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Use of Agricultural Machinery and Equipment in Non-professional Vegetable Gardens

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Abstract. Home vegetable gardens can be found in or near villages, or on fenced land bordering courtyards. Fifteen percent of these have an area of 50 square metres or less and are used solely for the family's needs and cultivated with hand tools only. Another 40% reach 1,000 square metres in size, and are organised to produce not only vegetables, but also fruit, livestock and woods. There are about 20 million people working in vegetable gardens across Italy, of whom five hundred thousand are in Friuli-Venezia Giulia, contributing great economic and social value. A great deal of machinery of all kinds is used in these home gardens, as well as equipment for processing and preserving vegetables. It should be noted that sales of home gardening machinery increased significantly in recent years around the time of the COVID-19 pandemic; the items sold included chainsaws, blowers, motorised hoes, brush cutters, and others. One of the problems faced with this situation, is the safe and competent use of this machinery. As it does not have to be registered with any authority, no training is given in its use and no one checks whether Personal Protective Equipment (PPE) is being used. These problems are highlighted by the unusually high number of accidents that occurred in FVG (94 deaths and 71 injuries) in the period 2003 to 2024, although it is difficult to directly link these numbers to work in the vegetable gardens as they are generally recorded as domestic accidents.

Key words. Non-professional vegetable gardens, health and gardens, safety and gardens, agricultural accidents, training on agricultural machinery, personal protective equipment, accidents.

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1. Introduction. The kitchen garden, as a structure for producing food for the family's needs, had its origins in urban settings, convents and castles; in the case of Friuli, they were located close to the house or between it and cultivated fields.

As the name suggests, it was a variously-sized green area, usually surrounded by a protective structure (wall, hedge, fence), where people, farmers and friars grew edible plants and fruit trees to obtain fresh and preserved produce, medicines, etc.

Vegetable gardens, to this day, have developed in various forms: urban, peri-urban or agricultural; mixed (half garden, half vegetable garden); created on terraces; equipped with variously-sized greenhouses; with a portion planted with woods; with hedges; or even organised in a combination of all these forms.

The structure of these gardens, their location and the protection adopted have become an integral part of the Friulian landscape.

In Italy, too, the passion for cultivating a vegetable garden is widespread, and it is estimated that at least 20 million people of different genders, ages and social background devote themselves to the activity across a total cultivated area of around 30,000 ha, compared to 385,000 ha dedicated to the cultivation of professional vegetable gardens.

Friuli-Venezia Giulia (henceforth, FVG) is certainly no exception, and research carried out by the IRTEF[1] (Simeoni 2010, IRTEF 2015), shows that this activity represents a not insignificant economic and social value; in fact, according to these studies (Longo 2015), there are more than 240,000 vegetable gardens cultivated in FVG.

Taking this IRTEF research (Simeoni 2010 and 2016, IRTEF 2015) further and processing the data obtained, it was seen that at least 15% of these vegetable gardens have a surface area of 50 square metres or less, with production aimed solely at family consumption (self-consumption); they nonetheless manage to cover the vegetable and other fruit and vegetable product needs for the summer period, while using solely manual tools (shovels, hoes, rakes, etc.) to work the garden. Another 40% of vegetable gardens are partially cultivated as gardens and have a surface area of up to 1,000 square metres, thus constituting a highly structured reality, destined not only for the production of vegetables, but also the production of fruit and timber, and the raising of breeding animals (typically hens and chickens).

Another 15% of vegetable gardens are up to one hectare in size and a further 30% include vegetable gardens larger than one hectare and including wooded areas. In other words, 54% of those we have termed non-professional vegetable gardens (from now on NPGs) are large

[1] Istituto per la Ricerca sulle Tecniche Educative e Formative (Institute for Research on Educational and Training Techniques).

enough to allow the processing of any crop with a wide range of both equipment and, above all, machinery for agronomic processing.

Alongside these processing operations, there are also all those operations that involve processing the harvested products (fresh produce, selections for the preparation of preserves, pickles, jams, etc.). The result of all these activities impacts the territory and is of significant importance in economic, food and, not least, landscape terms.

As far as machinery use is concerned, to get a true measurement of the population's actual involvement, the data show that during the COVID-19 years, the gardening machinery and equipment sector experienced a considerable increase in the overall number of units, with tools such as chainsaws, blowers/vacuums, motorised hoes and robotic lawnmowers among the most important equipment. In 2023, the entire market declined by about 20% after several years of continuously increasing sales, indicating a substantial saturation of the segment (Comagarden 2022, Lo Savio 2024).

Delving further into the machinery sector, we see that 50% of NPG owners use motorised cultivators or electric cultivators to work the soil, thus reducing the effort of performing this task with a hoe or shovel. Considering how arduous this type of work is when cultivating even a few square metres, one can imagine the extreme physical effort any tilling operation requires on a plot that exceeds 100 square metres. The results obtained are often also worse than those achieved using a cultivator with a plough. The same study showed that a plough is used in only 10% of cases, while a hoe or cultivator is used more often. In fact, if the use of a plough could be somehow replaced by a shovel, breaking up the soil (usually done with a rake or hoe) could be far more easily done mechanically, even though doing it this way may encourage the spread of weeds.

If we look at the sales figures, a large slice of the market is also represented by machinery for the management and care of green areas. IRTEF data (Simeoni 2010 and 2016, IRTEF 2015 show that in 45% of vegetable gardens, there is a motorised brush cutter (electric or endothermic) and in 30% of them also a chainsaw. On the one hand, this latter fact is also confirmed by the presence, in half of the gardens, of fruit trees, hedges or woodland, which are difficult to maintain with just hand tools and, therefore, require specific machinery. On the other hand, the alternative to the motorised brush cutter is the scythe, which is a difficult tool to use and even more difficult to keep sharp.

Demonstrating that vegetable gardens are not just places where vegetable products are produced, but part of larger green areas, there is a substantial presence of manually-guided and robotic lawn mowers. In recent years, in fact, there has been a strong growth in sales of robotic lawnmowers, even though the market is now partly saturated as can be

Table 1. Market trends in horticultural and garden machinery.

Machinery	*Trends 2024 (%)*
Manual pruning shears and scissors	(+) 62.0
Ride-on mower (Ride-on MMV)	(+) 32.8
Atomisers	(+) 30.3
Tractors	(+) 13.5
Electric hedge trimmers	(+) 11.7
Hedge trimmers	(+) 9.7
Zero Turn MMV lawn tractor	(+) 8.2
Lawnmower (mulcher)	(+) 7.8
Manual mower (push)	(+) 7.0
Brush cutter	(+) 5.6
Garden harrow (soil scraper)	(+) 4.5
Blower	(+) 4.3
Lawn tractor (ride-on consumer)	(+) 3.4
Motorised hoes	(+) 2.2
Electric pruners	(+) 0.3
Robotic lawnmower	(-) 0.1
Zero Turn consumer lawn tractor	(-) 9.9
Chainsaws	(-) 22.5
Electric lawn scissors	(-) 42.9
Snowploughs	(-) 95.2

seen in Table 1; this concurs with the fact that up to 65% of respondents own a lawnmower (of various types) and the figure makes sense if we consider that, according to IRTEF data (Simeoni 2010 and 2016; IRTEF 2015), 45% of all vegetable gardens have a surface area greater than 1,000 square metres. In Table 1 we can also see which machinery and equipment were most in demand in 2024 in Italy, and that people continue to purchase a large amount of machinery of all kinds. We can also see the effect of climate change, perceptible by the near disappearance of snowploughs (Table 1).

All these machines (Table 1) for the care of gardens and vegetable gardens indicate that owners are not only interested in food production, but are also sensitive to the aesthetics of the landscape and the environment, as they use the grass cuttings either by leaving them, shredded, on the lawn itself or as an ingredient in compost.

In addition to productive aspects, vegetable gardens are also linked to social, educational and therapeutic aspects (Tei, Gianquinto 2010). This was extremely evident during the COVID-19 lockdown, when people were locked in their homes and the vegetable garden became an open-air refuge in which to move, work and escape the four walls of the house.

There even exists 'horticultural therapy' which uses horticulture as a therapeutic aid in the physical and mental rehabilitation of people with disabilities or various forms of social hardship (Matsuo 2008). Although horticultural therapy now has its own specific dimension, it is not an entirely new therapeutic approach. In Gemona, the case of the 'Sofia Pecol' colony is well known (its land extended over 12 hectares and it was equipped with stables, barns and other buildings) where, from 1930 until 1976 (the year of the earthquake in Friuli), the then-called 'madwomen' (who would today be more properly defined as mentally ill or mentally disabled), hospitalised in the San Michele psychiatric hospital, worked in the gardens producing food that was then used in the hospital kitchens.

In recent times, urban gardens and vegetable gardens, intended for the elderly or pensioners as a form of green therapy, have also been included in statistical surveys; they are included among the gardens and vegetable gardens surveyed by Italy's main statistical body, the National Institute of Statistics (ISTAT), which includes them under the heading 'Family Gardens' (La Malfa 1997), along with areas that are part of agricultural properties, but used for the production of vegetables for direct consumption by the farming family. In most cases (64%), urban gardens have a surface area of between 30 and 70 square metres, but administrations that allocate areas of more than 100 square metres are not rare (12%). These include, for example, Trieste (500 square metres), Naples (400 square metres), Perugia (150 square metres) and more than 10 municipalities in Emilia-Romagna (Tei 1997).

Another problem with NPGs is the lack of data on safety when using the many types of equipment, which are often not simple in their operation. However, reference data can be found on professional gardens – which, from a machinery and equipment perspective, differ very little from NPGs – at INAIL[2].

The key problem with using machinery, are the very poor safety conditions of most of the agricultural machinery examined, either because they were not equipped with guards or other safety devices, or because they were not properly maintained or were very old. The latter is a frequent case in all NPGs because the machinery, being used infrequently and for a short period, has a long service life, during which it is technically superseded by new machinery.

[2] National Institute for Insurance against Accidents at Work.

Research has also shown that most agricultural operators are unaware of the risks associated with the use of machinery and are unwilling to apply the safety regulations in force (Balloni et al. 2008).

A further complication in delineating the health safety situation relates to manual operations; these often predominate in NPG, both with regard to soil operations (spading, levelling, etc.) and harvesting operations, which, in most cases, are performed with incorrect worker postures, causing problems for the back, joints, etc.

The problems encountered by the researchers were manifold, particularly those related to the cultivation and harvesting of grapes (in many NPGs, vines are also grown). The most at-risk profiles, in fact, include those employed in the cultivation/management of vineyards and in grape harvesting: a substantial portion of their work involves a lifting index (LI, as defined by Italian law, with Legislative Decree 81/2008) greater than 1.25 (irregular, repeated lifting over time), see Cividino et al. (2010).

Occupational diseases related to working in gardens and vegetable gardens (both non-professional and professional) are also caused by the chemicals used to control the proliferation of weeds or kill insects, and include malignant skin tumours (Campo et al. 2021). This danger also emerged in research conducted in Argentina, where, among other things, laws on poisonous substances differ from those in Europe. The investigation showed that 52% of accidents were caused by poisoning by the poisonous substances used in agriculture. Moreover, the accidents involved multiple parts of the body, making hospitalisation necessary in 19% of cases. Regarding the use of agricultural substances, 35% of the respondents (IRTEF 2015) received technical advice again, while the others turned mainly to suppliers. Only 20% of the respondents used complete and effective personal protective equipment (PPE), while 35% of the respondents stated that they did not use it at all (Paunero et al. 2009).

The aim of the research, therefore, is to present the results of a survey conducted among those working in NPGs, looking at injuries, accidents or illnesses, and to consolidate the problems related to working in NPGs, which are generally not recognised or are categorised as domestic accidents or general illnesses.

2. Methodology. More than a thousand questionnaires were completed in FVG to analyse the typical size and possible use of machinery and equipment in NPGs in the region. The survey was conducted in 2015-2016 by IRTEF in collaboration with the University of Udine, which was specifically involved in the part related to the mechanisation of vegetable garden activities. The questionnaires were administered by telephone by trained personnel, and involved people who owned vegetable gardens throughout the FVG region.

In order to analyse the injuries or accidents and trace them, fully or partially, back to the NPG activity, all accidents reported in the newspapers published in FVG in the twenty-year period 2003-2024 were catalogued, classifying them according to the same categories of occurrence used by INAIL: cause, place of occurrence, etc.

A total of 166 cases were analysed; this is not a very large number, since it refers only to cases of death or serious hospitalisation, i.e. those normally found in newspaper reports. It is clear that not all the data collected referred to work in NPGs, since many accidents involved people who run farms (Fig. 1).

Moreover, as already mentioned, most of the accidents reported were serious or fatal; this is also because minor accidents are usually only recorded in the emergency room as 'domestic accidents', and minor injuries occurring in the home are of no interest to newspapers.

In order to be able to properly relate the accidents and the machinery used, a classification of the equipment used in the gardens was then carried out (Fig. 2).

3. Results. The first important result of the initial data processing phase, was the assessment of the number and type of machinery used in NPGs. Table 2 shows the incidence percentages of the different types of tools in NPGs. Many small machines and equipment are listed, but what is immediately apparent is the presence of several machines that are known to be dangerous to use and which would require qualified personnel to operate them properly. In fact, it is estimated that there are more than 60,000 chainsaws and at least 100,000 motorised cultivators, i.e. machines equipped with an internal combustion engine that can be connected to various types of equipment such as reciprocating mowers, rotary mowers, hoes, and so on.

The questionnaire data also showed that, for 59.9% of machinery owners, the maintenance carried out by operators on their equipment amounted to less than 5 hours/year, which suggests that they are not always in optimal condition and, therefore, at greater risk of causing an accident. Furthermore, some of these machines – such as chainsaws or sprayers – require specific training in order to be used correctly; this is mandatory in professional companies and, consequently, results in fewer accidents or poisonings. Since NPGs are not registered as companies for tax purposes (in particular for the management of VAT, value added tax) – given that they are not farms but are seen as activities carried out by private individuals – they are not obliged to either train workers (in particular with regard to the use of tractors and chainsaws) or conduct periodic machinery inspections, such as the control functions of sprayers. In fact, it is not mandatory for NPG owners to register the presence of any of this equipment with any office or public body.

The data drawn from the questionnaires show that there is a substantial presence in NPGs of trees

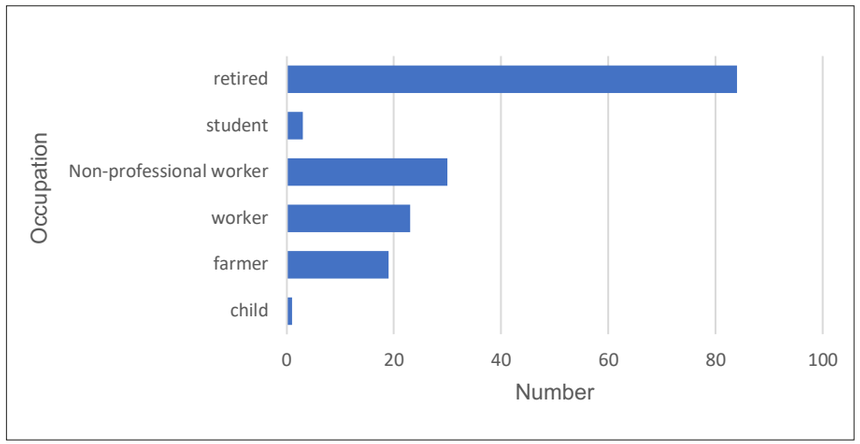

Figure 1. Number of persons injured recorded by type of occupation.

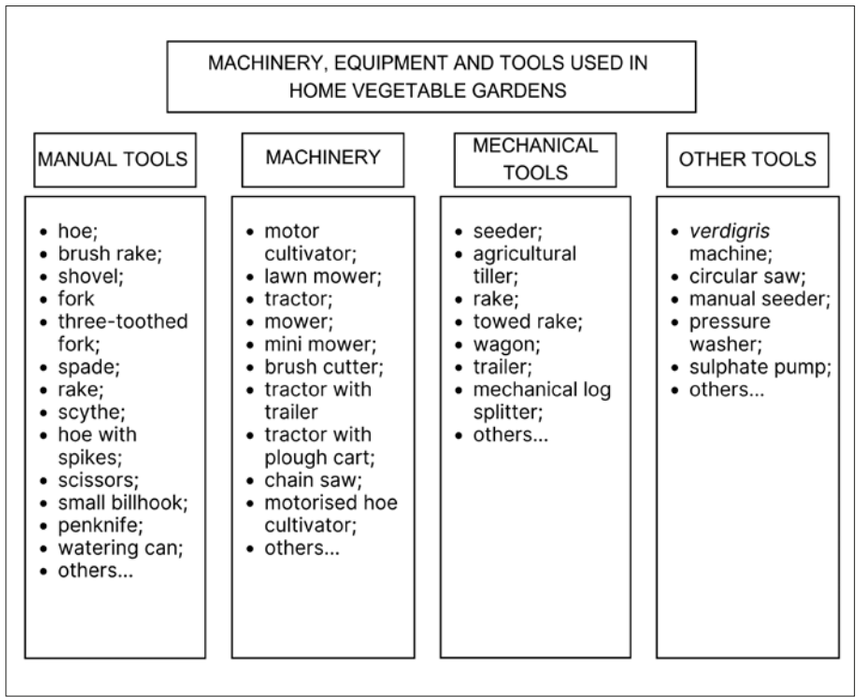

Figure 2. Classification of equipment, tools and machinery used in NPGs.

Table 2. Percentage of agricultural tools and machinery used in non-professional vegetable gardens in Friuli Venezia Giulia and the estimated number present.

Agricultural machinery/tools	*Percentage of use (%)*	*Estimated number of agricultural machinery present*
Manual tools only	45.5	-
Machinery and other powered tools	54.4	110,000-130,000
Plough	9.5	20,000-25,000
Brush cutter	43.6	80
Agricultural milling machine/ Milling machine	17.7	100,000-110,000
Motorised cultivator	50.5	120,000-130,000
Mower	4.4	10,000-12,000
Chainsaw	28.5	60,000-70,000
Wagon / Trailer	6.4	15,000-20,000
Seeder	1.1	2,000-3,000
Log splitters	9.9	20,000-25,000
Sulphate machine	2.7	5,000-7,000
How many tools loaned	10.2	> 25,000
Less than 5 hours of machinery maintenance	32.6	> 80,000
Tools or machinery used only in own garden	85.7	-
Tools or machinery used only in one plot of land	87.6	-

– both fruit trees (cherry trees, peach trees, apple trees, plum trees, etc.) and firewood trees – and this is consistent with the considerable presence of chainsaws, mechanical log splitters and auxiliary tools (cleavers, axes, ladders, and so on). Moreover, if – when comparing the data – one considers the most frequent accidents, this is reflected in the considerable number of falls from heights. In fact, activities related to tree pruning, wood cutting or even fruit picking (apple trees, for example) – if carried out inappropriately, such as using an old ladder without protection, or with inadequate equipment – can be extremely dangerous due to the likelihood of falls and possible injuries caused by cutting tools.

In Figure 3 it can, in fact, be observed that many accidents occur while workers are carrying out work on trees, such as pruning or harvesting, or even during the cutting phase in the case of collecting firewood.

Many accidents can also occur during road transport, mainly because the vehicles used are often old and not always equipped with protective devices, and the drivers themselves

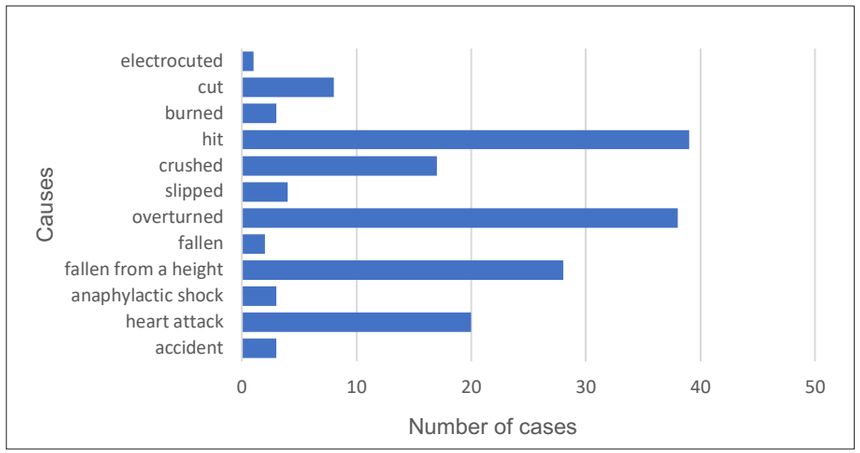

Figure 3. Accidents reported in daily newspapers published in FVG between 2003 and 2024. This graph clearly shows the four most frequent types of accidents.

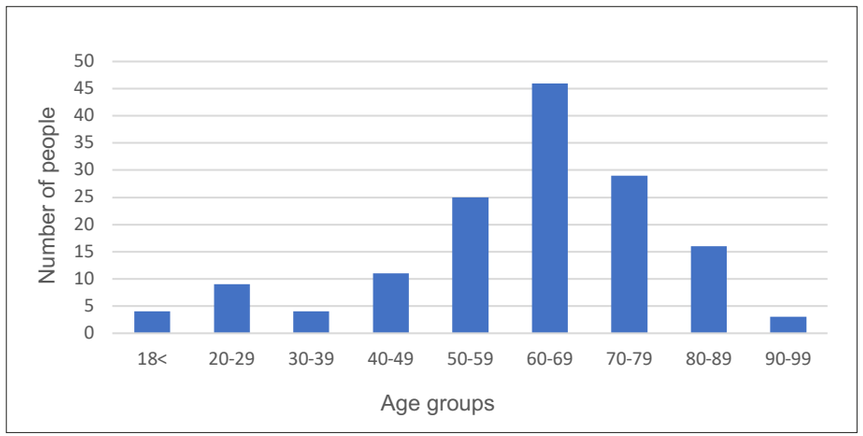

Figure 4. Average age at the time of the incidents, as reported in local newspapers (reference period: 2003-2024).

are often very old and therefore slow to react. In fact, the accidents recorded in local newspapers showed an average age of 60 to 69 years, with a maximum recorded age of 95 years and a minimum age of 5 years (Fig. 4). We also see a consistent increase in this type of accident over the age of

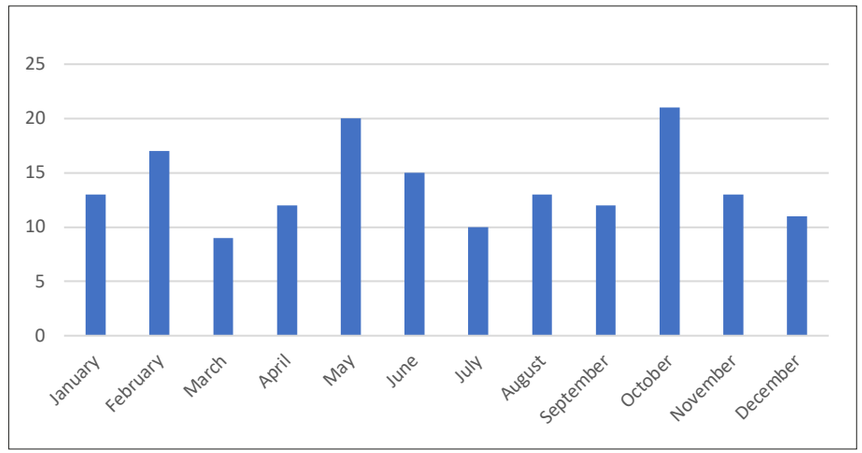

Figure 5. Number of accidents per month reported in newspaper articles published in FVG (2003-2024).

50, which means that, if not all, at least a large number of people over the age of fifty work in the garden.

This, in part, explains why the total number of accidents resulted in 94 deaths and 71 injuries, all of them male.

In none of these incidents were women involved, which can mean many things: that men are often less alert to dangers or believe that they still have the same strength and agility they had when younger, or that they feel they are the only ones capable of using certain machines and doing certain jobs, such as chopping wood, pruning, and repairing the house (roofs, electrical installations and so on).

As can be seen in Figure 5, accidents occur mainly during the timber cutting and pruning season (February), in the month when most work is needed in the garden or vegetable garden (May) and in October, harvest time.

There appears to be no particular time at which the accidents occurred, with the time of occurrence varying throughout the day (Fig. 6).

As far as primary causes are concerned, there are three main agents (representing more than 70% of recorded cases) that determine an accident (Fig. 7): (1) tractors and machines (more than 30%); (2) falls from trees or injuries resulting from collisions with branches or pieces of wood (just under 20%); or (3) natural causes (excessive strain).

The natural causes are mainly due to the already mentioned high average age of the operators, while tree-related accidents are linked to tree pruning and felling activities, which are often carried out with ladders or machinery

Figure 6. Time of day when accidents occur, as reported in the chronicles published in newspapers in FVG (period 2003-2024).

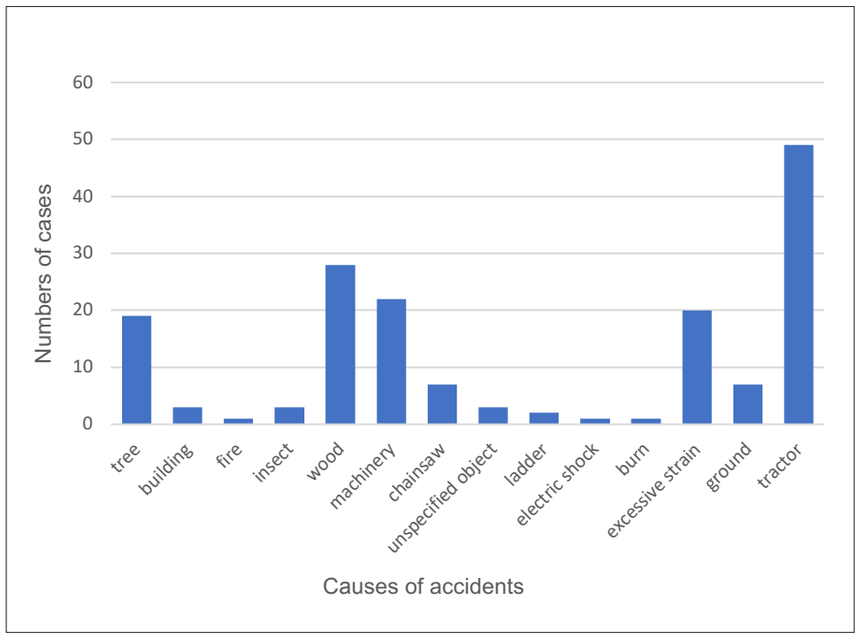

Figure 7. Causes of accidents in FVG as taken from the local newspaper survey of 2003-2024.

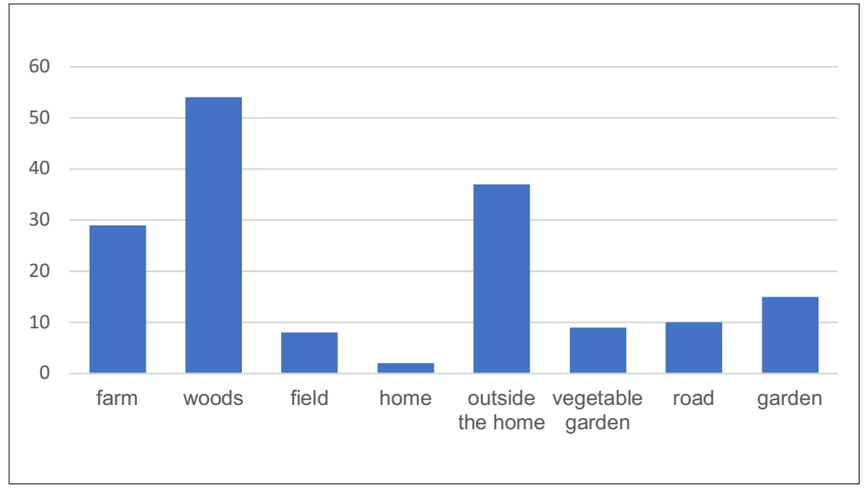

Figure 8. Accident locations.

(e.g. chainsaws) that are not always well maintained or lack protection. Virtually no workers use a ladder with protection, as required by safety regulations, in the vegetable garden, even when working at a height of more than two metres. Accidents involving tractors and machinery are often caused by the aforementioned age, poor maintenance and, above all, fragmentary use of the equipment itself. This prevents sufficient familiarity with the machinery, which is exacerbated by the lack of specific training before use. Two other causes of accidents, rarely encountered in the professional world, but fairly typical of domestic or non-professional contexts, are: (1) the lighting of fires in piles of residual pruning materials, often carried out with petrol, alcohol or other dangerous products; (2) electrocution caused by power tools; (3) and falls from heights from a house or building.

Another final cause of accidents, common to all agricultural workers, is insects; their stings can cause anaphylactic shock, which often proves fatal.

Figure 8 shows that the vast majority of accidents occur in the woods or outdoors during the transport phase (tractor overturning).

A final comparison can be made between the above scenario of accidents in NPGs and the accidents occurring on farms in FVG since the early 1900s (Fig. 8). Farms during the period 1900 to 1970, showed a situation very similar to that of today's NPGs; indeed, many manual tools were used in a non-professional mechanisation scenario. In the graph shown in Figure 9, it can be seen that, here too, more than half of the

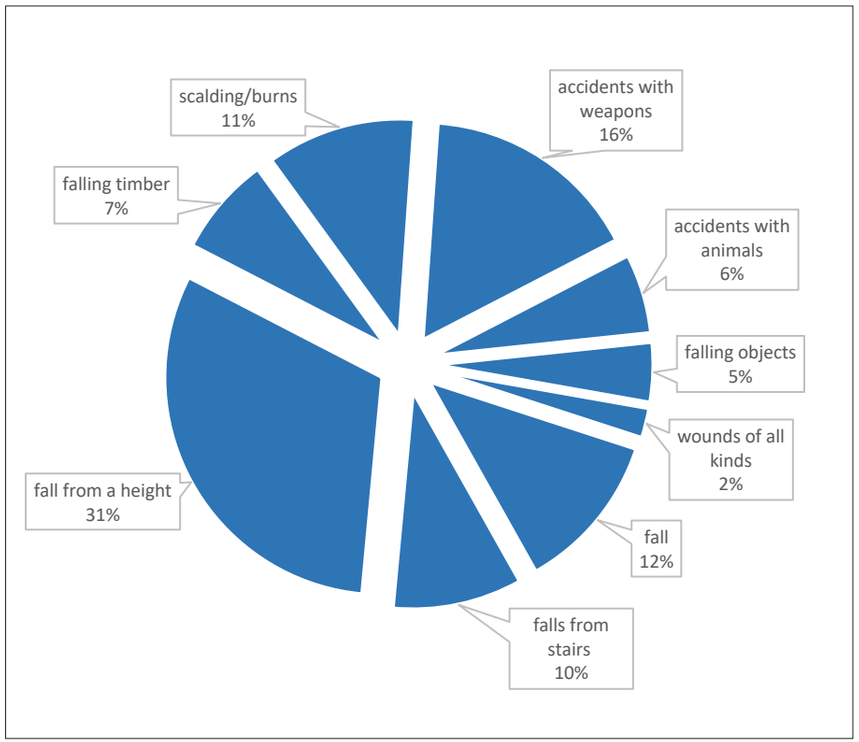

Figure 9. Causes of accidents on small farms in FVG in the period 1900-1970.

accidents were caused by falls from a height and there were also accidents caused by fires, a type of accident that has now practically disappeared in contemporary professional agriculture.

4. Conclusions. The number of people working in non-professional vegetable gardens in Italy is in the tens of millions, as shown both by the questionnaires completed in the FVG region and by data from other sources. Coldiretti, the Italian Confederation of Independent Farmers, indicates a number close to twenty million, demonstrating that NPGs are an important part of Italian popular culture. Moreover, these numbers are unlikely to decrease. Not only are urban gardens on the rise, but NPGs are also seen as a means of implementing Horticultural Therapy, where they are seen as a peaceful refuge for the physical rehabilitation and social reintegration of disabled or mentally ill people.

That people perceive the vegetable garden or green space as an opportunity

for well-being was evident during COVID-19, a period in which there was a sharp increase in the incidence of vegetable gardens.

While a vast number of manual tools are used in vegetable gardens, the amount of machinery, of all types, used, is in the order of several million. The numbers involved are certainly smaller than in the professional agricultural context, but they are still very important.

The training of NPG operators is less thorough and, in general, does not include the conditions of use of equipment, especially for those machines that can be dangerous if used incorrectly, such as chainsaws, rotary hoes and mechanical log splitters. In this context, there are few references to accidents and even more so to occupational diseases; this is because – apart from the very serious cases reported in the newspapers and on the news – there is no form of monitoring, and it was for this reason that we embarked on this research.

This work has highlighted the high number of accidents involving mainly the use of machinery by people over 50 years of age, predominantly pensioners, working in non-professional gardens.

It would therefore be desirable for the authorities in the future to pay more attention to the sale of dangerous machinery, especially chainsaws and motorised cultivators, to people who are not trained in their safe use or who are elderly.

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