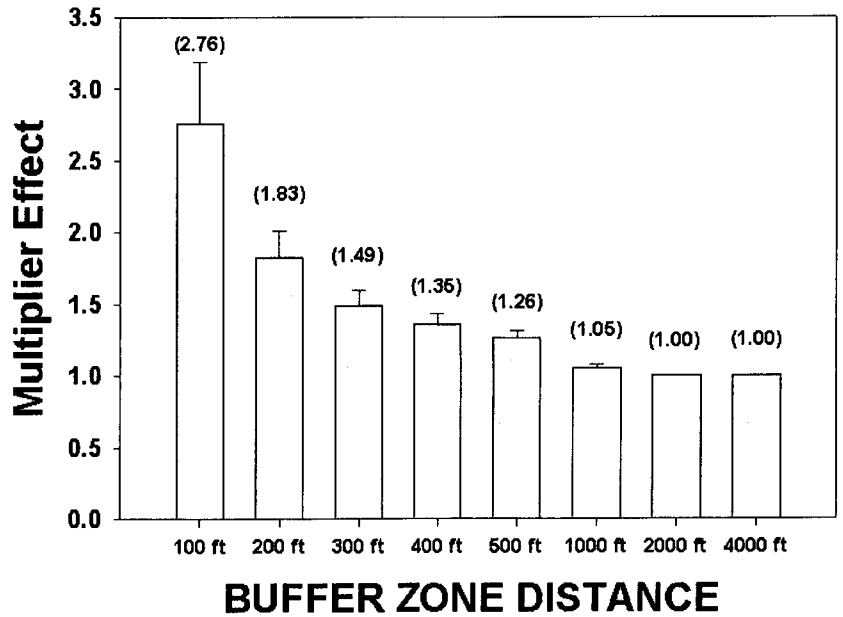
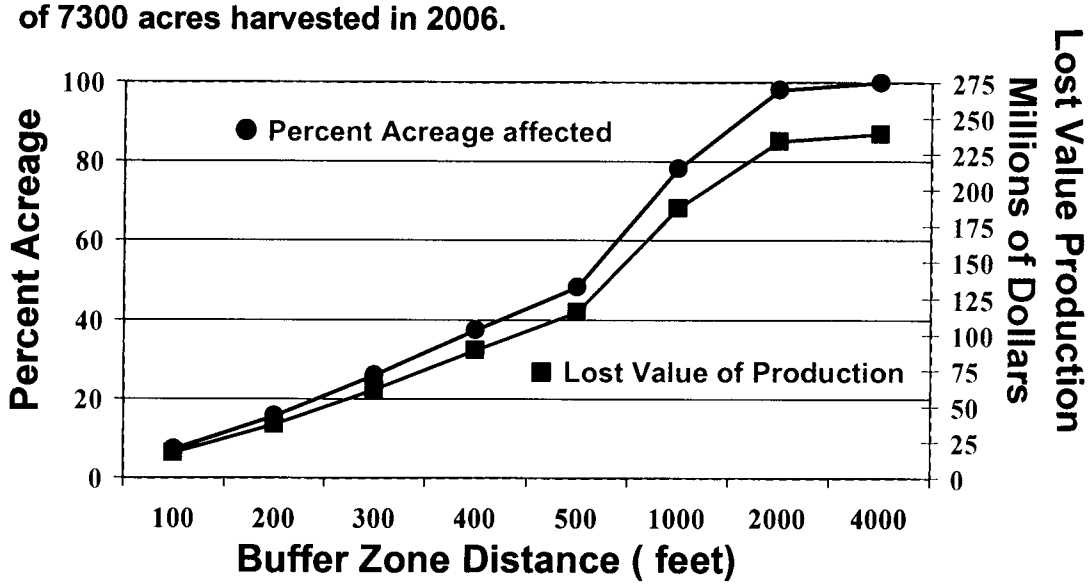



Fig. 4 The multiplier effect is the ratio of average percent acreage affected estimated by GPS coordinates for point centers (PC) of occupied dwellings and land / tax parcel centroids (C) for different buffer zone distances. The ratio (PC/C), or multiplier effect, is a measure of the degree to which the centroid method underestimates true buffer zone impacts compared to manual GPS referencing of center points of occupied dwellings. Each mean and standard error represents the average of 11 replications.



Using centroid estimates, adjusted by the appropriate multiplier effect determined by using the manually placed GPS coordinates for point centers (PC) of occupied dwellings analyses also indicated that buffer zone requirements of 2000 feet or more will virtually eliminate 100% of strawberry production in Hillsborough County, FL. In general, the results for imposing buffer zones of 100, 200, 300, 400, 500, 1000, 2000, and 4000 feet will cost Hillsborough County strawberry growers approximately $17.6, $37.8, $61.8, $89.3, $115.7, $187.4, $234.7, and $239.2 million dollars, respectively, by reducing available strawberry acreage by 7.4, 15.8, 25.8, 37.3, 48.4, 78.4, 98.1, and 100%, respectively (Figure 5;Table 3).

**Fig. 5. Impact of new EPA proposed Buffer Zone restrictions on percentage Florida strawberry acreage affected and net value of loss production (millions of dollars) in Hillborough County, FL using adjusted tax parcel centroid values for buffer zone distance determinations. Lost production value is calculated as a percentage of 7300 acres harvested in 2006.**




## Conclusions

Although values of acreage and net production value lost are large and significant, the procedure would have unavoidably, underestimated true loss potential if the analysis had only used centroid values rather than center points of occupied structure as reference points for buffer zone distance calculation. The degree to which buffer zone impacts are underestimated are documented within Table 2 and Figure 4, which compare the results generated by centroid values and those points in which the GPS coordinates for the center point of the occupied dwelling were manually placed. In general, use of the centroid values underestimates true buffer zone acreage impacts by as much as 66% when compared with use of the center points of each occupied dwelling. The effect was observed to diminish with buffer zone distance, such that at distances at which buffer zones consumed all

strawberry acreage, the differences were zero. The improved accuracy in which occupied structures are located for buffer zone determinations strongly suggest a need to upwardly adjust estimates of buffer zone impacts derived from use of centroid values.

The buffer zone impacts reported herein also do not account for anything other than the areas represented as circular 'bites' which extend into and around the perimeter of grower fields from each occupied residential structure. Additional losses in field acreage and production value will undoubtedly accrue because of impracticalities imposed by attempting to farm areas with significant discontinuity along rows paralleling the field boundary. As far as these estimates are concerned, we also that the impacts of buffer zones restrictions analytically determined for Hillsborough County could also be reasonably extrapolated to the types and magnitude of expected impacts in many other, highly populated counties of Florida where agriculture and urban housing coexist (Fig. 7). These include principally the west coast counties of Manatee and Collier, and entire east coast of Florida, extending from Indian River County to Dade County. These areas represent major production areas within Florida for CUE dependent crops of pepper, tomato, and eggplant.

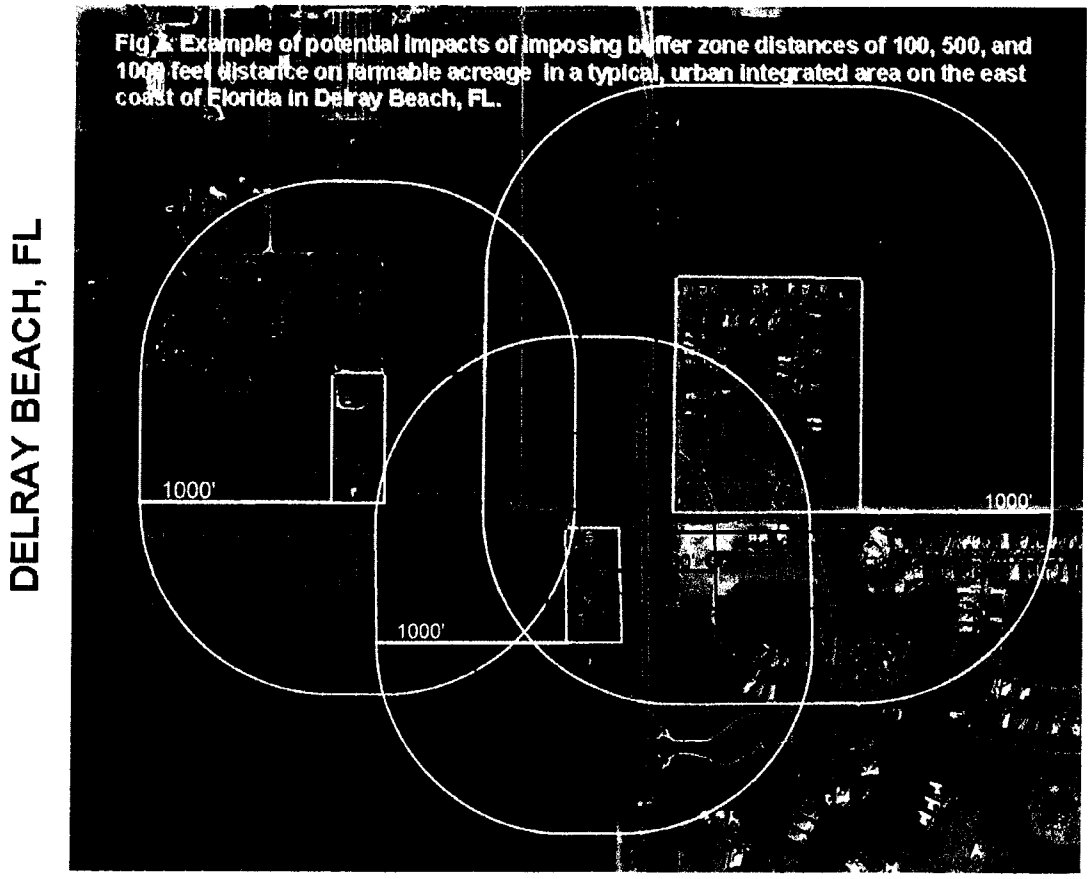


Fig 7. Example of potential impacts of imposing buffer zone distances of 100, 500, and 1000 feet distance on farmable acreage in a typical, urban integrated area on the east coast of Florida in Delray Beach, FL.

Over a decade of field research has repeatedly demonstrated the need for combinations of chloropicrin, 1,3-dichloropropene (Telone), and other soil applied

fumigants and or herbicides to replace the broad spectrum pest control activity of methyl bromide for strawberry production in Florida and California. Currently the best available alternative prescribed for Florida strawberries recommends use of Telone C-35 (1,3-Dichloropropene + 35% chloropicrin), applied in-bed at 35 gallons per treated acre, 3-5 weeks prior to planting. In addition to Telone C35, use of KPam or Vapam at 60 or 75 gallons per treated acre respectively, may also be needed as a supplementary herbicide treatment, injected to the bed surface just prior to plastic laying. Reduced rates of these fumigants are being used with virtually impermeable and or high barrier plastic mulches. Additional time and research will be required to further determine effective, rate minimizing treatment regimes which satisfy grower buffer zone constraints.

Prior to 1998, Telone buffer zones of 300 feet (at the time federally required by the product label) were declared unrealistic to even consider 1,3-D products as methyl bromide alternatives. Based on this experience, it should be evident that any significant increase or expansion in buffer zone distances resulting from new EPA regulatory actions can render use of any soil fumigant impractical for grower use. The impact of implementing increasing buffer zone distances on the disappearance of farmable acreage is illustrated in Figure 6. It demonstrates that if acceptable regulatory changes in proposed buffer zone restrictions do not occur in Florida, Florida strawberry growers will either have to move to new production sites in which buffers are not at issue, or accept significant yield penalties following use of other, less effective, pest and crop management tactics.

With regard to use of these fumigants, these analyses show that when even relatively small buffer zones (< 500 feet) are imposed, even minimal uses of chloropicrin, KPam, or Vapam will likely force some growers out of strawberry production and trigger significant, industry-wide, economic losses. The sheer magnitude of these economic impacts will surely make use of soil fumigants like chloropicrin, Kpam, or Vapam impractical for growing strawberry in Hillsborough County, FL because of the relative proximity of occupied structures to production fields. Clearly, the rapid implementation of buffer zones could have disastrous economic consequences to the Florida Strawberry industry. It is hoped that some reasonable compromise can be obtained and that the time needed to develop new rate and emission reducing strategies will be factored into any EPA timetable to broadly implement buffer zone requirements for Chloropicrin and other essential fumigants.

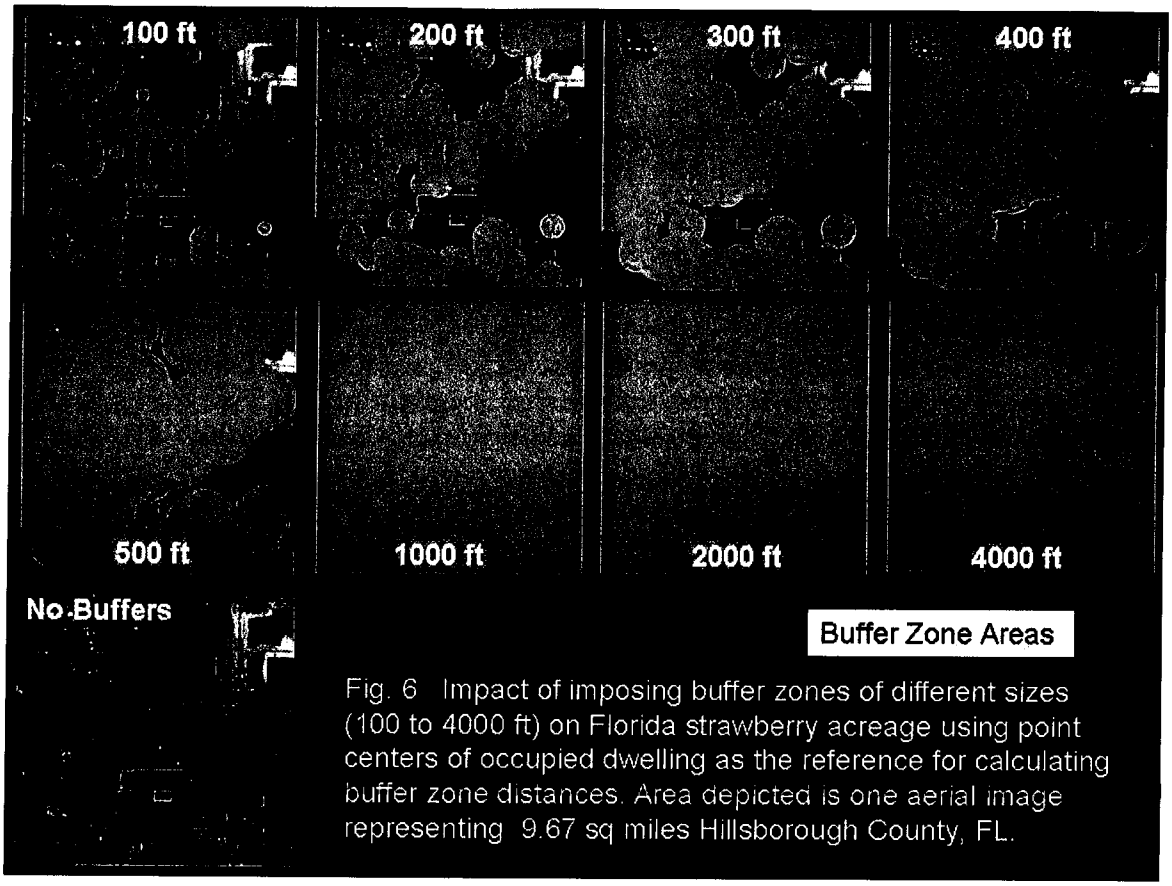



Fig. 6 Impact of imposing buffer zones of different sizes (100 to 4000 ft) on Florida strawberry acreage using point centers of occupied dwelling as the reference for calculating buffer zone distances. Area depicted is one aerial image representing 9.67 sq miles Hillsborough County, FL.

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**Table 1**. Impact of implementing newly proposed buffer zone restrictions of varying distance for fumigant use on countywide changes in strawberry production acreage and lost production in Hillsborough County, Florida using land / tax parcel centroids as epicenter coordinates for calculation of buffer zone distances.

| Buffer Zone Distance (feet) | Number Impacted Acres | Percent of Total Acres | Estimated Production Losses ($$) |
|---|---|---|---|
| **100** | 176.9 | 2.67 | 6,385,252 |
| **200** | 571.7 | 8.63 | 20,638,472 |
| **300** | 1146.8 | 17.31 | 41,396,519 |
| **400** | 1827.8 | 27.59 | 65,980,933 |
| **500** | 2544.7 | 38.41 | 91,856,747 |
| **1000** | 4943.6 | 74.62 | 178,452,238 |
| **2000** | 6501.1 | 98.13 | 234,675,932 |
| **4000** | 6625.0 | 100.00 | 239,148,000 |

**Table 2.** Comparison of impacts of implementing newly proposed EPA buffer zone restrictions of varying distance for fumigant use on changes in strawberry production acreage and lost production estimated from eleven aerial images each representing 9.67 square mile areas of Hillsborough County, Florida using land / tax parcel centroids or GPS coordinates for point centers of occupied dwellings for calculation of buffer zone distances. Note underestimations with use of centroid values.

| Buffer Zone Distance (feet) | Number Impacted Acres | | Percent of Total Acres | | Estimated Production Losses ($$) | |
|---|---|---|---|---|---|---|
| | Centroid | House Center | Centroid | House Center | Centroid | House Center |
| 100 | 35.9 | 73.8 | 2.7 | 5.5 | 1,176,461 | 2,419,015 |
| 200 | 180.9 | 293.9 | 13.5 | 21.9 | 5,926,366 | 9,627,591 |
| 300 | 398.4 | 558.3 | 29.6 | 41.5 | 13,051,224 | 18,290,219 |
| 400 | 606.6 | 792.2 | 45.1 | 58.9 | 19,872,052 | 25,952,636 |
| 500 | 790.2 | 973.2 | 58.8 | 72.4 | 25,886,543 | 31,883,408 |
| 1000 | 1240.5 | 1296.6 | 92.2 | 96.4 | 40,638,567 | 42,475,961 |
| 2000 | 1345.0 | 1345.0 | 100.0 | 100.0 | 44,062,200 | 44,062,200 |
| 4000 | 1345.0 | 1345.0 | 100.0 | 100.0 | 44,062,200 | 44,062,200 |

**Table 3.** Impact of implementing newly proposed buffer zone restrictions of varying distance for fumigant use on changes in strawberry production acreage and lost production in Hillsborough County Florida using manually place GPS coordinates for occupied structure to **adjust** underestimates derived from use of land / tax parcel centroid coordinates for calculation of buffer zone distances.

| Buffer Zone Distance (feet) | Number Impacted Acres | Percent of Total Acres | Estimated Production Losses ($$) |
|---|---|---|---|
| **100** | 488.21 | 7.369 | 17,622,816 |
| **200** | 1046.28 | 15.793 | 37,768,644 |
| **300** | 1712.15 | 25.844 | 61,805,409 |
| **400** | 2473.06 | 37.329 | 89,271,557 |
| **500** | 3206.27 | 48.397 | 115,740,458 |
| **1000** | 5190.75 | 78.351 | 234,675,932 |
| **2000** | 6501.11 | 98.130 | 234,675,932 |
| **4000** | 6625.00 | 100.000 | 239,148,000 |