

## **Ergonomics in agriculture: An Approach in Prevention of Work-related Musculoskeletal Disorders (WMSDs)**

**Hassan Sadeghi Naeini<sup>1</sup>, Karmegam Karupiah<sup>2</sup>, Shamsul Bahri Tamrin<sup>2</sup>  
and Koustuv Dalal<sup>3</sup>**

### **Abstract**

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A review of articles was performed by categorizing the selected articles into four approaches – ergonomic design, ergonomics task analysis, educational and epidemiological concepts – in order to highlight the ergonomic problems in the agriculture industry. The articles were retrieved from four search engines “PubMed, Scopus, Metapren, and Ebsco” by using specified key words ‘ergonomics’, ‘agricultural workers’, and ‘awkward posture’. The results highlight that ergonomists are capable of providing a safer work environment for the agricultural workers in both developing and developed countries. In addition, the results show that it needs global cooperation of international organizations to enhance the occupational health intervention in agriculture. Furthermore, the efforts of ergonomists to develop a practical ergonomic task analysis for the interventions in agriculture seem significant, as is the necessity for hand tool designs based on ergonomic considerations. Based on the evaluation of articles and related experiences, a recommended model has been introduced to promote health for farmers. This model covers a participatory ergonomic approach to practical ergonomic changes.

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**Keywords:** ergonomics, agriculture, WMSDs, task analysis, hand tool design

### **1. Introduction**

According to the International Labor Organization (ILO), around 160 million work-related illnesses per year occur around the world, in which work-related musculoskeletal disorders (WMSDs) have a prominent role in terms of occupational health and also economics (Niu, 2010).

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<sup>1</sup> PhD, Industrial Design Department, School of Architecture, Iran University of Science & Technology (IUST), Tehran, Iran. Email: [naeini@iust.ac.ir](mailto:naeini@iust.ac.ir).

<sup>2</sup> PhD, Department of environmental and occupational health, Faculty of medicine & health sciences, Universiti Putra, Malaysia.

<sup>3</sup> PhD, Centre for Injury Prevention and Safety Promotion, School of Health and Medical Sciences, Örebro University, Örebro, Sweden.

One of the working activities that threaten the workers by related risks is agricultural work. The agricultural sector is acknowledged to be one of the most important sectors worldwide, not only in terms of supplying food but also in terms of the number of employees.

Agriculture is regarded as one of the most unsafe sectors in both the developing and the developed worlds. Therefore, it is attracting increased attention concerning the application of practical actions in agricultural settings to help reduce work-related accidents and illness.

## **2. Working in Agriculture**

According to the ILO, agriculture is defined as:

“Agricultural and forestry activities carried out in agricultural undertakings including crop production, forestry activities, animal husbandry and insect raising, the primary processing of agricultural and animal products by or on behalf of the operator of the undertaking as well as the use and maintenance of machinery, equipment, appliances, tools, and agricultural installations, including any process, storage, operation or transportation in an agricultural undertaking, which are directly related to agricultural production” (Hurst & Kirby, 2004).

Generally, agricultural activities, which range from the plantation and harvesting by manual tools to the usage of tractors and other mechanized equipment, create some musculoskeletal risk factors, which result in various sprains, strains and back problems (Villarejo & Baron, 1999).

## **3. Ergonomics and Agriculture**

Ergonomics is a multidisciplinary science that endeavors to make a better fitting between the job and the worker to make them safe..

Some branches of ergonomics are defined as “micro-ergonomics”, macro-ergonomics, cognitive ergonomics, and environmental ergonomics”; however, micro-ergonomics is acknowledged to be the main problem among farmers.

It emphasizes on designing and arranging things so that workers can use them easily and safely

Some ergonomic problems are farmers' awkward postures and work-related musculoskeletal disorders, hand tools, work-rest schedule and also training of workers, should be done.

Work-related disorders, especially low back pain and musculoskeletal problems are prevalent among farmers (Richardsona. et al. 2005). Through ergonomic assessment and related interventions not only the WMSDs risk factors will be explored but also some practical ways for the prevention of awkward postures are introduced. In this study, the mentioned field was focused upon and some related papers have been selected for review.

According to WHO (1985), there are some factors that create or aggravate work-related disorders, such as work demands, social and cultural factors, work place characteristics, and environmental factors. In this respect, as ergonomics covers all of the mentioned farms, it has an important role in occupational health. In addition, WMSDs as one of the main ergonomic concerns, are known to be a common problem for the majority of female workers (NIOSH, 1995; OSHA, 2000; Parimalam, Kamalamma, & Ganguli, 2005). Otherwise, in most working cases in agriculture, some sort of musculoskeletal problem occurs according to the physical demands on the body, awkward postures, prolonged standing and kneeling, stooping, bending, and repetitive muscle activities. Assuredly, these postures will result in fatigue, illness, and accidents. In addition, the inadequate knowledge of workers about agricultural health and safety leads to the most life threatening situations.

Scientific reports and published papers confirm the significance of work-related diseases in agriculture. Therefore, to providing better conditions – especially ergonomic considerations for the related workers is required.

Furthermore, the incidence of low back pain (LBP) and upper limb injuries among farmers are more than average (Osorio, 2998; Runyan, 1993).

Hildebrandt (1995) assessed musculoskeletal disorders and workload among a sample of 2,580 agricultural workers and employers using a questionnaire.

This study showed that the LBP prevalence rate was 51% among employees and 47% among employers, neck disorders were also 35% among employees, and 30% among employers .

#### **4. Rational of Study**

According to the International Labor Organization (ILO) around 2.3 million workers die per year because of occupational accidents and work-related diseases, also, every year, about 337 million occupational accidents and 160 million work related illnesses occur around the world (Niu, 2010).

More than one million workers suffer some kind of injury every year in which over exertion, awkward postures, and repetitive motion are the primary causes. In this respect, agriculture is acknowledged to be a high risk job and includes many sorts of occupational risk factors that threaten farmers (Mazza, Lee, Gunderson, & Stueland, 1997). Static postures, manual lifting and carrying, awkward postures during the job are some samples of the risk factors that might result in musculoskeletal illnesses (Meyers, et al, 2001; Nonnenmann, et al. 2010). In addition, these injuries lead to loss of time and money.

During agricultural-based activities, most farmers are exposed to several kinds of occupational hazards, such as ergonomic problems, awkward postures, handling of materials, and exposure to chemical and even biological agents. In addition, farm machinery, is a major cause of accidents and contribute to around half of the agricultural based deaths (DeRoo, Lisa , & Rautiainen, 2000). Undoubtedly occupational diseases and accidents cause a considerable burden to the industrial sector in terms of economic aspects. According to the European Commission report (2004) the cost of work-related accidents among 15 European countries (in year 2000) amounted to 55 billion Euros.

In addition, some of the agricultural activities are done by vulnerable groups comprising children and women. About 218 million children around the world are hired for hard working activities, and these conditions have a negative effect in terms of child development, education, health and wellbeing. Also, about 70% of the children hired work in agriculture (Hurst, 2007).

In addition, as aforementioned, children and women do some parts of the work. About 126 million children aged 5-17 work in varying activities including agriculture, and, consequently, are exposed to accidents and hazardous conditions that might result in severe injuries and even death. According to the CDC, in 2009, about 16,100 children and adolescents in the USA were injured on farms. Also, around two million youth work on farms in the United States facing some risk from WMSDs (Myers, & Hendricks, 2001). The rate of fatality and work related accidents in the agricultural sector is high (Hurst, 2007).

Agricultural jobs and related activities threaten the health of farmers, hence, safety and health sciences, such as ergonomics, play an important role in health promotion and injury prevention. Ergonomics, as a multidisciplinary science, is able to improve working conditions, because one of the preliminary objectives in ergonomic assessment is the prevention of work-related musculoskeletal disorders (WMSDs). Moreover, the majority of agricultural duties create some awkward body postures, which should be assessed throughout ergonomic evaluation (Vyas, 2012). Many farm activities are done manually, especially in developing countries. Manual handling is also acknowledged to be one of the main risk factors for musculoskeletal disorders. In this systematic review article, the authors have focused on ergonomic problems in agriculture.

Generally, some agricultural activities are not only hard in terms of physical effort but also prolonged, and workers have to work more than 8 hours per day, especially during the planting and harvesting seasons. During these busy times, workers are busy with their activities from early morning to even dusk without fair or adequate rest. Several scientific reports have confirmed that farmers around the world are facing safety related problems. Some samples of these reports have been considered in this article.

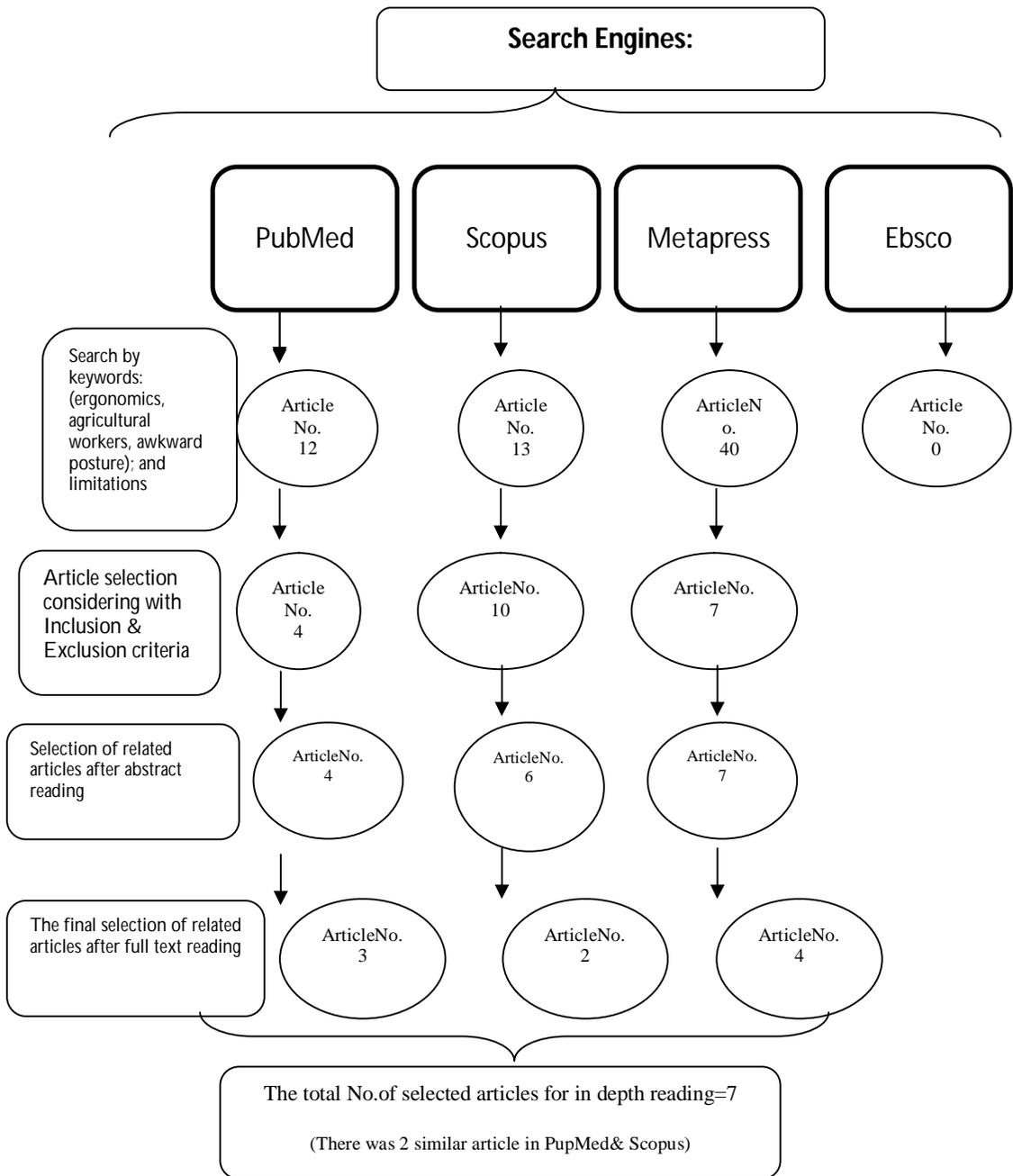
According to the importance of safety and health promotion in agriculture, in this systematic review, we compiled the related scientific reports, and assess them to introduce some recommendations for improving the health conditions of farmers. Furthermore, we defined some concepts for a review of the articles while considering the articles' context and the authors' conclusions. These concepts are education, ergonomic design, epidemiology, and ergonomic task analysis.

## 5. Method

In this research, we focused on agricultural ergonomics. We reviewed the literature on the ergonomics of agricultural activities and related awkward postures. For data gathering, four search engines "PubMed, Scopus, Metapress, and Ebsco" were used. The key words were "ergonomics", "agricultural workers", and "awkward posture". In the first phase, we identified 65 relevant papers by the following limitations: "English language", and "last 10 years".

The following articles were found: 12 in PubMed, 13 in Scopus, 40 in Metapress, and zero in Ebsco. We also had some inclusion and exclusion criteria. In this phase of article screening our inclusion criteria were "Ergonomics, agricultural workers, and occupational health" and the exclusion criteria were "health economics and cost-benefit injury studies, in-vitro research, dairy farm,". According to the mentioned criteria, after the initial screening of relevant titles, 44 articles were excluded. These preliminary selected articles were 4 in PubMed, 10 in Scopus, and 7 articles in Metapress.

Finally, after reading the abstracts, 9 articles were included in our study, however, as two of them were common to both PubMed and Scopus, 7 articles were ready for in depth full text reading. The whole screening and acceptance process is described in Figure (1). Furthermore, according to the context of the articles', we categorized the reviewed ones into four different concepts: Ergonomic design, epidemiology, ergonomic task analysis, and educational concepts.



## 6. Results

The seven selected papers, which have some different research methods and concepts were read, in detail. Table (1) shows the outcomes, methodology, and authors' conclusions in brief. The main results of these papers are as follows:

### a) Alves Costa & Alberto Camarotto, 2012:

In this paper, entitled "An ergonomic approach to citrus harvest Mechanization", the manual and mechanized fruit removing of trees among some farms in the state of Sao Paulo in Brazil were compared. In Brazil, citrus fruit has an important role in marketing and job opportunities so safety and occupational health are very important. In this article, an important dilemma was considered. Indeed, although mechanization in the harvesting process helps to increase productivity, one of the main factors in fruit picking is fruit quality, and it seems that manual fruit picking results in the fruit being in better condition than when mechanization is used. However, the work related musculoskeletal disorders during farms manual activities are costly. Hence, this dilemma should be managed by introducing some supporting mechanical devices to assist the farmers during harvesting, while ensuring and preserving the quality of the fruit removed from the trees. A time study and comparison between manual and semi-mechanized harvesting was done using the stopwatch technique. In-depth observation among six pickers showed that using a platform improved conditions in terms of awkward postures, static postures, and use of grip related muscles. This study also showed that the semi-mechanized harvesting speeded up the activity compared to a manual one.

### b) Vyas, 2012:

Vyas, in her article entitled "Mitigation of musculoskeletal problems and body discomfort of agricultural workers through educational intervention", conducted a study about WMSDs among 120 Indian farmers (60 males and 60 females) and also developed an educational intervention to improve conditions for workers in terms of safety. A body map and Visual Analogue Discomfort 11-point scale (VAD) were used for data gathering. The results showed that all of the respondents had some degree of MSDs, especially in the neck, shoulder, upper arm, and fingers.

The overall discomfort rating (ODR) also showed that the workers reported a higher discomfort rate during activities, such as land preparation, sowing, irrigation, weeding, harvesting and threshing. However, the overall discomfort rating among the females was more than male workers. This study showed that educational intervention improved the workers' knowledge about WMSDs.

c) Bhattacharyya & Chakrabarti, 2012:

Bhattacharyya and Chakrabarti (2012), in their paper entitled "Ergonomic basket design to reduce cumulative trauma disorders in tea leaf plucking operation", showed that tea leaf plucking operation is the main task in tea plantation including some WMSDs risk factors. Their study was done in India among 180 female workers who worked on tea farms. As plucking needs some severe body effort, ergonomics interventions will create safer conditions. In this study, some methods and questionnaires, such as the methods of Occupational Repetitive Assessment (OCRA), Quick Exposure Check (QEC), Heart rate monitoring, NMQ and Rating of Perceived Exertion (RPE), were OCRA outcomes that confirmed the existence of the risk of WMSDs. In this study, and considering the gathered data, a new basket was designed. Two baskets – traditional and new design – were compared during usage in terms of certain physiological indicators, such as heart rate, energy expenditure, and rating of perceived exertion. These indicators showed the effectiveness of the new basket design in terms of work physiology and ergonomics.

d) Eun Shil Cha., et al., 2009:

Cha et al in their study and related article entitled "Prevalence and changes in chronic diseases among South Korean farmers", which was done on a case series study among the registered data of the Korean Ministry of Health and Welfare, assessed the prevalence of chronic diseases among women farmers and compared it to other occupational groups. In this study 39,060 cases were assessed. All of the cases were divided into three occupational groups "self-reported farmers, manual workers, and non-manual workers" according to the classification of Korean standards. This study showed that chronic disease prevalence, especially disc problems and arthritis among the female farmers, was more than for other occupational groups. Visiting doctors by the female workers was also more frequent than for the men.

e) Scott Fulmer et al., 2002:

In this case study, an ergonomic task analysis was conducted among 81 workers in 12 apple orchards in New York and Pennsylvania, by the revised method of Posture-Activities-Tools-Handling (PATH). This study showed that in about 25% of activities during reaching for fruit, body postures were not neutral. Approximately, 53% cases of trunk flexion were in the middle range and in 24% of cases, bending and awkward postures occurred in the trunk, according to the PATH method assessment. This outcome also illustrates the necessity for ergonomic evaluation and intervention for the prevention of MSDs.

f) Susan E. Kotowski et al., 2009:

In the article entitled "Investigation of Select Ergonomic Interventions for Farm Youth. Part 2: Wheelbarrows", they conducted an assessment of work related ergonomic problems, and also showed the significance of ergonomic intervention. In this study, 20 youth, aged 11 to 18 years old (10 girls, 10 boys), who had already worked on farms were assessed. During the study, working on a flat grassy area, four different wheelbarrows were evaluated while trunk flexion and back inclination were also measured. The Borg scale was also used in this study. Furthermore, the level of comfort among the youth during the use of wheelbarrows was assessed. This study confirmed that the new design for a wheelbarrow based on ergonomics changed some awkward postures to neutral ones and also some parts of the body motions during handling the wheelbarrow were modified.

g) Bezerra et al., 2012:

In the article entitled "Manual bamboo cutting tool", they conducted an assessment of worker activities during Bamboo cutting. They also focused on ergonomics and eco-design to develop a useful hand tool.

In this study, a hand tool was designed and developed for workers who are involved in cutting Bamboo.

**Table 1: Systematic Reviews of Selected Seven Articles**

No	Author	Location & Date	Objectives	Method	Findings	Conclusion
1	Scott Fulmer, et al.	<u>USA</u> , New York and Pennsylvania <u>2002</u>	An ergonomic	<ul style="list-style-type: none"> <li>-A descriptive case study among 51 male workers in 8 apple orchards (8 orchards in New York, and 2 in Pennsylvania)</li> <li>- This study was done between September 30 and October 12, 1999</li> <li>- The PATH (Posture-Activities-Tools-Handling ) ergonomics task analysis method was used for related data gathering</li> <li>- The size of the apple trees and distances from the tree to the ladder were estimated.</li> <li>- In some cases the weight of apple bags ( with a bathroom scale) and also the dimensions of tools (by a tape measure) was measured.</li> <li>-Gathered data were evaluated by EpiInfo</li> <li>-Time study by stopwatch</li> </ul>	<ul style="list-style-type: none"> <li>-Awkward postures during apples' picking according to arm reaching and working at above shoulder were detected.</li> <li>-Static activities do some stress on the back according to bending during the apple bags reloading</li> </ul>	<ul style="list-style-type: none"> <li>- There are several risk factors in terms of musculoskeletal disorders among workers in an apple orchard.</li> <li>-For working style improvement some other research considering with force measurements are recommended as future studies.</li> <li>-Some sorts of ergonomic interventions are feasible in apples farms activities for decreasing the muscle disorders, especially for neck and back..</li> <li>- More ergonomic assessment should be done to these workers.</li> <li>-For effective and practical intervention, making a proper communication between researchers and related human power in the apple orchard is necessary.</li> <li>-Increasing the workers' knowledge about work related disorders are so important.</li> </ul>
2	Susan E. Koto-wski MS., et. al.	USA, 2009	To investigate	<ul style="list-style-type: none"> <li>- In this intervention study, the target group was youth among 10 girls and 10 boys (18 yrs) who had some experiences in farm related activities.</li> <li>- For trunk motion evaluation a lumbar motion monitor was used. Also the rate of exertion during pushing, pulling and dumping was determined</li> </ul>	<ul style="list-style-type: none"> <li>- Decreasing in trunk flexion by using a 3-wheels wheelbarrow equipped with a push bar, but not significant impact on back disorders risk. Also in this sample wheelbarrow</li> <li>- A significant difference among 3-wheel wheelbarrow was found</li> </ul>	<ul style="list-style-type: none"> <li>-The alternative wheelbarrow designs reduced motions and also awkward postures on trunk however long term usage should be done for the mentioned positive effect confirmation.</li> <li>- Effect of reduction of LBP risks</li> <li>-Considering the costs in new wheelbarrow design is important</li> </ul>

				-The related measurement was done for four different types of wheelbarrows.	in terms of twist velocity by gender	
3	Eun Shil Cha, et al.	Korean 2009	- Evaluation	This is a case series study in which gathered data of three cross-sectional national survey during were done in 1998, 2001, and 2005 assessed. Besides, the mentioned surveys covered more than 110000 samples	This study showed that in all of three studies chronic disease prevalence among female farmers is more than other workers who are working on another kind of jobs.	As this study also shows that work related the mentioned group. This study shows that chronic diseases (especially for musculoskeletal disorders) among the target group, have a prevalence higher than other population.
4	Bhattach	India, 2012	To study of ergonomics role in improving the working conditions among tea industry employees	In this study , 180 women workers as samples in the age group of 35-50 yrs were selected by a purposive sampling method. The samples were chosen from Jorhat district, Assam, India. The used ergonomics methods were also Strain Index (SI), OCRA, QEC, RPE ,and NMQ. Heart rate and energy consumption were also measured.	This study showed that body postures had some problems in terms of ergonomics and also the QEC scores were 110 (out of 138) for plucking job. Besides, the new design basket, too. There was a promoted condition in terms of WMSDs as well.	- Ergonomics intervention provides the better condition for working activities. - The plucking of tea leaves involved some kinds of awkward postures, so any promotion in productivity and decreasing of MSDs need some effective intervention in terms of ergonomics. by changing the working conditions and tasks methods and related technology. - The productivity will be improved by the proper improved technology, skill labor and efficient managements.
5	Simone Emmanu	Brazil 201	-To evaluate	-Time and motion study by stopwatch and comparison of gathering data among manual and semi-mechanized harvesting during the worker's activities (12 male pickers from state of Piaui in Northeast of Brazil). -Six pickers were filmed, and for each of the methods three counts of the cycle were performed. -Ergonomic Assessment among sampled workers. - Regarding the average times for each crop stage -In-depth observation	-Ergonomics redesigning and improvement among working conditions showed a better workers' performance and productivity, the mentioned intervention was raised by 60% in productivity.	-According to risk factor -Harvesting device redesign -According to changes s

				and assessment all of the process of harvesting		
6	<i>Rekha Vyas, et.al.</i>	India 2012	- To study - To develop	- In this study, 120 workers in two groups of man and woman participated were selected by a simple random sampling method, and the following assessment method was used for data - Body Part Discomfort Score (BPDS) - Body map.	This study showed that agricultural works make some severe musculoskeletal disorders especially in the trunk.	-According to manual and physical work activities of farm workers, musculoskeletal problems are known as one of the main work related diseases among them. - According to gathered data it seems that weeding and handling of heavy loads and prolonged work activities are known as the main risk factors of MSDs. - As in some parts of agricultural works, chemical is used so some safety problems might be occurring, as well.
7	Mariana	2012	-Introducing	-Ergonomic assessment of		Farmers activities related

## 7. Discussion

This review showed that farmers, especially vulnerable groups, face varying work-related musculoskeletal disorders (WMSDs). In addition, ergonomic interventions are an effective way for prevention of the micro-ergonomic work related problems, especially if these ergonomic considerations involve tool design and related educational interventions. Indeed the final result of this review emphasizes the significance of ergonomic intervention through ergonomic hand tool design.

**Agricultural ergonomic problems:** Generally, farming is acknowledged to be a high risk task including several kinds of occupational injuries, especially WMSDs. Assuredly, occupational health studies and ergonomic assessments have a significant effect on the promotion of farmers' health.

The majority of the papers reviewed show the significance of ergonomic assessment and also the necessity for ergonomic interventions through hand tool design. Furthermore, half of the articles reviewed had intervention methodology in which some ergonomic changes and hand tool design were carried out.

In addition, the effectiveness of the aforementioned interventional ergonomic approach has been confirmed not only by farmers who used the newly designed hand tools but also by re-evaluation of the body posture during the activities.

In addition to the selected articles, there are other studies based on ergonomic interventions that confirm the significance of ergonomic design. In a study conducted by Earle-Richardson et al. (2005) among workers in apple orchards, a new hip belt and bag were designed, which were used by the farmers during apple picking. This ergonomic belt not only revised some awkward postures but also some of the workers have been using this new belt design after finishing the study (Giulia et.al. 2005).

According to some important factors in agricultural work, such as economics, culture and also some work related limitations, the ergonomic design of hand tools might be more effective than high-tech tools. As some parts of farms are managed by the farmer's family and low income population, economic designs are important in any health promotion task. These facts also emphasize the significance of ergonomic interventions.

Furthermore, as farmers are threatened by severe WMSDs, ergonomic evaluation and effective intervention are inevitable, not just from the viewpoint of human beings, but also in terms of economics. Therefore, making some changes to the tasks and tools should be done. Ergonomic design in traditional hand tools might be considered as an effective and preliminary step to promote farm tasks and activities. Undoubtedly, these modified tools help to prevent some sorts of musculoskeletal disorder among farmers.

Agricultural ergonomics problems are not limited to developing countries, as there are many musculoskeletal disorders among farmers around the world; for instance, one of the high risk occupations in the USA is farming (Mazza, Lee, Gunderson, & Stueland, 1997). According to a report of the Australian Safety & Compensation Council (2006) musculoskeletal disorders are acknowledged to constitute the main work related injuries in Australia. Furthermore, in several cases, vulnerable groups, such as women and children, are working in agriculture, so the significance of controlling WMSDs is obvious (Australian Safety & compensation council, 2006).

Ergonomic task analysis: Among the reviewed articles, most of the ergonomic task analysis and ergonomic assessment included QEC, OCRA, PATH, and NMQ. Each method mentioned has some limitations and advantages. Hence, for the ergonomic assessment of farmers' activities a new ergonomic approach needs to be developed. Indeed, a new practical ergonomic task analysis method should be introduced to evaluate the body postures of farmers in respect of their trunk, upper and lower extremities, and hands and fingers. In this new developed method, the limitations of current ergonomic methods should promote consideration of specific tasks in agriculture. The method of analysis of the articles, as mentioned above, the main view of gathering the articles for review based on ergonomics in agriculture. Furthermore, we categorized the main approaches of the articles into four approaches of ergonomic design; ergonomic task analysis, educational and epidemiological concepts. As table (2) shows, half of the articles had "Interventional methodology" in which some sort of hand tool had been developed by ergonomic intervention. In addition, according to the post-test and re-evaluation of the newly introduced hand tools, the effectiveness of ergonomic interventions has been confirmed. In four out of seven articles, ergonomic task analysis was done.

Most of the articles emphasized practical survey and ergonomic intervention. This shows that these sorts of study are able to formulate some effective, feasible and efficient changes. In addition, the related epidemiological reports show the necessity for changes in the tasks and equipment in terms of safety and health. Undoubtedly, the farmers would like to have better working conditions in reality, therefore, practical studies, especially in terms of ergonomic interventions create a better situation for them. Finally, according to the different backgrounds and experiences of the authors of this review paper, and in considering the above mentioned approaches and concepts, the necessity for occupational ergonomics needs a revised interventional ergonomics activity. According to FAO (2011), agriculture has a prominent role in economic growth and also in reducing poverty (FAO, 2011).

**Table 2: Articles' Concepts and Methodologies**

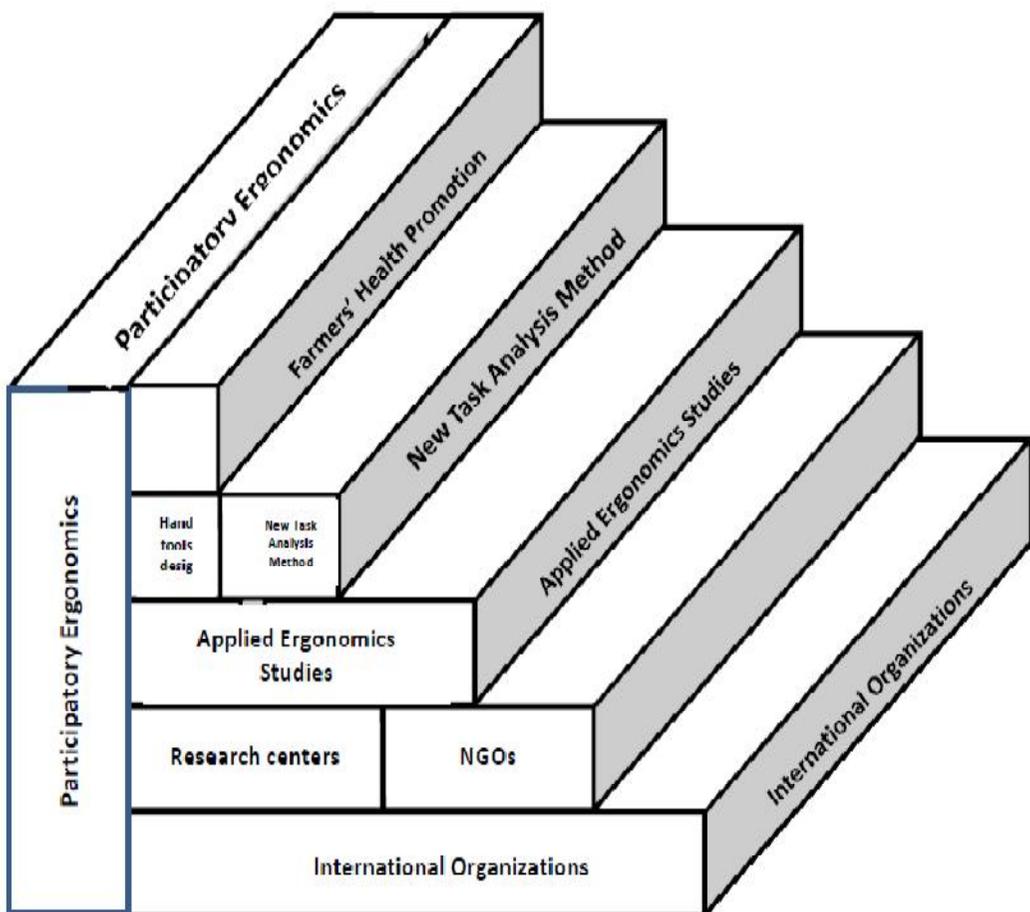
Authors	Country	Research methodology	Approach			
			Ergonomic Design	Ergonomic task analysis	Educational	Epidemiological
Scott Fulmer et al. (2002)	USA	Descriptive		*		
Susan E. Kotowski et al. (2009)	USA	Interventional	*	*		
Eun Shil Cha, et.al(2009)	Korea	Case series				*
Bhattacharya & Chakrabarti (2012)	India	Interventional	*	*		
Simone (2012)	Brazil	Cross-sectional	*	*		
Vyas (2012)	India	Interventional			*	

## 8. Conclusion

Ergonomists are able to develop and introduce some feasible solutions for agricultural tasks, which are affordable in terms of economic concepts, especially for lower-income societies. In addition, the implementation of cost-benefit ergonomic solutions can be done by related governmental bodies, large scale agricultural firms, and employers. Also, as this review shows, the ergonomic and occupational health studies in agriculture have been conducted in both developed and developing countries; hence, a global pledge should be defined to change the existing conditions to safer ones. Under this condition, if some of the related worldwide organization, such as the World Health Organization (WHO), International Labor Organization (ILO), World Bank (WB), Food and Agriculture Organization (FAO), and also related NGOs, define a common global project about occupational health interventions in agriculture, the condition of farmers will be modified. In this respect, the effective participation and cooperation of ergonomists is essential. Indeed for ergonomic intervention through design, and the development of a practical new task analysis method, some concurrent activities should be undertaken. We are recommending the involvement of ergonomics in agriculture through using step diagram model (ErgoAgro Model).

This participatory ergonomics based model covers various levels, such as International Organizations (i.e. WHO, ILO, FAO) in the first step, NGOs and related research centers in the second step, applied ergonomic studies in the third step, while in the fourth step, there are two parts – hand tool design and also the development of a new related and specified ergonomic task analysis method. Ultimately, these four levels, which are based on a participatory ergonomics approach, will lead to occupational health promotion in agricultural work.

**Figure 2: Recommendation model for Ergonomics in Agriculture (ErgoArgo Model)**



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Figure 1. Section of articles from different search sites