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The Reality of Ergonomic Design in the Agricultural Field: A Field Study at the Abdelkader Menkar Farm, El Oued Province

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Abstract:

This study is an attempt to uncover the reality of ergonomic design in the agricultural field in El Oued Province. It follows the descriptive exploratory method, relying on a questionnaire that includes sections reflecting the key indicators of the availability of ergonomic design. This includes the design of machinery and its adaptation to the worker's capabilities, as well as the design of health prevention programs to avoid accidents.

Keywords: Ergonomic design, Agricultural field, Eloued

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Introduction

The agricultural sector in Algeria is among the most important of the various economic sectors, and the country has made significant efforts to optimize its utilization. The substantial importance of this sector to the national economy is evident through its contribution to the Gross Domestic Product (GDP), its role in providing employment opportunities for a large portion of the population, especially in rural areas, and its contribution to earning foreign currency, capital formation, and the development of the industrial sector due to their reciprocal relationship. Thus, the agricultural sector holds a leading position in terms of importance among other sectors. The agricultural output accurately reflects the sector's contribution to the Gross Domestic Product (GDP), both in terms of quantity and the value of agricultural production. The sector has seen

significant growth between 2005 and 2013, with output increasing from 647 billion DZD to 1,627.18 billion DZD, representing a 60.23% increase, while the GDP grew by 54.61%, indicating that the growth in agricultural output exceeded that of the GDP. This is also attributed to the decline in revenue from the hydrocarbons sector, which is the largest contributor to the GDP, due to the drop in oil prices to below \$50 per barrel. The share of agricultural output in the total GDP was 8.60% in 2005, rising to 9.82% in 2013—a relatively low figure compared to the targets set in the National Agricultural Development Plan and the Agricultural and Rural Renewal Program. Despite the importance of the agricultural sector and its role in determining the extent of agriculture's contribution to the GDP compared to other sectors, the added value increased across all economic sectors from 2005 to 2013. The hydrocarbons sector ranked first, followed by the services sector, then the construction and public works sector in third place, with the agricultural sector in fourth, and the industrial sector coming last. The agricultural sector showed continuous growth from year to year, with its share of the GDP rising from 9.03% in 2005 to 11.56% in 2009, before slightly declining to 10.48% in 2011. However, this decrease did not coincide with a reduction in production; on the contrary, production reached 1,183.2 billion DZD, representing a 14.19% increase compared to 2010. The sector's share rose again in 2013 to 12.70%.

The workforce is the primary driver of agriculture and the production process as a whole, and Algeria heavily relies on labor in agriculture. However, this labor force is always influenced by the broader economic policies in place. Agricultural labor is most concentrated in coastal and steppe regions, accounting for 32.24%, followed by highlands regions at 29.16%, with mountainous and southern regions contributing 21.38% and 17.21%, respectively. This distribution is due to the concentration of agricultural activities in the northern regions, despite the extensive agricultural projects planned in the south by development programs. The number of workers in the agricultural sector was 2,234,915 in 2005, fluctuating until 2009, when the workforce was 2,244,148, and continuing to rise to 2,528,972 in 2013. This increase is attributed to the resources and care given to the sector by development programs. Nevertheless, this is still a lower percentage compared to other sectors (Jaber, 2018, p. 63).

The agricultural sector faces increasing competitive challenges in the coming decades, particularly due to rural-to-urban migration. The advancement of science and technology is exerting growing pressure on countries to modernize agricultural practices, aligning them with global developments, especially in agricultural techniques. These practices must be adapted to new contexts to be effective, and this depends on the ability of human resources to adapt to the changes they face in the agricultural environment.

Human resource development is a key factor in the success of agricultural development in general, and in the production, processing, and distribution of crops and food products in particular. Without qualified human resources, it is impossible to produce specialized and high-quality agricultural products, even if all other key factors such as land and water are available. Therefore, agricultural education and training play an essential role. In fact, agricultural education and training should be an integral part of any agricultural development effort (WILLIAM, 1995).

The agricultural sector in Algeria has seen significant growth, particularly in the El Oued region, which has experienced a "dynamism since the 1990s until today." This noticeable development is reflected in the presence of 1,240,000 palm trees, 1,605,320 quintals of field crops, and 1,605,320 hectares of agricultural land (Saifi, 2015, p. 52). This large sector employs over 5,000 workers. Agricultural workers are exposed to a wide variety of hazards. Countries address these hazards through laws, regulations, or standards, each covering a specific topic (e.g., farm buildings, tractors, pesticides, and woodworking machines) (Ministry of Health, 2001, p. 20). The demand for agricultural labor fluctuates with the seasons, reflecting on the nature of the workforce. Working hours are long during planting and harvesting, with shorter hours at other times. Workers often start at dawn and work until sunset. Payment systems exacerbate this situation, as wages are low, and many temporary or seasonal workers receive partial pay based on piecework—such as per kilogram of harvested crops, weeds, or hectare sprayed or planted. There is a strong financial incentive for them to extend their working hours to maximize earnings. Much agricultural work inherently requires physical strength, involving long periods of standing, bending, and performing repetitive movements in uncomfortable postures. This increases the risk of accidents due to fatigue, poor tool design, difficult terrain, exposure to weather conditions, and poor general health. Even when technological change has reduced the physical toil of agricultural work, it has introduced new risks, particularly those associated with the use of advanced machinery and the intensive use of chemicals, often without appropriate safety measures, information, and training. Consequently, the levels of fatal and serious accidents and illnesses remain high. Yet, agricultural workers are among the least protected when it comes to accessing healthcare, workers' compensation, and long-term insurance against disability and occupational accidents (Peter, 2007).

Given the vast number of agricultural workers worldwide, ergonomic technologies have been developed, implemented, and evaluated as a means to mitigate various accidents. These interventions aim to assist farmworkers by improving the workplace and tools, with small changes often translating into significant differences in the number of reported accidents, as well as temporary rest periods. The intervention for these improvements is carried out through what is known as human engineering.

Human engineering is a versatile and interdisciplinary field that involves identifying risk factors related to all diseases, determining their main causes, and developing, implementing, and evaluating interventions in machinery and work methods to create a comfortable work environment (Benos et al., 2020). Human engineering aims to understand human physical and cognitive capabilities to improve interaction with surrounding environments and systems. It provides essential guidelines that positively impact performance at a high level of safety and efficiency (Al-Lami, 2015, p. 204). Additionally, human engineering is a multidisciplinary science that seeks to best align the function with the worker, focusing on the design and arrangement of machinery so that workers can use them easily and safely. It encompasses branches such as cognitive and physical human engineering. The intervention of human engineering is not only to identify risk factors but also to offer practical ways to prevent these risks. Most farmers are exposed to various occupational hazards (Naeini et al., 2014).

Tools and the work environment are sources of many physical, chemical, biological, psychological, and social hazards, which can negatively impact a worker's physical and mental health and be the

cause of work-related injuries. These hazards may also contribute to or exacerbate work-related illnesses or aggravate other non-work-related diseases (Kahlouch, 2014, p. 16). Poor workplace and tool design can cause psychological discomfort and physical fatigue, which are harmful in the long term. Therefore, anthropometric data are essential for designing safe, comfortable, and efficient machines, tools, and workplaces. The first anthropometric studies began in the 1940s. In developing countries like Algeria, where there were about 7 million farmers in 1998, there is a need for anthropometric data for these farmers for various purposes, primarily for the design or redesign of agricultural equipment, workplaces, tools, and clothing to ensure their effective use with the safety and comfort of users in mind (Mokdad, 2002).

Based on this, the current study aims to answer the following question: What is the reality of ergonomic design in the agricultural field in the El Oued province? The following sub-questions arise:

- Are machines designed and adapted to the capabilities and capacities of the workers?
- Are health prevention programs designed to avoid accidents?

2- Importance of the Study:

The key points that encapsulate the significance of the current study can be summarized as follows:

- The study aims to provide a comprehensive information base on machine design, adapting these machines to the capabilities and capacities of workers on farms, and designing health prevention programs to avoid accidents and their impact on both humans and productivity.
- This study fills a significant gap in the field of occupational research, particularly given the scarcity of studies focusing on ergonomic design's influence within the agricultural sector.
- The findings of this research can be employed to develop solutions and strategies that enhance ergonomic design in the agricultural field, which, in turn, positively impacts the overall agricultural process.

3- Objectives of the Study:

The importance of the topic under investigation in this study lies in revealing the reality of ergonomic design in the agricultural sector in the Wilaya of El Oued. This is a critical topic in the field of occupational health and safety, particularly given the importance of the workforce in the agricultural sector.

4- Definition of Ergonomics:

The necessity for a deep understanding of the fundamental terms related to ergonomics arises from varying perspectives on what this field encompasses and its primary objectives. Although ergonomics aims to achieve a logical and relevant relationship between individuals, machines, and organizations, where it is viewed as a comprehensive system, the nuances in current terminology necessitate an overview of their definitions (Boatac & Cirjaliu, 2015, p. 55).

The terms "human engineering" and "ergonomics" are essentially synonymous. Human engineering, or ergonomics, focuses on the alignment between the user, equipment, and their environments, taking into account the user's capabilities and limitations to ensure that tasks, functions, information, and environments fit each user. Understanding the objectives of human engineering interventions creates the proper context for improvements and their integration into daily life. Moreover, organizational culture is a key aspect that must be considered when analyzing the setup of systems and processes from an ergonomic perspective (Gani et al., 2018).

Zunjic (2017) defines human engineering as an interdisciplinary science aimed at studying the effects of work tools, work conditions, and work stages, as well as their products on individuals from psychological, physiological, anatomical, biomechanical, social, organizational, and physical perspectives. This is done through the application of quantitative and qualitative research methods, and by adapting the design of the aforementioned elements to individuals, with the aim of improving comfort, safety, efficiency, and satisfaction—all of which are considered during their interaction with individuals.

Raolji et al. (2018) define human engineering as a discipline that is concerned with studying work more specifically, dealing with job design to fit the worker rather than forcing the worker to fit the job. It helps workers adapt to daily tasks, workplaces, tools, and equipment to eliminate various musculoskeletal disorders and environmental factors.

Lee et al. (2014) point out that human engineering comprises three aspects: the physical aspect, which deals with the body's movements during work; the cognitive aspect, which focuses on processes related to memory and perception; and the organizational aspect, which is concerned with improving the social systems of work and its policies. These aspects work together to prevent various worker disorders.

The International Ergonomics Association defines ergonomics as "the science concerned with understanding the interactions between humans and work elements, applying principles, theory, data, and methods to design for human well-being and improved performance" (Lee et al., 2014, p. 457).

Human engineering is a major factor in worker and workplace safety, derived from the Greek term "Ergonomics," which consists of two parts: "Ergon," meaning work, and "nomos," meaning laws. Thus, it refers to the laws of work and involves studying how employees physically and psychologically relate to their work environment (Nicholson, 2010). It is a multidisciplinary field that includes contributions from psychology, engineering, industrial design, graphic design, statistics, operations research, and physical measurements. At its core, it is the study of designing equipment and devices that fit the human body and cognitive abilities. Boatac & Cirjaliu (2015) emphasize that this field's multidisciplinary nature is a defining characteristic, as it can only exist through the participation of various disciplines, such as psychology, engineering, design, medicine, and economics. The multidisciplinary nature is essential for the existence of human engineering.

4/2 The Importance of Human Engineering:

a/ Safety and Health of Human Resources: Investing in human engineering increases worker health and safety, and proper practices reduce workplace injuries. The Occupational Safety and Health Administration (OSHA) reports that these injuries result in the loss of 650,000 workdays annually. Friedman et al. (2012) found that absenteeism due to widespread and costly general health problems, which can be prevented, is common. If a worker performs their job correctly, they are less likely to suffer from fatigue or injuries, reducing absenteeism and insurance claims. Moreover, it reduces indirect costs associated with the failure to apply human engineering in the workplace. When a worker is injured, it incurs many indirect costs, such as paying for the accident and the cost of recording some workers for overtime to cover for absent workers.

b/ Reducing Organizational Costs and Increasing Profits: Effective postures during work increase productivity by reducing the time required to complete daily tasks. As a result, company profits can also increase. In addition to increased productivity, product quality improves. On the other hand, neglecting human engineering can cost organizations a lot of money in both workplace and operational methods. A study by Tompa et al. (2007) found that improving work methods by suggesting certain postures at work helped perform tasks in less time and at a lower cost while improving product quality (Tawfik, 2017 & Mokdad).

4/3 Stages of Research in Human Engineering:

a- The First Stage: Classical Ergonomics: The classical perspective of ergonomics can be referred to as the relational perspective, which focuses on the relationship between humans and machines, primarily concentrating on display means and control tools. The key contributions of the classical perspective include improving the design of interfaces, measurement devices, control buttons, and the arrangement of display panels. The classical perspective's focus extends beyond just input and output functions to the overall design of the work environment, taking into account the arrangement of devices, seats, tables, and machines. However, its effectiveness in field industrial applications is limited due to the classical flaw of any laboratory research, meaning that the artificial nature of laboratory conditions limits the impact of many factors in the phenomenon under study, making it difficult to generalize its results in more complex situations. This puts the researcher in a position of offering general advice and guidance based on artificial laboratory results, as they cannot predict specific outcomes when deviating from the standards or guidelines provided, whether in similar laboratory conditions or different circumstances. In contrast, field practitioners, such as industrialists, inventors, and designers, seek specific answers to existing problems and find the classical approach unconvincing (Mubarki, 2004, pp. 15-16).

b- The Second Stage: Systemic Ergonomics: This approach emerged particularly in the United States during the Cold War in the 1950s as a reaction to the dissatisfaction with the classical view of ergonomics. This systemic approach starts from the early stages of design, passing through the definition of objectives and tasks that, in turn, achieve the ultimate goal of any system, then distributing the system's tasks between individuals and machines. Accordingly, the systemic ergonomics specialist, in addition to designing the relationship between humans, machines, and workplaces, develops and grows the subsystems that comprise the overall system under

consideration. They also oversee the system's process and monitor its stages. Moreover, the systemic ergonomics specialist intervenes in the selection and training process. Comparing systemic and classical ergonomics reveals:

- Collaboration between ergonomics specialists and engineers from the early stages of system development, which reduces the repetition of some high-cost development stages if each party works in isolation.
- One of the main advantages of the systemic approach is the elimination of the causes of conflict between disciplines that prevail in the classical view of ergonomics instead of complementarity between them.

However, this approach did not last long and did not achieve its desired goals due to several challenges, including:

- The lack of precise criteria for task and operation distribution between individuals and machines.
- The ergonomist's intervention in reorganizing and developing existing subsystems, which is seen by field practitioners as a direct threat to human management patterns, thus facing significant resistance. In this phase, human errors are taken into account, as humans are responsible for the system's failure since they are both the creators and users of machines (Mubarki, 2004, p. 17).

c- The Third Stage: Error Ergonomics: Error ergonomics can simply be described as errors committed by workers. Human error is an important concept in human engineering, but it becomes more complex as workers make mistakes. The reason behind committing errors is crucial. There is a belief that almost all human errors are related to design deficiencies because good design should consider human behavior and design for these possibilities. On the other hand, some believe that people make mistakes regardless of what is provided to them. Human error includes:

- Not performing or omitting a task
- Performing the task incorrectly
- Performing an additional or unnecessary task
- Performing tasks out of sequence
- Not performing the task within the specified time frame
- Inadequate response to emergencies (Adams, 2018).

4/4 Areas of Human Engineering Intervention:

a- Physical Ergonomics: Physical ergonomics concerns the anatomical, anthropometric, physiological, and biomechanical characteristics of the human body during physical activities. It includes the postures workers adopt while performing their tasks (Falzon, 2004).

b- Organizational Ergonomics: This type of ergonomics focuses on workshop organization, i.e., the distance between each machine and the size of the workshop itself, the regular movement of workers from one machine to another, and noise levels in the workplace.

c- Cognitive Ergonomics: Cognitive ergonomics concerns mental processes such as perception, memory, reasoning, and motor responses as they affect interactions between humans and other elements of a system (Stanton, 2014).

5- Methodology and Tools:

5/1- Study Methodology:

The current study employed the descriptive exploratory methodology, which is suitable for the nature of this research.

5/2- Temporal and Spatial Boundaries:

This study was conducted at the Manqur Abdelkader Farm, located in the municipality of Hassani Abdelkarim in El Oued province. The farm spans over 670,000.00 m² and includes facilities such as a poultry shed, a cattle shed, over 300 palm trees, various fruit trees, and large areas designated for the cultivation of potatoes, tomatoes, and other crops. The study was carried out in March 2022.

5/3- Study Sample:

The sample for the current study consisted of 52 male workers at the Manqur Abdelkader Farm, with the gender distribution attributed to the nature of the work.

5/4- Study Instruments:

After reviewing a number of previous studies and the tools they employed, the researcher decided to use a portion of a questionnaire designed by Ajjal Masouda (2021) in her study on the reality of ergonomic design within Algerian institutions—a field study conducted at a cable manufacturing company in Biskra city. The questionnaire focuses on two main dimensions:

- **First Dimension:** The design of machinery and its adaptation to the workers' capabilities, encompassing 19 items (01-19).
- **Second Dimension:** The design of health prevention programs to avoid accidents, also comprising 19 items (20-38).

The psychometric properties of the questionnaire were verified (reliability through split-half reliability, and validity through expert judgment).

The scale includes both positive and negative statements, with responses recorded using a three-point Likert scale. The response options and their corresponding scores for positive items were as follows: (Yes/Don't know/No), scored as (0/1/2) respectively. For negative items, the response options were: (No/Don't know/Yes), scored as (2/1/0) respectively. The following table illustrates the positive and negative statements:

Table (01) presents the positive and negative statements of the scale.

Statements	Numbers	Count
Negative items	36. 35. 33. 19. 18. 16. 15. 9	08
Positive items	38، 34 ، 32 إلى 20 ، 17 ، 14 إلى 10 ، 08 إلى 01 من	30

The total score of the questionnaire ranges between 0 and 76, where a score closer to 76 indicates adherence to ergonomic considerations, while a score lower than 38 suggests a lack of adherence to ergonomic design principles.

5/5- Statistical Processing:

The analysis relied on calculating percentages and arithmetic means after translating the responses of the sample members on the questionnaire into scores distributed across each of its dimensions.

6- Presentation and Discussion of Results:

After entering the results into the SPSS program, we obtained the outcomes presented in the following tables:

Table (02) shows the arithmetic mean and percentage for each dimension.

	Percentage	Arithmetic Mean	Total
Dimension 1: Machine Design and Adapting It to Worker Capabilities	% 29.30	11.13	579
Dimension 2: Designing Health Prevention Programs to Avoid Accidents	% 34	12.92	672
Overall Survey	% 31.65	24.05	1251

From the table, we observe that the arithmetic mean for the first dimension, which concerns the design of machines and adapting them to worker capabilities, is 11.23. This value is significantly lower than the survey's overall arithmetic mean of 19. This indicates a lack of attention to adapting machine design to worker capabilities and a lack of policies to address this. There is also a noted indifference from officials in this area, and even the term "ergonomics" is not known to workers and supervisors.

As for the second dimension, which deals with designing health prevention programs to avoid accidents, the arithmetic mean is 12.92. This is also much lower than the overall mean of 19,

suggesting a lack of focus on occupational safety programs. Despite working in environments exposed to high levels of sunlight and noise, workers show little concern for safety equipment. When discussing this with supervisors, they often claim that workers do not use the provided equipment.

The results confirm the lack of attention to ergonomic design in the agricultural sector, both in terms of machine design and adapting it to worker capabilities and designing prevention programs. This is despite the poor working conditions in such environments, as confirmed by the study of Saadani and Issadi (2021), which showed that all centers experience high levels of noise and temperature exceeding international standards for suitable working conditions.

Recommendations and Suggestions:

- Focus on health and safety programs as an integral part of daily work routines for workers.
- Encourage ongoing research in occupational health and safety and emergency response programs.
- Promote research in ergonomic design of equipment and its adaptation to workers' capabilities and potential.

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