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Noise exposure and hearing conservation for farmers of rural Japanese communities

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Abstract

Agricultural mechanization in Japan has progressed dramatically since 1955 with the introduction of tractors, harvesters, and processing machines. These technological developments have resulted in an increase in exposure to sources of noise that are not only annoying, but damaging to hearing. The present study was undertaken to determine, whether Japanese farmers are at risk for noise-induced hearing loss in comparison with office workers, and by evaluating the present conditions regarding occupational noise levels among agricultural workers.

The results suggest that farmers, especially male farmers, have a high prevalence of hearing loss in the higher frequency ranges. Daily noise exposure levels in L_{Aeq} ranged from 81.5 to 99.1 dBA for tea harvesting and processing, and from 83.2 to 97.6 for sugar cane harvesting. Taking into account their rather long working hours and excessive noise from farm machinery, it is concluded that farmers are at risk for noise-induced hearing loss. These findings clearly indicate a strong need for implementation of hearing conservation programs among agricultural workers exposed to machinery noise.

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1. Development of agricultural mechanization in Japan

The agricultural industry plays a very significant role in Japan—in terms of food production and the maintenance of local environments.

Under present conditions, the mechanization of agricultural work is essential with the goal of eliminating labor and increase the efficiency of the maintenance of food production. Fig. 1 shows changes in main indicators of agricultural mechanization since 1970. In a relatively short period, farm equipments such as riding tractors, powered rice planters, and head-feed combines have spread throughout lowland rice cultivation. The number of riding tractors per 1000 farm households reached 673 units in 1995. For upland and other crops as well as variety of harvesters, processing machines, and power carriers have been introduced into rural communities.

This mechanization has brought about higher efficiency and production, but at the same time, it gives rise to new problems in the working environment through the exposure of farmers to the high level noise inherent in such machinery. This noise is not only annoying but may also be damaging to hearing [1].

2. Evaluation of positive audiometry rates among farmers

2.1. Materials and methods

The present study was undertaken to explore the risk for hearing damage among farmers exposed to noise from mechanised farming equipment. A hearing test was conducted at

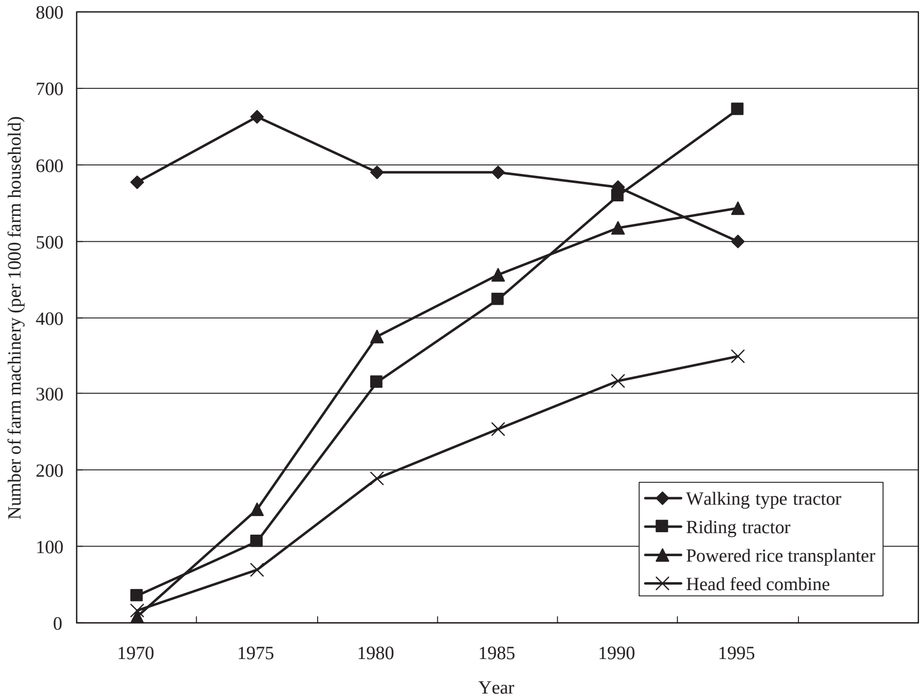

Fig. 1. Changes in main indicators of agricultural mechanization since 1975.

Kumamoto Health Care Center, the Red Cross of Japan among farmers ($n = 1538$) and office workers ($n = 4300$).

2.2. Results

As shown in Table 1, significant differences were found between male farmers and male office workers in the percentage of subjects with hearing levels more than 40 dB at 4 kHz. For subjects in their 40 s, the rate was 16.4% among farmers and 9.6% among office workers. For those in their 60 s, the rate was 50.3% for farmers and 29.9% for office workers. As for hearing levels at 1 kHz, no significant differences were observed among male subjects.

In female subjects, no significant differences were found between farmers and office workers except among the 50-year-olds at 1 kHz test frequency.

2.3. Comments

As there was no significant differences at 1 kHz, but a demonstrably higher prevalence of hearing loss at 4 kHz, these results suggest that Japanese farmers, particularly male farmers, are at risk from noise-induced hearing loss when compared with office workers. Our findings, based on rural Japanese communities, are in accordance with previous studies carried out primarily in the United States [2–9].Those studies demonstrated that farmers have greater high frequency hearing loss than can be accounted for by presbycusis alone.

In order to prevent noise-induced hearing loss in the workplace, the Japanese Labor Safety and Health Act was revised in 1989 and a hearing screening test has become a regular part of medical

Table 1
Rates of subjects with hearing level >40 dB among office workers and farmers by sex and age

	Age	Audiometric test frequency			
		1 kHz		4 kHz	
		Office workers	Farmers	Office workers	Farmers
Male	30—39	0.9%	2.9%	3.6%	11.4%
	40—49	3.3%	1.9%	9.6%	16.4%***
	50—59	7.0%	10.0%	16.1%	30.3%***
	60—69	18.3%	15.6%	29.9%	50.3%***
	70—79	—	33.9%	—	78.6%
Female	30—39	1.1%	0.0%	0.5%	0.0%
	40—49	2.9%	2.4%	2.2%	3.2%
	50—59	4.7%	9.9%**	5.7%	6.7%
	60—69	6.1%	15.6%	10.2%	17.2%
	70—79	—	—	—	—

Farmers vs Office workers *$p < 0.05$, **$p < 0.01$, ***$p < 0.005$.

check-ups. In addition, guidelines for preventing noise hazards were made public and a systematic hearing conservation program in noisy workplaces started in 1992. These act and guidelines do not, however, cover farmers as most of them are self-employed. As a comparison, in 1990 the number of hired farmers was 186,000—only 4.7% of the total number of agricultural workers. These facts indicate a strong need for participatory research to increase involvement and awareness among farmers [10,11].

3. Estimates of Japanese farmers exposed to high level noise

An estimate was made of the total number of workers with more than 40 dB hearing loss at 4 kHz due to occupational noise exposure [12]. Estimated values of major industry groups were as follows; approximately 780,000 in manufacturing; 410,000 in construction; 360,000 in agriculture; forestry & fishing for a total of around 2 million. Although it is rather difficult to estimate the number of farmers at risk of NIHL, is reasonable to suggest that roughly one-half or one million farmers should be covered by an effective hearing conservation program. For reference, a U.S. Environmental Protection Agency report states that approximately 323,000 agricultural workers were exposed to potentially hazardous noise levels [13].

A vast store of knowledge has been generated concerning the nature, etiology, and time-course of damage due to occupational noise exposure. However, there is still a need to reclarify the locations, nature, and magnitude of the problem in agricultural industry which has not so far been involved in these activities.

4. Present situation of noise exposure in agricultural work by population

4.1. Material and methods

To investigate the extent of noise exposure to which farmers are exposed, daily noise exposure levels were measured using Noise Badges (Larson Davis type 705) during a full work shift of 8 h or more in various agricultural settings. The dosimeters were activated at the beginning of the shift and ran until the end of the shift. The equivalent continuous A-weighted sound pressure level (L_{Aeq}) was determined every minute as well as every 10 min. In addition L_{Aeq} for full work shifts were calculated. The samples comprised 54 farmers in several job categories including tea harvesting and processing, rush harvesting and processing, sugar cane harvesting and tomato harvesting.

Table 2 summarizes L_{Aeq} during a full work shift in tea harvesting and processing—duration of sampling time in minutes and converted L_{Aeq} values for 8 h ($L_{Aeq}(8)$). L_{Aeq} (8) was calculated using the following equation, where measured L_{Aeq} is L_{Aeq} for a full work shift: $L_{Aeq}(8) = 10 \times \log(10^{LAeq/10} \times \text{sampling time (min)}/480)$.

4.2. Results

The results indicate that in 19 out of 23 cases, farmers' exposure exceeded the 8 h limits of 85 dBA recommended by the Japan Society for Occupational Health (JSOH) [14]. For tea

Table 2
Results of noise dosimetry: tea harvesting and processing, measured value = Mv, converted value = Cv

Case	Main job	Workshift			Mv L_{eq}, (dBA)	Cv $L_{eq}(8)$, (dBA)
		Start	End	Sampling time (min)		
1	Harvesting	09:00	18:30	570	90.7	91.4
2	Harvesting	08:25	15:50	655	92.1	93.5
3	Harvesting	09:00	17:40	520	92.7	93.0
4	Harvesting	07:30	11:40	250	99.1	96.3
5	Harvesting	07:30	11:40	250	93.9	91.1
6	Harvesting	08:22	12:10	228	99.0	95.8
7	Harvesting	10:00	11:41	101	96.0	89.2
8	Harvesting	09:55	11:52	117	92.4	86.3
9	Harvesting	09:55	11:52	117	94.6	88.5
10	Harvesting/processing	09:00	19:00	600	87.0	88.0
11	Harvesting/processing	08:00	18:00	600	95.2	96.2
12	Harvesting/processing	08:00	18:00	600	92.3	93.3
13	Harvesting/processing	08:20	00:43	983	90.2	93.3
14	Harvesting/processing	08:20	23:52	932	92.6	95.5
15	Processing	08:30	22:20	730	85.0	86.8
16	Processing	09:00	23:00	840	82.8	85.2
17	Processing	08:00	17:50	590	81.6	82.5
18	Processing	08:00	20:30	750	83.5	85.4
19	Processing	08:40	19:00	620	83.1	84.2
20	Processing	08:00	18:00	600	84.1	85.1
21	Processing	08:00	17:00	540	81.5	82.0
22	Processing	08:27	00:55	988	86.7	89.8
23	Spraying	09:00	17:05	485	71.1	71.1

harvesting an $L_{Aeq}(8)$ high of 96.3 dBA and a low of 86.3 dBA were measured. As for tea processing an $L_{Aeq}(8)$ high of 89.8 dBA and a low of 82.0 dBA were observed. Fig. 2 shows the results of noise dosimetory for Case 12 in tea harvesting and processing.

Table 3 shows the results obtained in rush harvesting and processing. Except in two harvesting cases in which $L_{Aeq}(8)$s were 89.3 and 86.6 dBA, most $L_{Aeq}(8)$s ranged from 74 to 83 dBA. However, rather long working hours should not be overlooked.

The results obtained in sugar cane harvesting are shown in Table 4. Of seven cases, the highest $L_{Aeq}(8)$ level was 96.0 dBA (Case 4) followed by 92.6 dBA (Case 5) and 91.3 dBA (Case 1). The lowest $L_{Aeq}(8)$—82.9 dBA—(Case 3), in which a harvester with cab was used, clearly points the way for future developments in developing quieter equipment.

$L_{Aeq}(8)$s for workers engaged in harvest of such green house products as strawberries, tomatoes and cherry tomatoes, and flowers were all well below 80 dBA as shown in Tables 5 and 6.

5. Discussion

For the achievement of high productivity and cost reduction in the field of agriculture, electronic and mechatronic developments are quickly adapted to the technology of farm

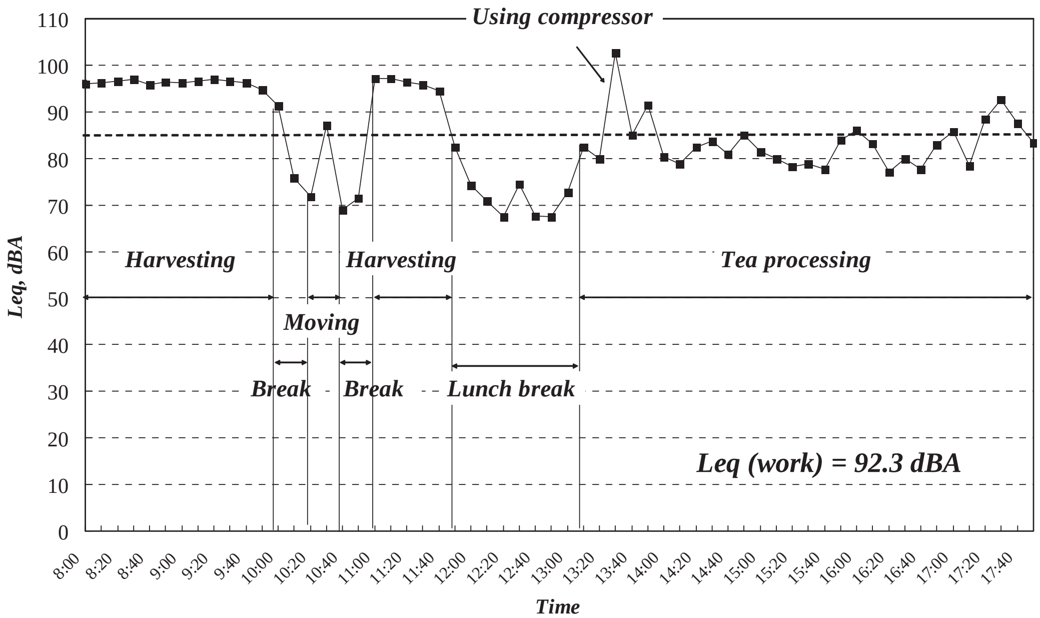

Fig. 2. Typical daily noise exposure in tea harvesting and processing.

Table 3
Results of noise dosimetry: rush harvesting and processing, measured value = mv, converted value = Cv

Case	Main job	Work shift Start	End	Sampling time (min)	Mv L_{eq}, (dBA)	Cv $L_{eq}(8)$, (DBA)
1	Harvesting	04:00	18:21	861	79.5	82.0
2	Harvesting	03:10	18:00	890	86.6	89.3
3	Harvesting	03:05	18:00	895	83.9	86.6
4	Harvesting	04:22	18:50	868	80.7	83.3
5	Harvesting	04:30	18:47	857	79.2	81.7
6	Harvesting	03:51	19:14	923	78.2	81.0
7	Harvesting	03:58	19:03	905	76.8	79.6
8	Harvesting	04:06	18:03	837	72.2	74.6
9	Processing	07:55	17:25	570	77.9	78.6
10	Processing	07:37	16:56	559	76.5	77.2
11	Processing	07:37	17:00	563	76.4	77.1

equipment and put on the market without sufficient consideration of user safety and health [15]. Because the basics of noise control is in reducing sound level at their source, the active cooperation of farm equipment makers and distributors is indispensable.

The results from the study illustrate the high risk for hearing damage among farmers. There is a need for dissemination of information about the auditory and non-auditory effects of noise among farmers to enable them to change and manage their working environment [16]. In

Table 4
Results of noise dosimetry: sugar cane harvesting and processing, measured value = mv, converted value = Cv

		Work shift			Mv L_{eq}, (dBA)	Cv $L_{eq}(8)$, (dBA)
Case	Main job	Start	End	Sampling time (min)		
1	Harvesting	09:00	17:30	510	91.0	91.3
2	Harvesting	09:00	16:09	429	86.6	86.1
3	Harvesting	08:58	16:09	431	83.2	82.7
4	Harvesting	12:58	18:30	332	97.6	96.0
5	Harvesting	13:01	18:35	334	94.2	92.6
6	Harvesting	12:58	18:29	331	89.8	88.2
7	Harvesting	12:56	18:03	334	90.2	88.6

Table 5
Results of noise dosimetry: floriculture, measured value = Mv, converted value = Cv

		Workshift			Mv L_{eq}, (dBA)	Cv Leq(8), dBA)
Case	Mainjob	Start	End	Sampling time (min)		
1	Sorting*1	07:00	17:30	630	75.9	77.1
2	Sorting*1	09:25	16:10	405	74.7	74.0
3	Sorting*1	07:30	16:30	540	74.1	74.6
4	Sorting*2	14:50	16:20	90	84.1	76.8

*1 Manual, *2 robot.

Table 6
Results of noise dosimetry: green house horticulture, measured value = Mv, converted value = Cv

		Work shift			Mv L_{eq}, (dBA)	Cv $L_{eq}(8)$, (dBA)
Case	Main job	Start	End	Sampling time (min)		
1	Harvesting*1	06:40	15:45	550	72.1	72.7
2	Harvesting*1	06:40	15:45	550	69.8	70.4
3	Harvesting*2	07:55	16:30	520	74.2	74.5
4	Harvesting*2	08:15	16:30	500	71.7	71.9
5	Harvesting*2	08:00	16:35	520	72.3	72.6
6	Harvesting*3	07:23	17:05	590	69.4	70.3
7	Harvesting*3	07:50	17:03	560	75.5	76.2
8	Harvesting*3	07:32	17:10	580	74.4	75.2
9	Harvesting*3	07:35	17:05	580	69.5	70.3

*1 Strawberries, *2 Tomatoes, *3 Cherry-tomatoes.

developing concrete measures for improvement, awareness by and involvement of farmers is vitally important [10,11]. Participatory research that meets the needs and demands of the farmers determines not only the working methods but also analysis if the changes made are to lead to effective improvement of working farm environment.

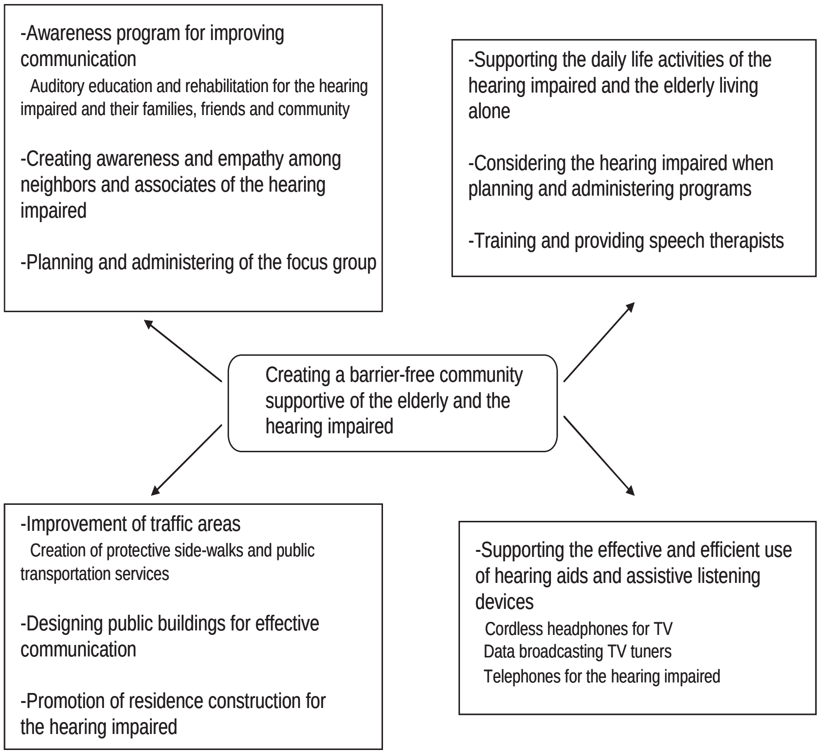

Fig. 3. Key components for creating a barrier-free community supportive of the elderly and the hearing impaired.

Providing information to local health departments and health service institutions regarding the present conditions of noise exposure in agricultural work is also essential to the primary and secondary prevention of disability. Annual audiometric evaluations as well as education and motivation concerning the use of hearing protection devices should be conducted whenever necessary.

Recently, disabilities are more and more being viewed in environmental terms rather simply as an attribute of individuals as has traditionally been the case [17]. In this context, more attention should be focused on the rehabilitative approach based on cooperative efforts among health care and treatment service and welfare agencies. The movement of creating a barrier-free community supportive of the elderly and hearing impaired in an aging society may be taken as a model for the future (Fig. 3).

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