Research report

# Effects of a three-year horticultural program on behaviors symptomatic of dementia in daily life among small-scale multifunctional care facility users

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**Objective:** Although a number of studies have reported the effects of horticultural activity in community-dwelling older people, no reports have tracked the effects of this intervention among older with dementia for longer than a year.
**Methods:** A three-year horticultural program comprising individual and group activities was conducted among community-dwelling cognitively impaired older users of a multifunctional care facility. Using a questionnaire, we examined the intervention effects by monitoring changes in 5 categories of behaviors symptomatic of dementia in daily life across the intervention period.
**Results:** We could observed in all categories except "difficulties in daily life", which became significantly differ between Years 1 and 2 and between Years 1 and 3. "Amnesic symptoms" ($p<0.05$), "loss of interest in living" ($p<0.01$), and "common forgetfulness" ($p<0.01$) were significantly more prevalent in Years 2 and 3 than they were in Year 1. "Emotional responses" were significantly less prevalent in Years 2 and 3 than in Year 1 ($p<0.01$).
**Conclusion:** The horticultural program brought improvement "emotional responses" in the long- term, but its effects on other symptoms diminish over time. Further data are needed to determine how to configure this horticultural program to enliven participants' lives in a more balanced way.

**Keywords:** older with dementia, behaviors symptomatic of dementia in daily life, horticultural activity, small-scale multifunctional care facility

## Introduction

The prevalence of dementia is increasing as the global population ages. Currently, the World Health Organization regards this situation as a global public health priority[1]. According to Kondo et al.[2] despite advances in epidemiological research, clinical screening, and disease-modifying therapies, dementia remains a problem. Kutoku and Mihara[3] further note that the onset, course, and prognosis of dementia vary according to factors such as background disease, comorbidities, and patient attributes (e.g., lifestyle, educational background, and living environment). Based on these situation, we considered that non drug therapies should not focus on improving cognitive function as such, but rather on empowering the patient to continue living in familiar surroundings.

Such an undertaking requires an intervention that is sustainable in the long-term, which is only possible if it is highly appealing to older adults with dementia. Yatomi[4] suggests that interventions based on travel, horticulture, cooking, and computing are both appealing to community-dwelling older people and effective for improving cognitive function. Among them, several studies have already examined the psychosocial effects of horticultural therapy on institutionalized older people with dementia[5)-12)]. Other studies have explored its effects on community-dwelling older people, including those who use day-care[13)], day-service[14)], and those who qualify for long-term care[15)]. Therefore, we considered that horticultural activities have the sustainability and practicability as a program, we decided to carry out the horticultural activities. In addition, to our knowledge, there have been no studies that have tracked the effects of horticultural therapy for more than a year. Besides, in previous studies[5)-15)] had observation during the activities or conducted comparative tests regarding each function (e.g., cognitive function and physical function) for evaluation of interventions between before and after horticultural activities. There was no study that attempted to evaluate of effectiveness of the interventions through continuous periodic surveys of the subjects' daily living conditions.

So in this study we conducted a horticultural program for community-dwelling older adults with dementia over a three-year period in this study. And we examined the effects of horticultural activities by monitoring their situations of daily life that increases the risk of dementia, not the change in cognitive function itself.

## Methods

### 1. Participants

The participants were users of an older facility (formally classified as a "small-scale multifunctional facility") located in City A. The participants were selected by the facility staff, and their consent to participate was obtained from the participants themselves as well as their family members. To be eligible to participate, candidates had to fulfill three criteria: (1) aged 65 years or older and had either been diagnosed with dementia or were rated as level II or higher (i.e., mild to severe) on the Degree of Independence in Daily Living for Older with Dementia subscale of the Dementia Scale used by the Japanese long-term care insurance system; (2) able to remain in a sitting position; (3) and able to operate gardening tools. This study examined the effects of horticultural activities by monitoring their situations of daily life that increases the risk of dementia. So that statistical sample consisted of those participants who used the facility for a half of year or longer except during periods when the facility was not used due to temporary hospitalization or withdrawal in each year of the study.

### 2. Study period

The data collection period was from April 2015 to March 2018. It follows as from April 2015 to March 2016 is the first year (Year 1), from April 2016 to March 2017 is the second year (Year 2), and from April 2017 to March 2018 is the third year (Year3).

### 3. Horticultural program

The horticultural program was conducted in a part of the courtyard or dining hall, and consisted of individual and group horticultural activities. Each activity was designed and run by the authors and facility staff. The group activities generally lasted for about an hour and took place once or twice per month during the participants' recreation time. We did not considered the group activities composition of participants but we devised the arrangement of the participants' seats based on the individuality and lifestyle of the participants. Also, in both individual and group activities, we supported to empower, the participants could be proactively involved in the activities. Participants who could not participate the group activity worked that same activity on another day while accompanied with facility staff. And, all participants whether they participated in group activities, they were able to request facility staff for daily horticultural tasks, such as watering, weeding, and maintaining, and carried out together. The horticultural program centered on the summer vegetables and tulip cultivation that familiar to the participants during each year. In addition, we selected that plants other than summer vegetables and tulip with participants and facility staff, we cultivated some plants throughout the year. Each horticultural activity lasted around an hour. In selecting the plants, the authors followed the method of Teraoka and Konishi[16]: that is, the plants were selected and prepared after consulting with the participants to ensure that the plants were familiar to the participants. Some of the plants were grown in the open ground, while others were grown in containers so that activities could be held regardless of the weather or season.

### 4. Measurements

#### 4.1. Behaviors symptomatic of dementia in daily life during the past month

The effects of the intervention were assessed using a Japanese questionnaire based on that of Teraoka et al.[17]. This questionnaire assessed the presence of behavioral symptoms of dementia in the past month. The questionnaire was administered to each participant monthly by the same staff member, and consisted of five categories with a total of 21 items. The questionnaire also included space for noting the presence of horticulture-related statements or behaviors in the participant's daily life and other notable matters.

The five categories were as follows: "emotional responses" consisting of 2 items (e.g., "the person would get angry easily" and "the person was easily moved to tears"), "amnesic symptoms" consisting of 4 items (e.g., "the person would say the same things repeatedly" and "the person would struggle to recall recent events"), "loss of interest in living" consisting of 8 items (e.g., "the person was uninterested in doing anything," "the person had stopped regular routines," and "the person was frequently drowsy"), "difficulties in daily life" consisting of 5 items (e.g., "the person would get lost in familiar places" and "the person would frequently miscount money"), and "common forgetfulness" consisting of 2 items (e.g., "the person would frequently mislay things or forget to put things away" and "the person would struggle to recall the names of things"). Each of the 21 items was rated on a four-point scale, as follows: "strongly agree" (4 points), "agree" (3 points), "disagree" (2 points), and "strongly disagree" (1 point). In other words, the higher the point indicate to spending the daily life with high risk of dementia. Also, fifth option, "Undecided," was also offered; "undecided" responses were treated as missing values. From the total score of each category, the average score per item of that category was calculated.

#### 4.2. Behavioral changes in participants by activity

According to Takayama[18] if researchers measure participants' activities of daily living accurately, they might be able to detect the subtle changes that occur during the earliest stage of cognitive decline. Although the participants in this study were not in the very earliest stage of cognitive decline, we

nevertheless examined these subtle changes in this study so as to gain more insight into participants' cognitive decline. After each horticultural activity, we met with the participating staff to discuss how participants engaged with the activity and what they were doing during and around the time of the activity. During these meetings, the attendees completed activity records describing the activity plan for that day, how well the activity was administered, and any matters that came to light.

We abstracted the written responses in these records into simple phrases, each of which was assigned to one of the five categories of the above scale. These statements were then used to assist in the interpretation of the questionnaire results.

**5. Statistical analysis**

All statistical analyses were conducted using IBM SPSS Statistics 25. Statistical significance was defined as a p-value of $<0.05$ (two-sided). In the analysis, the total scores of the behavioral symptom questionnaire for each category were compared between Years 1 and 2, between Years 2 and 3, and between Years 1 and 3, using the Bonferroni method. To determine the seasonal effects, we used the Friedman test and Wilcoxon signed-rank test to compare scores by month.

**6. Ethical considerations**

This study was approved by the clinical ethics committee of Kyushu University (approval No.25073).

We were provided to the participants and their family members with written and oral briefings before the study began. The written and oral briefings emphasized that the data collected in the study would not be used outside the study purpose, that they would remain anonymous and be carefully stored, that the results would be published as an academic paper, that the printed data would be shredded after the paper was published, and that the participants could withdraw their participation at any time. The family members provided written consent on behalf of the participants. The participant briefing was provided by the facility staff to avoid worrying the participants. Each participants' physical and mental condition were checked before each activity began.

**Results**

**1. Participant attributes**

Table 1 shows the participants' baseline attributes (as of April 1 in Year 1 — the start of the intervention). There were eight participants, all of whom were women. Their ages ranged from 80 to 88 years (average: 85.75 ± 2.66). One participant had cognitive impairment level of IIa, two had a level of IIb, and four had a level of IIIa. Six of the participants had been diagnosed with dementia at baseline. Among the eight participants, there were three participants with horticultural experience and five participants with no horticultural experience or unknown details.

**2. Participants' daily life behaviors**

**2.1. Behaviors symptomatic of dementia in daily life during the past month**

In each participant, the total scores of each category exhibited yearly variations. The changes between Years 1 and 2 and those between Years 1 and 3 were significant for all categories except "difficulties in daily life" (see Figure 1 and Table 2). Figure 2 and Table 3 show the monthly variations in each category.

"**Emotional responses**"**:** Of the five categories, "emotional responses" had the lowest average scores; this was also the only category that exhibited improvement after Year 1. Although subject to some monthly variations, the scores for this category were generally lower in Years 2 and 3 than they were in Year 1.

"**Amnesic symptoms**"**:** Of the five categories, "amnesic symptoms" had the highest score in Year 1. The scores varied little over the years. Although the scores were higher in Years 2 and 3 than they were in Year 1, fewer months exhibited

Table 1. The participants' baseline attributes

| Participants | Age | Dementia rating* |
|---|---|---|
| A | 86 | Ⅱb |
| B | 87 | Ⅲa |
| C | 86 | Ⅲa |
| D | 84 | Ⅲa |
| E | 88 | Ⅱb |
| F | 88 | Ⅲa |
| G | 80 | Ⅱb |
| H | 87 | Ⅱa |

*Criteria for determining the daily life independence level of older people with dementia (Ministry of Health, Labour and Welfare of Japan)

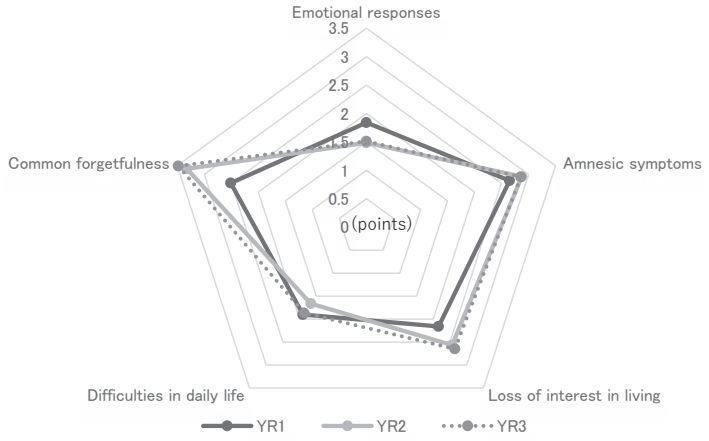


Figure 1. The mean scores of five category in each year

Table 2. Comparison in each year of the mean scores of five category (points)

| | YR1 | YR2 | YR3 |
|---|---|---|---|
| | Mean ± SD | Mean ± SD | Mean ± SD |
| Emotional responses | 1.84 ± 0.67 | 1.48 ± 0.79 | 1.51 ± 0.76 |
| | ** | | |
| | | ** | |
| Amnesic symptoms | 2.65 ± 0.84 | 2.87 ± 1.13 | 2.86 ± 1.16 |
| | * | | |
| | | * | |
| Loss of interest in living | 2.16 ± 0.65 | 2.57 ± 1.00 | 2.65 ± 0.96 |
| | ** | | |
| | | ** | |
| Difficulties in daily life | 1.90 ± 0.58 | 1.66 ± 0.77 | 1.87 ± 0.74 |
| Common forgetfulness | 2.51 ± 0.66 | 3.32 ± 0.71 | 3.48 ± 0.66 |
| | ** | | |
| | | ** | |

Bonferroni method　　*:p<0.05, **:p<0.01

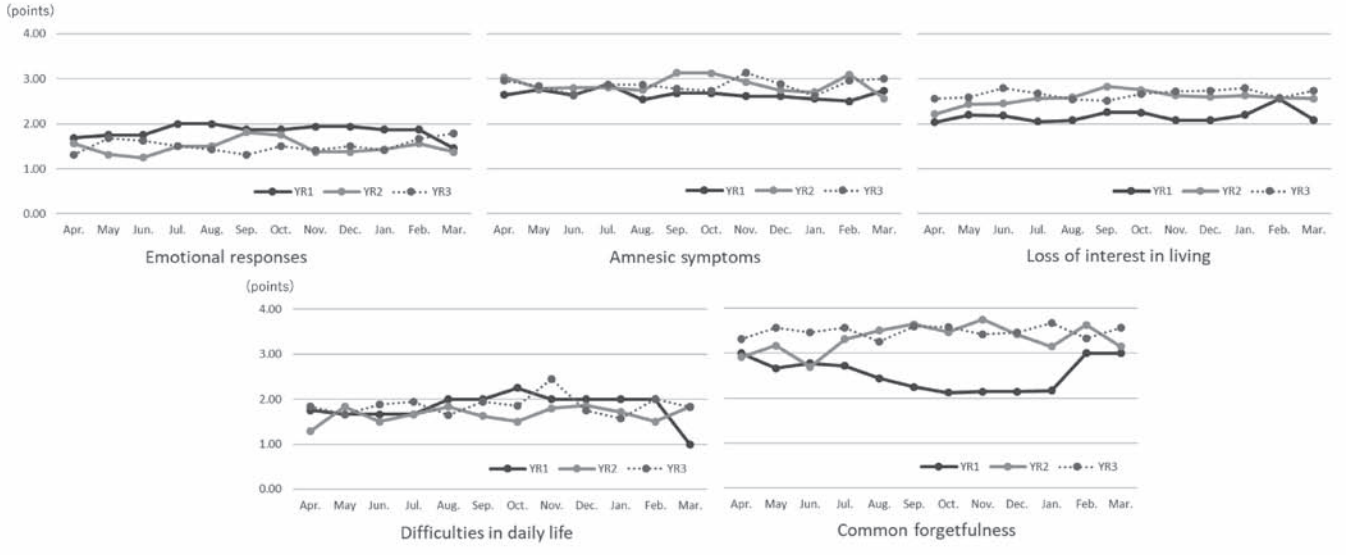


Figure 2. The monthly variations in each category

Table 3. Comparison in each year of the monthly variations in each categorycategory

| | | Friedman test | Wilcoxon signed-rank test | | |
|---|---|---|---|---|---|
| | | | YR1 vs YR2 | YR2 vs YR3 | YR1 vs YR3 |
| Emotional responses | Apr. | 0.78 | | | |
| | May | 0.94 | | | |
| | Jun. | 0.04 * | 0.02 * | 0.03 * | 0.56 |
| | Jul. | <0.01 ** | 0.01 * | 1.00 | 0.02 * |
| | Aug. | 0.00 ** | 0.02 * | 0.65 | 0.04 * |
| | Sep. | <0.01 ** | 0.56 | 0.00 ** | <0.05 * |
| | Oct. | 0.73 | | | |
| | Nov. | 0.03 * | 0.07 | 0.32 | 0.17 |
| | Dec. | 0.05 | | | |
| | Jan. | 0.14 | | | |
| | Feb. | 0.07 | | | |
| | Mar. | 0.23 | | | |
| Difficulties in daily life | Apr. | 0.61 | | | |
| | May | — | | | |
| | Jun. | — | | | |
| | Jul. | — | | | |
| | Aug. | — | | | |
| | Sep. | — | | | |
| | Oct. | — | | | |
| | Nov. | — | | | |
| | Dec. | — | | | |
| | Jan. | — | | | |
| | Feb. | 0.16 | | | |
| | Mar. | — | | | |

| | | Friedman test | Wilcoxon signed-rank test | | |
|---|---|---|---|---|---|
| | | | YR1 vs YR2 | YR2 vs YR3 | YR1 vs YR3 |
| Amnesic symptoms | Apr. | 0.18 | | | |
| | May | 0.28 | | | |
| | Jun. | 0.15 | | | |
| | Jul. | 0.24 | | | |
| | Aug. | 0.08 | | | |
| | Sep. | 0.02 * | 0.02 * | 0.01 * | 0.19 |
| | Oct. | 0.07 | | | |
| | Nov. | 0.10 | | | |
| | Dec. | 0.16 | | | |
| | Jan. | 0.13 | | | |
| | Feb. | <0.01 ** | 0.02 * | 0.25 | <0.01 ** |
| | Mar. | 0.85 | | | |
| Common forgetfulness | Apr. | 0.15 | | | |
| | May | 0.28 | | | |
| | Jun. | 0.11 | | | |
| | Jul. | 0.02 * | 0.10 | 0.06 | 0.04 * |
| | Aug. | <0.01 ** | 0.02 * | 0.32 | <0.05 * |
| | Sep. | 0.00 ** | <0.01 ** | 0.71 | 0.02 * |
| | Oct. | 0.00 ** | 0.01 * | 0.32 | 0.03 * |
| | Nov. | <0.01 ** | 0.02 * | 0.16 | 0.02 * |
| | Dec. | <0.01 ** | 0.02 * | 0.56 | 0.02 * |
| | Jan. | 0.02 * | 0.04 * | 0.02 * | 0.05 * |
| | Feb. | 0.31 | | | |
| | Mar. | 0.37 | | | |

| | | Friedman test | Wilcoxon signed-rank test | | |
|---|---|---|---|---|---|
| | | | YR1 vs YR2 | YR2 vs YR3 | YR1 vs YR3 |
| Loss of interest in living | Apr. | 0.42 | | | |
| | May | 0.01 * | 0.03 * | 0.02 * | 0.06 |
| | Jun. | 0.00 ** | 0.12 | 0.00 ** | 0.00 ** |
| | Jul. | 0.03 * | 0.01 * | 0.11 | 0.00 ** |
| | Aug. | 0.11 | | | |
| | Sep. | 0.02 * | 0.02 * | 0.27 | 0.06 |
| | Oct. | 0.02 * | 0.09 | 0.18 | 0.00 ** |
| | Nov. | 0.00 ** | 0.04 | 0.08 | 0.00 ** |
| | Dec. | 0.00 ** | 0.20 | 0.07 | 0.00 ** |
| | Jan. | 0.00 ** | 0.22 | 0.00 ** | 0.00 ** |
| | Feb. | 0.03 * | 0.19 | 0.12 | <0.05 * |
| | Mar. | 0.04 * | 0.11 | <0.01 ** | 0.06 |

*:p<0.05, **:p<0.01

significant changes compared to the same month in a previous year than for “emotional responses”, low motivation, and “common forgetfulness”.

“**Loss of interest in living**”**:** As with “amnesic symptoms”, “loss of interest in living” showed a slight increase in scores over successive years. Although the scores varied by month, those in Years 2 and 3 never fell below the equivalent figure for Year 1.

“**Common forgetfulness**”**:** Of the five categories, “common forgetfulness” exhibited the greatest increase over the study period. While the difference was minimal between Years 2 and 3, there was a statistically significant increase between Years 1 and 2 and between Years 1 and 3.

“**Difficulties in daily life**”**:** This category had numerous missing values, making the Friedman test unfeasible for many cases. When a Friedman test was conducted, no significant differences were ascertained.

### 2.2. Horticulture-related behaviors

After beginning the intervention, six of the eight participants (Participants A, D, E, F, G, and H) engaged in conversations or uttered words about horticulture topics in their daily lives. Participants G and H spontaneously engaged socially with others, inviting them to the deck to view the plants and chat even outside the horticulture program. Participant A mentioned to a staff member that she would like to go to the deck to see the flowers. She also used some of the harvested vegetables to prepare and season a dish she was accustomed to by herself.

## 3. Participants’ horticulture-related behavior for each activity

Table 4 shows the simplified statements from the activity records sorted into the five categories.

“**Emotional responses**”**:** On rare occasions, the hardness and poorness of facial expressions were seen. However, none of the participants exhibited emotional outbursts, interpersonal conflict, or any behavioral or psychological symptoms of dementia throughout the three years. Many participants showed emotional flexibility and enjoyed engaging in the activities with each other.

“**Amnesic symptoms**”**:** Participants often forgot their plan for the day, repeatedly asked the same questions, or engage repeatedly in the same conversation. However on a positive note, they would chat to the person sitting next to them during tasks, and when shown a photo, they were able to recall the scene portrayed therein.

“**Loss of interest in living**”**:** Throughout the intervention period, many participants remained drowsy and would only act if prompted. In Year 1, some participants uprooted the plants or unearthed the seeds, and some complained of anxiety due to incomprehension. Besides, Participant G was initially comb her hair before or after the horticultural activities using a comb that had brought with her. However, she grew less motivated to comb her hair in the later stages of the intervention. By Year 3, she was no longer combing her hair, although she continued to bring her comb. In addition, throughout the three-year period, this participant expressed worry and support her family, and she was continued her hobby reading a book before each activity.

“**Difficulties in daily life**”**:** No notes fitting this category were made in Year 1. In Year 2, the notes mentioned that some participants were unable to write their own name. In Year 3, some participants could not recall their family name. Furthermore, some participants could no longer come to the facility on their own, and thus needed someone to pick up them.

“**Common forgetfulness**”**:** Participants often forgot to take their belongings home with them

Table 4. Participants' behavior across each activity

| | YR 1 | | YR 2 | | YR 3 | |
|---|---|---|---|---|---|---|
| | Positive | Negative | Positive | Negative | Positive | Negative |
| Emotional responses | Converses animatedly and with a smile<br>Gentle and amenable expression<br>Thanks others<br>Smiles often, seems relaxed<br>Says she is enjoying herself<br>Hums plant-related songs<br>Frequently converses with others | Poor expression | Eagerly chats with others<br>Sits in a chair and watches activities with a smile<br>Once an activity is over, she says she is glad to have taken part<br>Engages in a task with an amenable expression | Appears uninterested in the crops<br>Expression hardens when an activity ends<br>Negative expressions | Sings boisterously<br>Says she enjoyed the activity and that the food was delicious<br>Seems to enjoy harvesting the crops<br>Thanks others<br>Frequently converses with others<br>Wears a beaming smile | Stern expression |
| Amnesic symptoms | Remembers to place saliva test chip under tongue when asked to take the test<br>Recalls locations depicted in photographs<br>Engages in task while talking eagerly to a person sitting next to her<br>Understands where the plants discussed in a conversation should be planted<br>Shows others where to clear up | Cannot recall today's plan<br>Repeatedly talks about the same thing with a certain companion<br>Each time she takes a saliva test, she asks what the test is for<br>Plants the seeds without removing them from their pot, despite repeated exhortations to the contrary<br>Is unsure whether she participated in the previous activity | Recounts how she engaged in the task while chatting with her companion<br>When shown a photo of someone she has never met, she understands that she has not met the person<br>Declines a post-activity saliva test, saying that the pre-activity test results were favorable | Forgets to eat if there is no photo<br>Repeatedly goes over the characteristics of a vegetable<br>Each time she takes a saliva test, she asks what the test is for | Shows interest in plant growth<br>Accurately states her age<br>Recalls a previous activity when shown a photo of it | Forgets something she was speaking about a moment ago |
| Loss of interest in living | Puts other activities aside to focus on the horticultural activity<br>Chooses what to plant<br>Uses the gardening tools effectively<br>Can sow, plant, transplant, and harvest<br>Went indoors for a while but then returned to the courtyard and resumed the task<br>Reaches for plants within her reach<br>Goes to the courtyard to have a chat with her companion<br>Reads newspapers and books<br>Emphasizes her desire to support her family<br>Combs her hair with her comb | Remains inactive unless prompted to act<br>Cannot make conversation<br>Watches others working<br>Unresponsive<br>Expresses unease at not understanding anything<br>Uproots plants and unearths seeds | Can sow, plant, transplant, and harvest<br>Proactively engages in tasks she is capable of doing<br>When she cannot do a task, she asks someone else to do it for her<br>Picks up the seeds she dropped<br>Writes the names of flowers on labels<br>Eats harvested vegetables with the seasonings she likes<br>Gets herself ready and remains on standby for going to the courtyard<br>Emphasizes her desire to support her family<br>Eagerly eats the vegetable samples<br>Reads a book before the activity commences<br>Cares about how she appears in photos | Remains inactive unless prompted to do something Has grown apathetic about things she used to be particular about | Chooses the plants she likes<br>Engages in planting and harvesting without prompting<br>Wants to take photos herself<br>Reaches out to touch plants and expresses admiration<br>Willingly heads out to courtyard<br>Eats the harvested vegetables with the seasoning she likes<br>Reads a book before the activity commences<br>Emphasizes her desire to support her family Chooses many plants | Remains inactive unless prompted to do something<br>Attends with unkempt hair despite bringing her comb |
| Difficulties in daily life | | | | Cannot write her own name<br>Eats edamame one bean at a time | Can read her own name | Cannot state her family name when asked<br>Cannot come to facility as she used to; requires a pick-up |
| Common forgetfulnes | Can recall the names of the plants that were planted<br>Can recall the names of plants to be planted<br>Can recall how to cook and season a vegetable<br>Cleans up by herself | Forgets to take home belongings she said she would take home<br>Cannot recall the names of plants that were planted<br>Cannot recall the names of vegetables | Can demonstrate how to cook and season a vegetable | When asked at the end of the activity about what plants she used, she cannot accurately recall the names | Knows the names of vegetables in front of her<br>Can show how to cook and season a vegetable Can recall the names of flowers | After harvesting vegetables, she remarked that she had caught plenty of fish |

or forgot the names of things. On the other hand, throughout the three-year period, many participants were able to remember the names of plants and vegetables and how to cook them.

## Discussion

### 1. Effects of horticultural activities on behaviors symptomatic of dementia in daily life

"Amnesic symptoms", "loss of interest in living", and "common forgetfulness" were significantly more prevalent in Years 2 and 3 than they were in Year 1. According to Teraoka et al.'s study[17] of community-dwelling older people in the, "common forgetfulness" were by far the most, "amnestic symptoms" were next most, "loss of interest in living" were third most. Therefore, we considered that the significant increase of these categories had more likely to occur with aging in this study, too. In the same previous study[17] suggested that individuals who exhibited indications of these three categories tended to be less active in their daily lives when compared to those who had none of the 21 items. They also mentioned that "loss of interest in living" indicate that daily-social life are inactive, and this is affected from external relations and intellectual activities rather than domestic life (e.g., conversations with family, housework) [17]. By contrast, in the present study, participants did not become markedly less active over time. Judging by the daily living conditions, as well as their behavior in each horticultural activity, the participants generally engaged socially with each other and enjoyed their daily lives, despite showing some negative indications (e.g., one participant had stopped combing her hair). These findings suggest that the intervention was effective in enlivening participants' lives. Particularly, in Year 1, the launch of the intervention might have enlivened participants' lives by providing them with novelty opportunities to engage in social and horticulture-related activities. The fact that the participants' conditions were less favorable about three categories in Year 2 might be due to the decrease in novelty stimuli, as in previous study result[19]. We considered the participants had grown accustomed to the activities and to working together on the tasks, caused the novelty of social and horticultural activities might decrease. In Year 3, the participants continued the activities as they had in Year 2 with no novelty stimuli. However, the fact that there was no significant difference between Year 2 and Year 3 of the participants' conditions, it might be considered the effect of the intervention.

Unlike the above categories, "emotional responses" were significantly less prevalent in Year 2 than in Year 1. This finding is consistent with the literature [6), 8), 10), 12), 19)], which suggests that horticultural activities have a psychologically calming effect on older adults with dementia. We considered that the fact that the subject became familiar with the face and established a relationship with another participants from the behaviors of daily life and horticultural activities situations were thought to have influenced. In addition, Nagakura et al.[20] reported that the introduction of small group activities changed the emotional stability and behavior of subjects, so that we surmised results in this study might have been promoted by group activities, too.

Thus, we conjectured the increasing of "common forgetfulness", "loss of interest in living" and "amnesic symptoms" proceed with aging. Also, the unfavorable situation in these categories might be brought by a decrease in novelty stimuli too. So, we considered that these three categories' situation might be able to improve by incorporating novelty stimuli. On the other hands, the improvement over time in "emotional responses" implies that this category was brought by the participants' development of a rapport with each other over time.

### 2. Limitations and ongoing issues

This study longitudinally assessed the impact of horticultural activity on behaviors symptomatic of dementia; however, the sample size, at eight

participants, was too small to generalize the findings. Moreover, this study did not use general cognitive function scales such as MMSE, so it is difficult to compare cognitive function with anyone else. We also used a community-dwelling sample and they also participated another activities in facility. These making it difficult to isolate the effects of the horticultural activities. Additionally, the responses for the category "difficulties in daily life" could not be fully analyzed owing to the large amount of missing values, which suggested that the assessor felt unable to answer many of the items. To address these limitations, the questionnaire should be made more comprehensible to facility staff. The sample size will also need to be increased.

However our findings highlighted an important issue: in the long-term horticultural activities are effective in reducing emotional responses, on the other hand, the novelty of social and horticultural activities may decrease. Further research is required to address this issue. Specifically, we need to reconsider horticultural programs that can bring the stability and novelty of participants in a more balanced way. For example, we considered that it might be effective to maintain novelty by interrupting horticultural activities during the winter and doing other indoor activities such as making crafts (e.g., flower vase).

## Conclusion

We organized horticultural activities for community-dwelling cognitively impaired users of an older facility, and tracked the effects of this intervention over a three-year period. The following changes were observed over this period:

1) Other than "difficulties in daily life", the behaviors symptomatic of dementia showed significant changes between Years 1 and 2 and between Years 1 and 3, but not between Years 2 and 3.
2) "Amnesic symptoms", "loss of interest in living", and "common forgetfulness" were significantly more prevalent in Years 2 and 3 than they were in Year 1.
3) "Emotional responses", on the other hand, were significantly less prevalent in Years 2 and 3 than they were in Year 1.

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