Injuries to Tobacco Farmers in Kentucky

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ABSTRACT: Like all types of farming, raising tobacco has many hazards that may lead to injury, disability, or death. Burley tobacco farming is a multistep process that is not highly mechanized. An 8-year emergency department surveillance system in Kentucky identified 674 injury cases related to the production of burley tobacco. Most of the injuries were a result of a fall, cutting and piercing instruments, or sprains and strains. More than 90% of the injured patients were treated as outpatients, and the average charge for emergency room services was $402 (range, $0 to $14,729). One quarter of the patients were uninsured. Injuries to Hispanic workers increased over the 8-year period. Estimated hospital charge per acre of tobacco produced ranged from $1.28 to $1.74. Low-cost interventions such as gloves and chaps could reduce the injuries incurred in burley tobacco farming.

AGRICULTURE has remained one of the more dangerous industries in the United States, having been consistently ranked as one of the top three occupations with the highest rates of injuries.[1] The National Safety Council found agriculture to have the second highest death rate relative to employment resulting from unintentional injuries in 1999.[2] Farm occupations were second in number of fatalities (after truck drivers), with one third of the farm fatalities due to tractor-related incidents.[3] The impact of fatal injuries includes both human suffering and the associated economic burden, which has been measured in potentially productive years of life lost.[4] However, nonfatal injuries also bring an economic burden. The estimated cost of both occupational fatalities and injuries was $122.6 billion for 1998,[2] though this estimate may be too conservative because of data limitations.[5]

Burley tobacco production in the United States was reported at 649,103,000 pounds in 1997, of which Kentucky produced 470,800,000 pounds (72.5%).[6] Tobacco is the leading cash commodity in Kentucky, accounting for 20% of the total agricultural cash receipts in the state.[6] Of the 82,273 farms in Kentucky, 44,967 (55%) produce tobacco.[7]

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Investigating agricultural injuries by segmenting a particular commodity is not new. However, literature review revealed only one study of tobacco farming injuries in which 23 cases were identified through trauma registry data during a 14-month period.[8] The purpose of this study is to describe injuries incurred during burley tobacco production and the subsequent hospital charges.

BURLEY TOBACCO PRODUCTION PROCESS

Burley tobacco farming is a labor-intensive, multiphase process exposing the farmer to various modes of injury. The cycle normally begins with growing tobacco plants in a greenhouse in large polystyrene trays. Before the trays can be packed with soil medium and seeded for germination, they are sanitized to prevent transmission of plant pathogens. This process is usually accomplished by fumigation with gases such as methyl bromide or by washing the trays in a 10% chlorine bleach solution, which exposes the farmer or farm worker to chemical burn risks.

After germination, the young tobacco plants are "set" or planted in the field via a setter, a manned piece of planting equipment attached

KEY POINTS

- Burley tobacco production is a highly manual process resulting in injuries.
- Injuries incurred while working in burley tobacco production are most often caused by falls, cutting and piercing instruments, and overexertion.
- The majority of injuries are minor, but some exceed thousands of dollars in medical charges.
- Injuries are preventable with the use of low-cost personal protective equipment such as gloves and chaps.

to the back of a tractor. Workers ride on the setter, placing the plants into rotating clamps as they move over the field, exposing workers to pinching injuries on their hands and fingers and to muscular strain and repetitive movement joint injuries. Falls may occur when mounting the setter or as the equipment moves over rough or uneven terrain. The plants are then grown in the fields for several months. Crop maintenance involves "topping" or removing the bloom from the top of the tobacco plant, which may result in cutting/piercing injuries. Pesticides are sometimes used on the crop and can be inhaled by or spilled on the farmer, resulting in respiratory problems or chemical burns. A machine called a high boy is used to drive between the rows of tobacco and spray crops, exposing farmers to overturns, falls, and chemicals.

During crop maintenance and harvest, green tobacco sickness (GTS)—nicotine poisoning caused by wet tobacco—is a common problem for workers. The moisture on the tobacco carries nicotine, which is absorbed through the skin during contact with the plant. Saturated clothing can also pass along nicotine. Cases of GTS were excluded from this study because of their complex nature. The noninjury effects of nicotine poisoning have been described elsewhere.[9-15]

During tobacco harvest, farmers must stoop repetitively to cut the plants low at the stalk using a hatchet-like, long-handled knife, and then impale these stalks onto a tobacco "spear." The spear usually consists of a conical shaped metal cap that fits onto a sharpened wooden stick. The stick is typically oak, roughly squared, approximately 1½ to 2 inches on each side and about 5 feet in length. The harvest is an especially dangerous period for farmers, with potential for cuts to the hands, feet, and shins when cutting the plant and lacerations and wounds to the hands, upper arms, legs, and head as the farmer tries to force the tough, pithy stalk over the spear and down the stick. The loaded sticks are lifted onto a wagon and transported to a barn where they are hung to dry evenly in tiers.

Barns designed for hanging tobacco have three to five levels of wooden rail framework usually beginning 6 feet above the floor and continuing to the top of the barn, reaching heights of 30 feet, thus allowing air to circulate around the tobacco, These rails are generally rough-sawn 3 x 4 inch boards approximately 8 feet long. To hang the tobacco, workers stand on the narrow rails one above the other to the top of the barn, balancing between rails in a splay-legged position. The loaded sticks of tobacco, consisting of six or more stalks and weighing 100 to 125 pounds, are handed upward from the workers on lower levels to workers on the uppermost level to be filled. This process is hazardous for several reasons: (1) the rails are often unsecured and can roll or slip under the workers; (2) rails can break; (3) falls generally result in multiple injuries due to impact with the lower rails or tier poles, equipment, and other workers; and (4) the demands of balancing and lifting can cause muscular strain.

After the tobacco is dry, it is taken down from the barn in a reverse process. The dry leaves are stripped from the pithy stalk, loaded into a tobacco press and compressed into bales. The bending, lifting, and carrying required to bring the sticks to the stripping room, as well as the repetitive motion of the stripping process itself, expose the worker to muscular strain or back injury. Workers using the tobacco press are exposed to possible entanglement, pinching, or crushing injuries. The finished bales of tobacco are loaded on wagons or pickup trucks and transported to warehouses to be sold.

In addition to these modes of injury, throughout the process, farmers face the hazards of uneven ground, snake and insect bites, heat exhaustion, eye irritation or abrasion, respiratory hazards, and other illnesses such as GTS.

METHODS

Data from two sequential projects were combined for this study. Between April 1992 and September 1996, as part of the Occupational Health Nurses in Agricultural Communities (OHNAC) Project, funded by the National Institute for Occupational Safety and Health (NIOSH), community-based registered nurses collected data on agricultural injuries from emergency department medical records in three regions that were typical of farming in Kentucky. A case was defined as an injury occurring on a farm (during both work-related and recreational activities) in the nine-county surveillance area, including children, visitors, and farm workers. A farm was defined as any property that produced an agricultural commodity with sales in excess of $1,000 per year. Follow-up interviews were conducted on sentinel cases: machine-related injuries, injuries to children (<18 years), and injuries due to falls when the person was over 55 years of age.

The geographic boundaries and the health care delivery services in the three areas allowed for a comprehensive surveillance system. Severe injuries requiring transfer to a tertiary care cen-

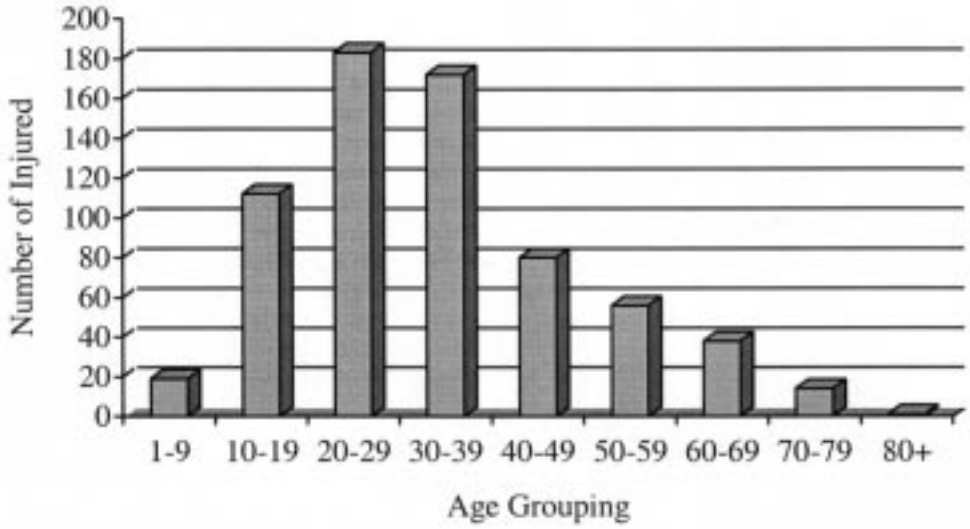

FIGURE 1. Number of injured by age.

ter were included when the injury occurred in the surveillance counties. Fatal cases were also included, although the services of an emergency department were not always used.

Beginning January 1997, the NIOSH-funded Community Partners for Healthy Farming (CPHF) replaced the OHNAC program, allowing for continued surveillance through September 1999. This program used reporting criteria and methods identical to those of its predecessor to collect data from two of the three previous reporting regions.

The narrative field for every case in the combined data set (N = 2,892) was evaluated by two reviewers to determine whether the injury occurred during tobacco production. The original reporting questionnaires were examined to clarify ambiguous or insufficient narratives. Of the 2,892 records, 674 (23.3%) were related to tobacco production excluding cases of GTS (n = 264). Nonwork injuries (n = 12) were included only in the case of children who were playing or being tended in the work area during tobacco production activities. Injury causes were classified using the International Classification of Diseases, Ninth Revision (ICD-9),[16] and all E-codes were compared with the narrative fields for accuracy. Body parts injured were coded using narrative fields and injury codes provided from hospital medical records. Analysis was conducted using SPSS.[17]

TABLE 1. Cause of Injury

Cause (E-Code Group)	*No. (%)*
Falls	199 (29.5)
Cutting/piercing instruments	183 (27.2)
Overexertion	88 (13.1)
Agricultural machinery	69 (10.2)
Struck by/against object	28 (4.2)
Struck by falling object	27 (4.0)
Foreign body in eye	27 (4.0)
Heat exhaustion	13 (1.9)
Motor vehicle crashes	10 (1.5)
Caught in/between objects	8 (1.2)
Poisoning	7 (1.0)
Bites	7 (1.0)
Other	8 (1.2)
Total	674 (100)

RESULTS

Of 674 tobacco-related cases, 89.3% of the individuals injured were white, 2.5% black, 7.0% Hispanic, and 1.8% unknown; 82.5% were male and 17.5% female. Private insurance or self-pay covered 55.0% of cases, Medicaid 12.6%, and Medicare 4.2%. Less than 1% received workers' compensation benefits, 25.1% were uninsured, and 3.1% were of unknown insurance status. Hispanics who were injured and sought medical care were less likely to be insured than non-Hispanic workers (chi-square = 16.4, $P < .01$). Age distribution is shown in Figure 1; the mean age was 33.1, and the median age was 31 years. In 91.7% of the cases, the injured were treated as outpatients in the emergency department, 4.3% required an overnight hospital stay, 2.8% required transfer to a higher level of care, and 0.7% died. Of the five fatalities, one resulted from a fall while hanging tobacco, three from farm tractor overturns, and one from tractor runover. The hazards previously described during each step of the process are reflected in the injuries incurred (Fig 2). E-codes are shown in Table 1.

Falls were the leading cause of injury, and falls from tier poles or barn rails accounted for the largest portion (22.4% of all injuries). Falls while

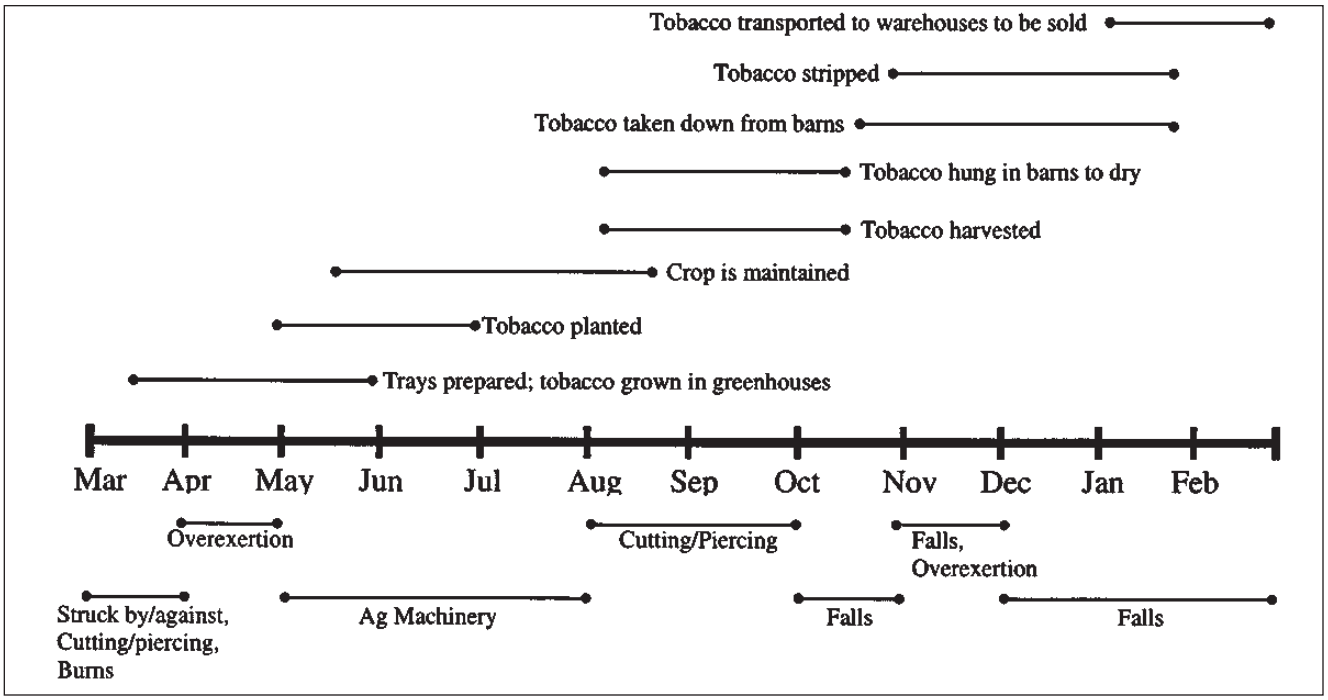

FIGURE 2. Tobacco process and leading injuries by month.

mounting or alighting from wagons and other falls from one level to another accounted for 4.7% of all injuries. The second leading injury consisted primarily of knife wounds (16.2% of all injuries) and tobacco spear wounds (6.7% of all injuries). Injuries resulting from overexertion (13.1%) involved predominantly back strain/sprain (3.9% of all injuries), as well as strains/sprains to the chest, wrist, shoulder, and arm (5.6% of all injuries). Included in this category were injuries from overexertion while jumping or stepping from a height, accounting for 11.4%

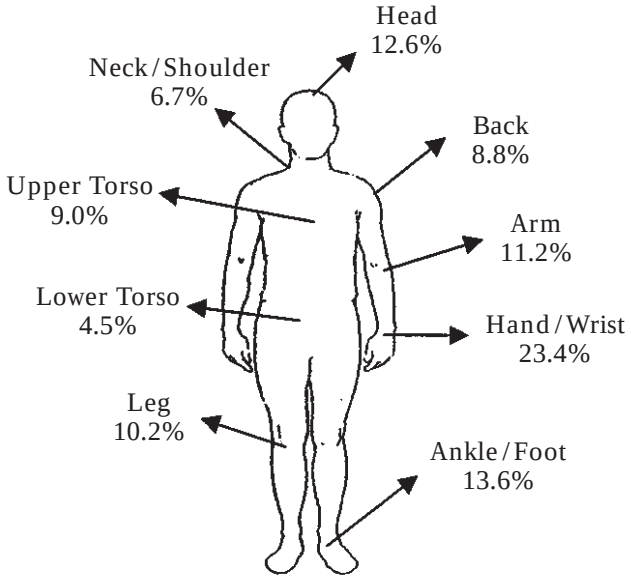

FIGURE 3. Body part injured.

(n = 10) of the overexertion injuries. In the category "struck by object" (n = 42), more than half of the cases resulted from individuals being struck by falling objects or persons.

The agricultural machinery injuries (n = 69) varied, with frequent events including tractor overturns (n = 10), fell/thrown from tractors/attachments (n = 9), struck by machinery or a part of the machinery (n = 8), tractor/attachment runovers (n = 7), and high boy overturns (n = 6). Seventeen injuries occurred when a person was caught by or pulled into machinery; of those, seven injuries were to feet/ankles. Five injuries were due to specialized tobacco processing machines, including a press, baler, and stripper. In the cases of persons caught between objects (n = 8), half were caught between two implements (eg, trailer and truck, wagon and tractor) while attempting to hitch them together.

Motor vehicle crashes (n = 10) included all incidents on public roadways and those classified as nontraffic incidents not occurring on a public roadway. Six were riding on tractors or wagons in operation on public roadways. All three of the cases occurring off public roadways involved all-terrain vehicles; one was used to haul tobacco and the remaining two were used as transportation to or from a field. The remaining case involved a truck on a public roadway.

By age group, 14.5% of the injuries were to children (<18 years), 74.2% to adults (18 to 54), and 11.3% to older adults (>54). Some similari-

TABLE 2. Hospital Charges* by Cause of Injury

Cause of Injury	*No.*	*Sum ($)*	*Mean ($)*	*Median ($)*	*Range ($)*
Falls	125	93,318	747	317	8-14,729
Cutting/piercing instruments	124	21,086	170	138	22-747
Overexertion	54	14,611	271	194	27-3,269
Agricultural machinery	43	15,276	355	306	0-1,190
Struck by/against object	16	3,457	216	191	76-609
Struck by falling object	16	4,924	308	285	103-693
Foreign body in eye	15	2,671	178	177	62-294
Heat exhaustion	10	4,298	430	448	99-949
Motor vehicle crashes	5	2,960	592	230	155-1776
Caught in/between objects	5	5,426	1,085	476	148-3,862
Poisoning	5	1,942	388	255	41-1,174
Bites	4	461	115	99	55-208
Other	4	1,201	300	214	72-701
Total	426				

*Rounded to the nearest dollar.

ties were seen in the most common causes of injury among the age groups. The three leading causes of injury for children were cutting/piercing instruments (45.9%), agricultural machinery (19.4%), and falls (11.2%). For adults, the three leading causes were falls (31.6%), cutting/piercing instruments (25.6%), and overexertion (16.2%). For those aged 55 and over, the leading causes of injury were falls (39.5%), agricultural machinery (18.4%), and cutting/piercing instruments (13.2%).

Of 674 cases, 20 patients had injuries not specific to body parts (eg, chemical poisoning), 4 had multiple injuries (more than three body parts injured), and 4 cases were undetermined. Of the remaining 646 cases, 748 body parts were injured (Fig 3); in 85 incidents, two to three body parts were injured. Most of the hand/wrist injuries were due to cutting/piercing instruments (52.0%), followed by falls (14.3%), agricultural machinery (9.7%), and overexertion (9.7%). Injuries to the ankle/foot were from falls (37.3%), cutting/piercing instruments (29.4%), and agricultural machinery (15.7%). Almost 32% of injuries to the head were due to falls, followed by 28.7% from a foreign body in the eye. Of the injuries to the upper torso, 61.2% were from falls, 20.9% from overexertion, and 11.9% from agricultural machinery. Falls were also the leading cause of injury to the lower torso (55.9%). More than 40% of injuries to the arm were from falls, followed by almost 30% from cutting/piercing instruments. Cutting/piercing instruments were the leading cause of injury to the leg (38.2%), followed by agricultural machines (20.6%). The two leading causes for back injuries were falls (45.5%) and overexertion (45.5%). Of injuries to the neck/shoulder, 54.0% were from falls, 24.0% from overexertion, and 14% from agricultural machinery.

COST OF TREATMENT

Hospital charges were available for 63% (n = 426) of the cases and are shown by cause of injury in Table 2. The average charge was $403, with a median of $217 and a range of $0 to $14,729. The zero charge was for a fatal case in which the individual was dead on arrival and thus no hospital charges were incurred. Total charges were $171,630. Ninety-four percent of the injuries resulted in charges less than $500. Cases for which charges were known did not differ in mean age from those for which charge data were not known ($t = -.41$, $P = .68$). The seven leading causes in those cases with charge data did not differ from those without charge data (Pearson chi-square, 2.91; $df = 6$; $P = .82$).

DISCUSSION

Comparing data for Kentucky tobacco farm work, excluding all fatal and child nonwork injuries (n = 657), with national estimates of injuries to field crop farmers indicates some notable differences.[18] Those injured while engaged in tobacco farming in Kentucky were 82.5% male and 17.5% female, differing from the 1994 national estimate of sex distribution for injuries in field crop operations of 94.7% male and 5.3% female. Overexertion was a leading cause of injury in tobacco farming, accounting for approximately 12% of the total injuries; however, it accounted for only 3.7% of those nationally in field crops, possibly because field crops are produced with less manual labor and more mechanization. For tobacco production, injuries due to being struck by a falling object accounted for 4.1% compared with 7.1% nationally. Falls accounted for 30% of the tobacco injuries, noticeably higher than the national estimate of 16.9% for falls from elevation in field crop operations. Kentucky data show "caught in or be-

TABLE 3. Estimated Total Hospital Charges* by Cause, Using Mean Charge Per Cause

Cause of Injury	*No.*	*Mean ($)*	*Sum ($)*
Falls	199	747	148,653
Cutting/piercing instruments	183	170	31,110
Overexertion	88	271	23,848
Agricultural machinery	69	355	24,495
Struck by/against object	28	216	6,048
Struck by falling object	27	308	8,316
Foreign body in eye	27	178	4,806
Heat exhaustion	13	430	5,590
Motor vehicle crashes	10	592	5,920
Caught in/between objects	8	1,085	8,680
Poisoning	7	388	2,716
Bites	7	115	805
Other	8	300	2,400
Total	674		273,387

*Rounded to the nearest dollar.

tween objects" tobacco-related injuries accounted for only 1%, while national data showed this accounted for >11%, also possibly because of increased mechanization.

Cases requiring an inpatient stay or a transfer to a higher level of care were compared with data collected in the Pugh study of 23 patients admitted to a level 1 trauma center. Numbers were similar with regard to sex (89% male in this study and 96% in the Pugh study), and falls were the leading mechanism of injury in both studies.

In this study, hospital charges were estimated for all injuries by applying the average charges shown in Table 2 to the total number of injuries grouped by cause (Table 3). The estimated sum of hospital charges for the 674 injuries is $273,387. This estimate does not include physician fees, rehabilitation charges, or other fees relating to the injury. Therefore, the reported figures are a conservative estimate of the total charges that could be incurred.

Calculating an average charge per month for each surveillance period allows specific monthly estimates of charges. Applying this average to the months absent in the data set (January to March 1992, October to December 1996, and October to December 1999), the total hospital charge estimate for 8 complete years is then $294,005 ($219,655 for the OHNAC surveillance region and $74,350 for CHPF). The yearly average was $43,931 for OHNAC and $24,783 for CPHF.

Using an average of burley tobacco harvested during 1995,1996, and 1997,[19-21] the OHNAC region represented approximately 13% of total acres of burley tobacco harvested in Kentucky, and the hospital charge per acre was $1.75 based on the yearly average. The CPHF region represented approximately 10% of burley tobacco acres harvested in Kentucky, with a hospital charge of $1.28 per acre. The number of injuries reported during the CPHF surveillance was substantially lower than during the OHNAC surveillance, possibly because of lessened reporting by hospital staff rather than a reduction in injuries. The average of burley tobacco harvested for all of Kentucky during 1995 to 1997 was 186,667 acres, resulting in $326,667 of hospital charges per year using the OHNAC charge per acre.

Although actual medical costs would be a more appropriate figure on which to base resource allocations for prevention, the charges shown here describe the relative burden on the medical system, insurers, and individuals. Twenty-five percent of the injuries were to uninsured persons, accounting for roughly $73,711 of the estimated sum of hospital charges over the 8-year surveillance period. Without knowledge of the cost-charge ratio for each reporting facility, a more precise analysis of the total cost of the injury is not possible. Furthermore, indirect cost calculations such as lost work time, replacement workers, and pain and suffering should be included in a complete cost analysis and is beyond the scope of this paper.

Four of the five fatalities resulted from tractor overturns. Of the decedents involved in these cases, all were male; two were in the age range 50 to 59 and two were more than 60 years old. These findings are consistent with data reported in studies of Kentucky tractor-related fatalities in which overturns are cited as the leading cause of fatality, and approximately 50% of the decedents in these fatalities are men more than 60 years old.[22]

During the surveillance period, a dramatic increase was noted in the percentage of Hispanic workers injured, from 3.2% in 1992 to 19.2% in 1999. Overall the Hispanic origin population has grown markedly in Kentucky over the past decade, increasing by 172.6% according to US Census Bureau.[23]

PREVENTION AND PLANNING

Given the high number of falls from barn rails and the medical charges associated with these injuries, since they often involve multiple trauma, intervention during the barn phase of production is essential. Single-story barns have been proposed as one possible solution but may not be economically feasible and practical for farmers to build (Larry Piercy, MS, oral communication, May 2001). However, various low-cost

curing structures such as post-row frameworks and single-story field curing structures, have been suggested as a viable alternative to traditional barns.[24-26]

Most injuries from edged or piercing instruments were incurred at harvest. Workers stooping to cut the plant low at the stalk sometimes miss the tobacco stalk striking their lower legs, or follow through with too much force and strike their other hand or arm. Since the tobacco spear consists of a metal cone, which is not permanently affixed to the oak stave, or stick, the spear often moves or "jumps" as the worker attempts to impale the pithy stalk. This leads to piercing injuries or lacerations to the hand. Wearing protective shoes and leggings, and wearing stout gloves made from materials such as wire mesh, leather, or canvas that cover the hand and part of the forearm could help prevent these injuries.

The increase in injuries to migrant workers points to a need for interventions that specifically address Hispanic workers. While instructional videos are available in Spanish, to suggest that barriers faced by Hispanic workers are purely language-related is to underestimate the scope and cause of the problem. Warning labels containing signs or symbols on agricultural chemicals and machinery are culture-bound and thus may be unclear to Hispanic workers.

This study is not rate-based because it was not possible to establish a reliable denominator. Some cases occurring in the surveillance region may have been treated in physicians' offices or not treated at all because workers fear they may be fired for missed days of work or do not want to take time to care for their injuries. Hospital reporting may not have been complete because reporting was voluntary. It is likely the more severe cases were remembered by hospital staff and thus reported to the project personnel. Finally, charges presented here do not reflect physicians' fees, rehabilitation charges, and charges incurred from hospitals servicing transferred cases (n = 19).

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