

Fatal Work-Related Injuries
in the Agriculture Production Sector
Among Youth in the United States, 1992-2002

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ABSTRACT. Youth working on farms face unique risks that are not present for many other young workers, including machinery, large animals, electrical hazards, chemical hazards and excessive noise. This research identified the number and rate of occupational fatalities for youth working in the agriculture production industry, which is most closely affiliated with farming, for the years 1992-2002. The Census of Fatal Occupational Injuries (CFOI), developed by the Bureau of Labor Statistics (BLS), was the database used for the analysis. There were 310 work-related deaths to youth less than 20 years of age from 1992 through 2002 in the agriculture production sector. This compares to 1,958 total fatalities for all workers less than 20 years of age for the same time period. The number of agricultural production fatalities to youth has shown a general downward trend over this time period. The rates were higher for young workers in agriculture production than for young workers in all industries by a factor of 3.6. Fifteen year olds had the highest fatality rates with the crop production sector having a rate six times that of all 15 year old workers. The objective of this descriptive research was to identify, prioritize and publicize the risks to children and youth who work on farms in order to provide public health and safety professionals relevant information upon which to base decisions for interventions or other prevention activities for this priority population. This research also has direct applications for farm parents and safety and health professionals who work with the priority population of young agricultural workers. doi:10.1300/J096v11n02_09 [Article copies available for a fee from The Haworth Document Delivery Service: 1-800-HAWORTH. E-mail address: <docdelivery@haworthpress.com> Website: <<http://www.HaworthPress.com>>]

KEYWORDS. Agriculture, occupational accidents, adolescent, child mortality

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The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

The history of youth labor on farms impacts and pervades both farm culture and societal views regarding the practice of youth working on farms.^{1,2} Youth working on farms face unique risks that are not present for many other young workers, including machinery, large animals, electrical hazards, chemical hazards and excessive noise.³⁻⁵ Furthermore, because there are no legal age restrictions on the type of work that farm resident youth are permitted to do on their family operated farms, these youth typically operate equipment or engage in activities that would be prohibited for non-resident youth of the same age. Finally, because privately operated farms often have easy access to youth labor in rural areas, local youth can be recruited into the work force on an "as needed" basis with little or no job training.^{6,7} These and other factors place youth working in agriculture at high risk for occupational death in the United States.⁸

This research assessed the trend in occupational fatalities for youth working in the agriculture production industry, which is the industrial sector most closely affiliated with farming, for the eleven year time period from 1992-2002. It builds upon previous research that looked at agriculture production and services fatalities among youth from 1992-1996 and other research of youth farm deaths.⁹⁻¹¹ The objective of this descriptive research was to identify, prioritize and publicize the risks to children and youth who work on farms in order to provide public health and safety professionals relevant information upon which to base decisions for interventions or other prevention activities for this priority population. This research also has direct applications for farm parents and safety and health professionals who work with the priority population of young agricultural workers.

METHODS

The Census of Fatal Occupational Injuries (CFOI), developed by the Bureau of Labor Statistics (BLS), was the database used for this analysis. The time period of 1992-2002 was selected since 1992 was the start of the CFOI surveillance system and 2002 was the last year which incorporated the Standard Industrial Classification (SIC) system for agriculture within CFOI. The North American Classifica-

tion System (NAICS) is utilized in 2003 and later, which BLS indicates should be treated as a time series break. CFOI compiles a count of all fatal work injuries occurring in the U.S. in each calendar year. The program uses diverse state and federal data sources to identify, verify, and profile fatal work injuries. Information about each workplace fatality (industry, occupation, and other worker characteristics; equipment being used; and circumstances of the event) is obtained by cross-referencing source documents, such as death certificates, workers' compensation records, and reports to federal and state agencies. The National Institute for Occupational Safety and Health (NIOSH) CFOI research file excludes data for New York City. The Occupational Injury and Illness Classification Structure (OIICS) was used to code body part injured, the event leading to the injury, and the source of the injury.¹² Industry was coded according to the Standard Industrial Classification (SIC) System.¹³ The Bureau of the Census regional classification was used to define the regions of the United States.

Fatalities in the agriculture production sector (livestock and crops) were selected (SIC codes 0100 - 0299) for youth less than 20 years of age from a special CFOI research file, which excludes New York City, provided to the NIOSH by the BLS.

The Current Population Survey (CPS) employment data was used for population estimates to calculate fatality rates. CPS is a monthly survey of U.S. households selected from a probability sample representative of the civilian noninstitutionalized population.¹⁴ Data collected by the CPS includes demographic characteristics of employed civilians, as well as information on what primary job(s) workers hold and the number of hours worked by the employed individuals. Unpaid family members are considered to be employed if they work for the family business. Self-employed individuals are included in the CPS sample. Rates were not calculated for youth 14 years of age and younger since the CPS does not collect employment data for these ages.

In addition, CPS data were used to determine monthly estimates of the hours worked by youth 15 years of age and older who were employed in the agriculture production sector. Although the exact age was available for each fa-

tality, in some instances they could not be reported due to confidentiality requirements by BLS. The monthly estimates were annualized and summed for each calendar year to provide estimates of the total employed hours. These annual employed hours were converted to Full-Time Equivalents (FTE) using the BLS definition of a FTE (2,000 hours of work per calendar year). Rates are presented per 100,000 FTE. This method is recommended for calculation of work-related injury rates for youth specifically, and especially when rates are to be contrasted with those of older workers. Hours of work are a crude measure of exposure and they are typically lower for youth when compared to adults. Failure to control for lesser hours worked by youth results in an underestimate of their risk.¹⁵

Numbers and rates were calculated by NIOSH and may differ from previously published BLS CFOI numbers and rates because the data excludes information from New York City, there may be differences in whether the data used was in its "final" form and different parameters may have been used when subsetting the file.

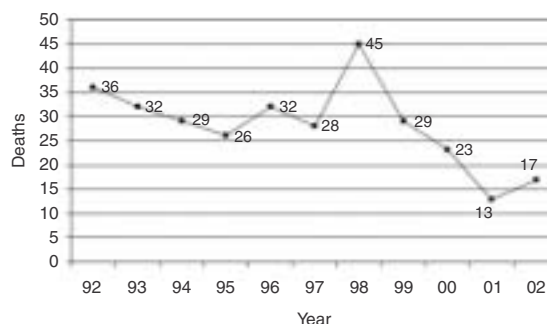
Since CFOI by its design only collects work-related deaths, there is no way to ascertain deaths to youth who were not working but exposed to hazards in the work environment by either living on a farm, visiting a farm or accompanying their parents while they were working.

RESULTS

According to CFOI data, there were 310 work-related deaths to youth less than 20 years of age from 1992 through 2002 in the agriculture production sector. This compares to 1,958 total fatalities for all workers less than 20 years of age for the same time period. The number of young worker agriculture production fatalities has shown a general downward trend over this time period (Figure 1).

The agriculture production workforce 15-19 years of age accounted for 7.1% of the total youth workforce (FTE adjusted) during this time period. However, the agriculture production sector incurred 15.8% of all the occupational fatalities that occurred during this time period for this age group. For workers under 16

FIGURE 1. Frequency of Fatalities in Agriculture Production for Workers < 20 Years of Age in the United States, 1992-2002



years of age, the agriculture production sector accounted for almost 60% of the deaths in this age group. Also, 79% of all work-related deaths for youth 10 years of age and younger occurred in agriculture production. For youth 10 years of age and younger who were fatally injured while working in agricultural production, more than half of these fatalities occurred in the Midwest, with crop production accounting for more than two-thirds of the deaths and males being most likely to be killed. The largest event category was "Non-highway accidents" which consisted primarily of falls from moving vehicles or mobile equipment and being struck by the same (23.5%). Machinery and vehicles were the primary sources of fatalities, each accounting for 38% of the deaths. However, tractors were the single largest source of fatalities, accounting for 42.9% of the vehicle deaths and 17.6% of all the deaths to the youngest of the young agricultural workers.

The five states that had the highest number of agriculture production young worker fatalities for 1992-2002 were: Wisconsin (25), Pennsylvania (22), New York (21), Ohio (18), and Montana (16). Forty-eight percent of all the fatalities occurred in the Midwest, followed by the West (19%), the South (18%) and the Northeast (16%).

The highest fatality rate during 1992-2002 in agriculture production for young workers was for 15 year olds at 18.5 deaths per 100,000 FTE, followed by 17 years olds (14.9/100,000), 19 year olds (13.2/100,000), 16 year olds (12.8/100,000) and then 18 year olds (11.1/100,000). The rates were higher for young workers in ag-

riculture production than for young workers in all industries by a factor of 3.6 (Table 1). Also, the agriculture production young worker fatality rate was 2.9 times that of adult workers in all industries combined (4.7/100,000) for the same time period.¹⁶ Indeed, for the 15-19 year old age categories, agriculture production fatality rates ranged from 3 to almost 5 times higher than other young worker rates. The fatality rate in crop production (21/100,000) was 2.4 times the livestock production rate (8.7/100,000). Fifteen year olds in crop production had the highest fatality rate at 31.7/100,000 during this time period (Table 1). This was slightly more than 2.5 times the rate for 15 year olds in livestock production and 6 times the fatality rate for all 15 year old workers.

For comparison purposes and to assess the trend in fatalities, rates from 1992-1996 (5 years) and 1997-2002 (6 years) were calculated. For young workers in all industries, the rates were lower during the 1997-2002 part of the study period for all listed age categories (Table 2). However, for agriculture production young workers, three of the five age groups had increased rates in 1997-2002. The 15 year old rate for 1997-2002 was 24.1/100,000, an 81% increase from the 1992-1996 period, while the 16 and 19 year old rates also increased. The crop production sector had the highest occupational fatality rate (52.2/100,000) among all youth during 1997-2002. The overall rate for 15-19 year olds for all young workers decreased between the study periods while it increased for agriculture production. The overall rate also

increased for the production sectors within agriculture production (Table 2).

Individuals working in the family business comprised more than half (53.8%) of the total fatalities in agriculture production, while working for a wage or salary accounted for the other large proportion of deaths (41.3%) to young workers in agriculture production. The crop production sector accounted for almost two-thirds (64.5%) of the total deaths in agriculture production with the livestock production sector accounting for the other one-third (35.5%) of the fatalities (Table 2). Within the crop sector at the detailed SIC four-digit level, general farms that were primarily crop farms comprised 51% (102) of the fatalities, followed by agricultural production crops (7.5%), field crops, except cash grain (7.0%), cash grain (5%) and vegetable and melons (3.5%). Within the livestock production sector at the detailed four-digit level, dairy farms had 50% of the total fatalities within the sector followed by general farms, primarily animal (21%), and then beef cattle, except feedlots (10%).

The vast majority of fatal injuries in agriculture production occurred to males (96%), which was not dissimilar for all young worker fatalities for the 1992-2002 time period (all young worker male fatalities = 90%). Almost 2/3 (65.3%) of the agriculture production male deaths occurred in crop production, with the majority (52.1%) being in "general farms, primarily crop," followed by "field crops except cash grain" (15.5%) and then "cash grain" (11.3%). Livestock production accounted for more than one-third of the male fatalities with "dairy" comprising half of these livestock fatalities. General farms, primarily livestock (22.3%) and livestock except dairy and poultry (15.5%) were the other main sectors of fatalities for male youth in livestock production. Livestock production had slightly more than half (53.8%) of the female fatalities with crop production accounting for the remaining 46.1%.

Whites accounted for 91.9% of the agriculture production young worker fatalities with the majority of the fatalities occurring to White workers in the Midwest (50.2%) and then being similarly distributed throughout the other regions. The majority (62.8%) of fatalities to White workers were found in the crop production sector (34.7% general farms, primarily

TABLE 1. Frequency and Rates per 100,000 FTE of Fatal Work-Related Injuries for Workers 15 to 19 Years Old for All Industries and the Agriculture Production Industry in the United States, 1992-2002.*

Age (Years)	All Workers		Ag Production		Crops		Livestock	
	Deaths	Rate	Deaths	Rate	Deaths	Rate	Deaths	Rate
15	88	5.2	32	18.5	18	31.7	14	12.0
16	156	3.1	29	12.8	16	17.5	13	9.7
17	263	3.2	38	14.9	27	28.0	11	6.9
18	489	3.7	33	11.1	17	12.9	16	9.7
19	774	4.2	47	13.2	34	21.7	13	6.5
Total	1770	3.8	179	13.7	112	21.0	67	8.7

*Numbers and rates were calculated by NIOSH and may differ from previously published BLS CFOI numbers and rates.

TABLE 2. Rates per 100,000 FTE of Fatal Work-Related Injuries for Workers 15 to 19 Years Old for All Industries and the Agriculture Production Industry in the United States, 1992-1996 and 1997-2002.*

Age (Years)	All Workers			Ag Production			Crops			Livestock		
	1992-96 Rate	1997-02 Rate	% Change	1992-96 Rate	1997-02 Rate	% Change	1992-96 Rate	1997-02 Rate	% Change	1992-96 Rate	1997-02 Rate	% Change
15	5.2	5.1	-1.9	13.3	24.1	81.2	17.8	52.2	193.3	10.6	13.4	26.4
16	3.6	2.8	-22.2	10.5	15.2	44.8	14.7	20.6	40.1	7.5	11.7	56.0
17	3.5	2.9	-17.1	16.8	12.9	-23.2	28.1	28.0	-0.4	9.8	†	†
18	4.1	3.4	-17.1	12.0	10.3	-14.2	20.6	†	†	5.7	14.2	149.1
19	4.4	4.0	-9.1	11.8	14.6	23.7	17.9	24.9	39.1	7.6	5.4	-28.9
Total	4.1	3.6	-12.2	12.8	14.6	14.1	19.9	22.2	19.4	8.1	9.3	14.8

*Numbers and rates were calculated by NIOSH and may differ from previously published BLS CFOI numbers and rates.

†Data do not meet BLS publishability requirements.

crop). However, dairy farms ranked second for the most number of deaths (22.8%) occurring to Whites. "Other" races accounted for 3.2% of the total deaths, with 50% of fatalities in this racial category occurring in the South. Blacks were the next prominent race category accounting for 2.6% of all the deaths, primarily in the South, with the majority of the deaths being in the crop sector. The occupation of "farm worker" had the largest number of deaths with 264 (85.2%) fatalities followed by a distant second of "farmers, except horticulture" with 20 fatalities (6.4%).

The most prevalent event for death among youth working in agriculture production was transportation (56.1%), followed by contact with objects (24.8%), exposure to harmful environments or substances (8%) and assaults (7.1%) (Table 3). Using more detailed analyses of these major event categories, the majority of the transportation fatality events were non-highway events (91) followed by highway events (60). Detailed examination of these categories indicated that of the 91 fatalities attributed to non-highway events, 48 (52.7%) were due to overturns with 32 (67%) involving tractors, 19 of these being in crop production, and 28 (30.8%) occurred when an individual fell from or was struck by a vehicle or mobile equipment, with 6 (21.4%) involving animal powered vehicles. Highway events (60) had 34 (56.7%) jackknifed or overturned vehicle incidents with tractors being the source of fatal injury in 19 (55.9%) of these incidents. ATVs accounted for a total of 7 work-related fatalities for all injury events. The next major event category

"contact with objects," found the highest categories of detailed events being caught in or compressed by equipment or objects (35), struck by flying object (22) and caught in or crushed by collapsing materials (16).

The top five major sources of injury were vehicles (50.3%), machinery (21.6%), person/plant/animal/minerals (9.3%), other sources (7.7%) and parts/materials (4.8%) (Table 3). Within the vehicle category, the tractor (84) was the single largest identifiable source of injury accounting for over 1/2 (53.8%) of the deaths in the "Vehicle" category but also 27.1% of all the agriculture production young worker fatalities. Of the 84 fatalities attributed to tractors, the largest category for the event associated with the fatalities was "overturns," accounting for 57.6% of the Highway accidents (19/33) and 62.8% of the non-highway accidents (32/51). The next largest source of injury in the "Vehicle" category was truck (31), which accounted for 19.9% of the vehicle deaths. Within the major category of machinery, "other agricultural machinery" (18) was highest, followed by loaders (13) with a tie among harvesting/threshing machinery and plowing/planting/fertilizer machinery (12). The most common part of body injured was the head (30%), multiple body parts (27.7%), trunk (23.2%), and body systems (17.4%) (Table 3).

DISCUSSION

The findings are similar to other research on agricultural youth work-related fatalities: the

TABLE 3. Descriptive Characteristics of Fatal Work-Related Injuries Among Youth Less Than 20 Years of Age in the United States, 1992-2002*

Characteristics	All Workers		Agriculture Production Workers					
	Deaths	%	Deaths	%	Deaths	%	Deaths	%
Employment Status								
Family Bus.	250	12.8	167	53.9	110	55.0	57	51.8
Wage/Salary	1508	77.0	128	41.3	†		†	
Self-Employed	63	3.2	9	2.9	†		†	
Age Dist.								
≤ 10 years	43	2.2	34	11.0	23	11.5	11	10.0
11-15 years	233	11.9	129	41.6	83	41.5	46	41.8
16 years	156	8.0	29	9.3	16	8.0	13	11.8
17 years	263	13.4	38	12.3	27	13.5	11	10.0
18 years	489	25.0	33	10.6	17	8.5	16	14.5
19 years	774	39.5	47	15.2	34	17.0	13	11.8
Event								
Transportation	853	43.6	174	56.1	123	61.5	51	46.4
Contact w/Objects	361	18.4	77	24.8	48	24.0	29	26.4
Exposure Harmful Envir./Sub.	224	11.4	24	7.7	13	6.5	11	10.0
Assaults	331	16.9	22	7.1	10	5.0	11	10.0
Source								
Vehicle	843	43.0	156	50.3	110	55.0	46	41.8
Machinery	190	9.7	67	21.6	41	20.5	26	23.6
Person/Plant/Animal	119	6.1	29	9.3	16	8.0	13	11.8
Other	373	19.0	24	7.7	15	7.5	9	8.2
Parts & Materials	131	6.7	15	4.8	7	3.5	8	7.3
Region								
Midwest	497	25.4	148	47.7	98	49.0	50	45.4
West	446	22.8	58	18.7	37	18.5	21	19.1
South	815	41.6	55	17.7	43	21.5	12	10.9
Northeast	200	10.2	49	15.8	22	11.0	27	24.5
Part								
Head	614	31.4	93	30.0	67	33.5	26	23.6
Multiple Body Parts	574	29.3	86	27.7	56	28.0	30	27.3
Trunk	327	16.7	72	23.2	42	21.0	30	27.3
Body Systems	387	19.8	54	17.4	34	17.0	20	18.2
Total	1958	100.0	310	100.0	200	100.0	110	100.0

*Numbers were calculated by NIOSH and may differ from previously published BLS CFOI numbers.

†Data do not meet BLS publishability requirements.

high number of fatalities occurring to males, the high risk of death when working in agriculture production and the high risk of death due to tractors and overturns.^{2,3,6,7,9-11} This study builds upon previous research by identifying trends in agriculture production fatalities for youth and the resulting hazards associated with them. If one were to observe only the number of

fatalities that have occurred, a sense of achievement could erroneously be concluded. As the data indicate, while generally the number of fatalities has been decreasing over the years, the rate has remained steady or increased for many age groups. As a proportion of all young workers, young workers in agriculture production incur a disproportionate share of fatalities.

Their fatality rate is 3.6 times higher than young worker rates in all industries and 2.9 times the rate for workers of all ages in all industries combined for 1992-2002. Within the crop production sector, for 15 year olds, the rates are more than 2.6 times higher than the other agriculture production sector, livestock production, and 6 times the 15 year old young worker rate for all industries. Clearly additional prevention efforts are needed to address this problem.

While farms that employ 11 or more people in the United States are not exempt from Occupational Safety and Health Administration (OSHA) regulations, the annual funding authorization from Congress does not allow OSHA to use any funds for enforcement activities on farms with 10 or fewer employees. This in effect does exempt these farms from enforcement by OSHA. Additionally, child labor requirements under the Fair Labor Standards Act (FLSA) specific to agricultural occupations, while applicable to youth employed on farms involved in interstate commerce or the production of goods for interstate commerce, do not apply to youth employed by his or her parent or person standing in place of the parent at any time in any occupation on a farm owned or operated by the parent or person standing in place of the parent.¹⁷ Thus, non-regulatory approaches should be considered.

Since 1997, NIOSH has been leading the Childhood Agricultural Injury Prevention Initiative. This is a congressionally funded research program that seeks to reduce childhood agricultural injuries through surveillance, research and establishing partnerships, such as the Federal Interagency Work Group for Preventing Childhood Agricultural Injury. Voluntary guidelines, the North American Guidelines for Children's Agricultural Tasks (NAGCAT), developed by the National Children's Center for Rural and Agricultural Health and Safety, are designed for use by farm parents in assigning farm tasks to children that are appropriate for their developmental level and skills.¹⁸

Since 2002, the United States Department of Agriculture, Cooperative State Research, Education, and Extension Service (USDA/CSREES) has funded a competitive-based program, Hazardous Occupational Safety Training in Agriculture (HOSTA), designed to reduce farm youth injuries.^{4,19} The program seeks to update

and revise the training materials that are used for allowing the exemption of 14-15 year olds under the Hazardous Occupations Orders for Agricultural Employment (HO/As). Additionally, it is determining the future demand for young workers in agriculture production.

Engineering solutions are currently available that have been proven effective in preventing deaths due to tractor overturns. Rollover protective structures, in combination with seat belts, have a very high effectiveness rate (75-99%) in preventing deaths.²⁰ FLSA Hazardous Occupations Orders for Agricultural Employment (HO/As) identify as particularly hazardous the operation of a tractor of more than 20 power-take-off (PTO) horsepower, or connecting or disconnecting an implement or any of its parts to or from such a tractor and prohibit the operation by youth younger than 16 years old. An exemption is allowed for 14 and 15 year olds who have successfully completed either a 4-H federal extension service or vocational agriculture training program for tractor operation and/or machine operation. However, a youth of any age may be employed by his or her parent on a farm owned or operated by the parent.¹⁷ Thus, ensuring that youth use only a tractor with the proper safety equipment and having the appropriate training is paramount in reducing deaths in agriculture production associated with tractor overturns. Many farms have more than one tractor and often the newer tractor is equipped with a ROPS. While the majority of tractors in operation do not have ROPS, two-thirds of farmers surveyed indicated they own at least one tractor with a ROPS.²¹ Ideally, every tractor would have a ROPS and thus be safer for both young and adult workers to operate. However, since they don't and there are no federal standards, regulations or laws to require their installation on older tractors on farms that employ less than 11 people, if a young worker is to use a tractor, then ensure they use the one equipped with a ROPS and seat belt with proper supervision and under proper environmental conditions, as recommended by the NAGCAT Tractor Operation Chart.²² This can mean merely changing the usage patterns of the current equipment available on the farm, without incurring any additional costs, in order to address a high risk population (young agriculture production workers) and procedure (operating a tractor).

There is ongoing debate on issues that affect young agriculture production workers, such as whether youth under a certain age should be allowed to operate tractors on farms or roadways, the rate of adoption of ROPS on farm tractors, and public policy as a venue for change in agriculture.²³⁻²⁶ However, this manuscript does not provide conclusive data upon which to resolve these debates, although it is acknowledged these debates are healthy and desirable for the agricultural safety and health community.

The youngest ages for which rates could be calculated, 15 year olds, have the highest rate of death among young agriculture production workers. For 1992-2002 the rate was 18.5/100,000 but from 1997-2002 it was 24.1/100,000 (Table 1/Table 2). These rates are 3.9 to 5.1 times, respectively, of the combined industry and all worker rate (4.7/100,000). The 15 year olds in the crop production sector for 1997-2002 have a rate that is 10-fold greater than their peers in other industries and a rate 11 times greater than working adults. Particular emphasis should be placed on providing these young workers with a safe workplace, including but not limited to: assessment of appropriate developmental readiness for the work, adequate training and supervision for the job, appropriate safety equipment and finally, consideration of the fact that the youngest of workers should not be exposed to or put at risk in life threatening jobs.

It is clear that no single specific intervention or type of intervention activity (education, enforcement or engineering) will dramatically curtail young agriculture production worker deaths. A combination of thoughtful, planned, well executed research-based interventions (engineering and education) promoted through a network of grass roots individuals and organizations along with safety and health professionals will likely provide the best prospect of having an impact. Parents also have a critical role in ensuring their children's safety while working on the farm.

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RECEIVED: 02/07/2006
REVISED: 05/23/2006
ACCEPTED: 05/23/2006

doi:10.1300/J096v11n02_09